



Mental Health and Well-being in Animals

3rd Edition

Edited by Franklin D. McMillan





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Franklin D. McMillan

College of Veterinary Medicine, The Ohio State University, Columbus, Ohio, USA

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Contents

List of Contributors vii

Part 1 Foundational Issues of Animal Mental Health and Well-being 1

1. Making Sense of the Terminology for the Good Life 3
Franklin D. McMillan and James W. Yeates

2. The Philosophical and Biological Evolution of Feelings in Well-being 17
Ian J.H. Duncan

3. The Relationship Between Mental and Physical Health 30
Melissa Bain and C.A. Tony Buffington

4. Nutrition in Companion Animal Mental Health 50
Donna M. Raditic

Part 2 The Pleasant Experiences: Mental Wellness 63

5. Happiness and Personality in Animals 65
Lauren M. Robinson and Alexander Weiss

6. The What and Why of Fun in Animals 79
Richard W. Byrne

7. Quality of Life of Animals in Veterinary Medical Practice 84
James W. Yeates

8. The Mental Health and Well-being Benefits of Personal Control in Animals 101
Franklin D. McMillan

9. The Mental Health and Well-being Benefits of Social Relationships, Social Support, and Social Buffering in Animals 118
Franklin D. McMillan

10. Fostering Mental and Behavioral Wellness During Upbringing and Throughout Life 135
Jessica Lockhart, Daniel Q. Estep, and Suzanne Hetts

Part 3 The Unpleasant Experiences: Distress, Suffering, and Mental Illness 153

11. Distress and Suffering: On the Nature of the Extremes of Unpleasant Experience 155
Franklin D. McMillan

12. Psychological Trauma and Posttraumatic Psychopathology in Animals 181
Franklin D. McMillan

13. Psychological Resilience in Animals – Focus on Dogs 213
Katriina Tiira

14. Emotional Disorders and Problem Behavior: A Psychobiological Perspective with Implications for Diagnosis and Humane Treatment 224
Daniel S. Mills

Part 4 Mental Health Issues in Special Populations 241

15. Cognitive and Emotional Disorders in the Aging Pet 243
Margaret Gruen, Jacqueline Wilhelmy, and Gary Landsberg

16. Promoting a Good Life for Farmed Animals 260
Siobhan Mullan

17. Mental Health Issues in the Horse 279
Daniel S. Mills, Sophie S. Hall, and Claire Ricci-Bonot

18. Behavioral Health and Mental Well-being of Sheltered Animals 294
Victoria A. Cussen and Pamela J. Reid

19. From Fish to Mice to Monkeys in Research: Challenges and Opportunities for Mental Well-being 308
Carine E. Serageldine, Amy Robinson-Junker, Gina Alvino, and Larry Carbone

20. Psychological Well-being of Animals in Zoos and Aquariums 323
Stephanie Allard, David Shepherdson, and Kathy Carlstead

21. Mental Health Issues in Captive Psittacine Birds 337
Lynne Seibert

22. Mental Health and Well-being in Reptiles 350
Clifford Warwick

Part 5 Assessment and Management of Emotional Distress and Disorders 367

23. Assessing Affective States in Animals 369
Michael Mendl and Elizabeth S. Paul

24. The Importance and Intended Use of the Mental State Domain in the Five Domains Model 387
Kat Littlewood, Nikki Kells, Ngaio Beausoleil, and David Mellor

25. Psychological Trauma as a Form of Animal Cruelty: Advancing the Use of Scientific Evidence Under the Law 403
Pamela J. Reid, Jennifer Chin, and Victoria A. Cussen

26. Treatment Options for Emotional Distress in Animals 423
Karen van Haaften

Index 439

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Part 1 Foundational Issues of Animal Mental Health and Well-being

1 Making Sense of the Terminology for the Good Life

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1.1 Introduction

Suppose you were given the task of looking at one nonhuman animal (hereafter animal) and measuring that animal's welfare, well-being, quality of life (QOL), and happiness. But time and funding constraints allow you to measure only one of these. If you wanted that animal to have the best life, would any of the four concepts be the best one to look at? If you pick any one of the four, would there be anything important to the animal that you would miss by not being able to measure the others?

An individual's judgment of how their own life is faring can vary widely in its cognitive complexity. We aren't certain whether and how such judgments are made by different animals, or by humans – particularly those lacking verbal or other behavioral capacities to convey their thoughts. For many, it may be that such judgments consist simply of feelings based on time frames as short as each moment, or possibly based on the animal's experiences over several hours or even days prior to the judgment. At the other end of the cognitive spectrum, judgments of how one's life is faring can involve not just feeling states but also complex cognitive appraisals (e.g., comparisons with others, a sense of meaning or purpose in one's life, and an appreciation of personal accomplishments) and incorporate an extensive time frame dating back decades and a vision forward to one's life goals and overall life narrative. Furthermore, in terms of complexity of *emotional* processing, some animals might experience relatively simple feelings of momentary enjoyment and suffering, while others' assessments may be based, at least partly, on more complex emotions such as relief, hope, jealousy, guilt, and shame.

We are far from being able to determine where individual humans and animals fall on these scales of complexity in their evaluations of how things are going for them, but it seems likely that all conscious beings have some conceptualization of judging how their lives are faring – by affective and cognitive processes – as going well or not so well, whether the life being self-assessed consists of only this moment or the last several years. For example, Kahneman and Riis (2005) suggested that a measure of momentary well-being in humans could consist of asking the person to indicate whether they feel impatient for their current situation to end, or would prefer for it to continue. When this measure is repeated over a period of time, the average summing of the momentary preferences for continuing or stopping 'identifies well-being with the extent to which individuals live their lives in a state of wishing for the present to extend, as against wishing they were somewhere else – or not caring one way or the other'. Furthermore, they regard the information obtained by a single assessment as different than that obtained by average multiple assessments over time. Behavioral research, in particular preference and aversion studies, has indicated that the capacity to exhibit a desire for one's current situation to continue or end is observed in a wide range of animal species (Kirkden and Pajor, 2006).

How an individual perceives his or her own life to be faring, on a scale of good to bad, is currently described by an indistinct and confusing number of terms. In the human and animal literature alike, limited agreement has been reached about the meaning of *well-being*, *welfare*, *quality of life*, *happiness*, and *subjective well-being (SWB)* (Novak

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and Suomi, 1988; Nordenfelt, 2006). While all of these concepts refer in some way to how much one likes the life they are leading, at present authors frequently – but in different ways – equate or differentiate terms, use terms interchangeably, and define terms by using other similar ill-defined terms. Different studies often use the same terms to refer to different phenomena or different terms to refer to the same or very similar phenomena. Factors as immaterial as geographical preferences contribute to the confusion, as, for instance, in the animal literature where 'welfare' is the European term for the North American 'well-being' (Jones, 2004; Nordenfelt, 2006). Moreover, certain languages may not contain terms for concepts that bear different terms in other languages (e.g., French uses *bien-être* with no obvious equivalent for 'welfare').

To illustrate the terminology problem, Table 1.1 presents reference citations from the animal literature in which different terms have been equated (stated explicitly as equals or used interchangeably as synonyms). The human literature is equally if not more problematic while also including additional terms such as *emotional well-being* (Diener and Lucas, 2000) and *life satisfaction* (Lyubomirsky *et al*., 2005).

The first challenge in scrutinizing this field is deciding on a term to use to refer collectively to these similar concepts – that is, to give a name to the overall topic under discussion. To date no single

Table 1.1. Terms equated (explicitly or used as synonyms) in the animal literature.

	Well-being	Subjective well-being	Welfare	Quality of life
Subjective well-being	Boissy *et al*., 2007			
Welfare	Appleby and Sandøe, 2002 Christiansen and Forkman, 2007 DeGrazia, 1998 Fraser and Weary, 2004 Hurnik *et al*., 1995 Jones, 2004 Mason, 1991 Mench, 1998 Scott *et al*., 2007 Stafford, 2006 Wojciechowska and Hewson, 2005	Nordenfelt, 2006 Robinson *et al*., 2017 Weiss *et al*., 2009 Parry-Howells *et al*., 2023		
Quality of life	Appleby and Sandøe, 2002 Boissy *et al*., 2007 Christiansen and Forkman, 2007 DeGrazia, 1998 Fraser and Weary, 2004 Hurnik *et al*., 1995 Mench, 1998 Nordenfelt, 2006 Sandøe, 1999 Stafford, 2006 Wojciechowska and Hewson, 2005	Boissy *et al*., 2007 Nordenfelt, 2006	Appleby and Sandøe, 2002 Bracke, 2007 Broom, 2007 Christiansen and Forkman, 2007 DeGrazia, 1998 Fraser and Weary, 2004 Green and Mellor, 2011 Hurnik *et al*., 1995 Mench, 1998 Nordenfelt, 2006 Sandøe, 1999 Wojciechowska and Hewson, 2005	
Happiness		Robinson *et al*., 2016 Robinson *et al*., 2017 Weiss *et al*., 2009 Weiss *et al*., 2011	Nordenfelt, 2006 Robinson *et al*., 2016 Robinson *et al*., 2017 Webb *et al*., 2019 Weiss *et al*., 2009	Belshaw, 2018 Nordenfelt, 2006

agreed-upon term (or conceptualization) has emerged to describe the different valuations individuals (human and nonhuman) make regarding their lives, the events happening to them, their bodies and minds, and the circumstances in which they live – in short, how much one views his/her own life as 'the good life' (Diener, 2006; Yeates, 2017). For the purposes of the present chapter this umbrella term will be Well-Being[1] – capitalized to distinguish it from the use of well-being as an individual concept – and 'Well-Being concepts' will refer collectively to the terms welfare, well-being, QOL, happiness, and SWB.

As we will see, some interpretative discrepancies among these terms are difficult to reconcile. One of the most important reasons for this challenge is rooted in a fundamental difference regarding what the terms are referring to. The Well-Being concepts may be about: (i) the quality of one's *life conditions*, or (ii) the quality of one's *life experiences*. The former includes *physical health*, *biological functioning*, and *environmental factors*; the latter includes only conscious experiences. The two can be strongly linked, as when an individual is being chased by a predator, or they may be uncoupled from one another, as when an individual has an early, asymptomatic cancer. Adaptation can also disconnect life conditions and life experiences, such as after one loses their vision or the use of one or more limbs; in these cases, disability causes permanent functional impairment but after adaptation the individual often regains very high levels of Well-Being with positive life experiences (humans: Duggan and Dijkers, 2001; Diener *et al*., 2006; animals: Bauer *et al*., 1992). We will return to this conundrum later.

1.2 Similarities and Differences Between Well-Being Concepts in Animals

On the basis of their usage in the scientific literature, the different Well-Being concepts can be found to have extensive similarities as well as some dissimilarities. This approach provides an important starting point in understanding the entanglement that has evolved between these terms. However, no matter how meticulous we approach this task the terms will not come out at the other end as clearly the same nor clearly distinct. We might think of this as problematic, inevitable or, perhaps, even valuable as a more pluralistic and inclusive approach to complex phenomena and ideas. The following discussion will focus primarily on the animal literature while including relevant information from human literature where it can help provide some clarification.

1.2.1 Common attributes among Well-Being concepts in animals

Represents the individual's perspective and perception

The first feature shared broadly among Well-Being concepts is that they are, at the minimum, based on a view from within, of how the individual perceives and appraises aspects of his/her own life. This means it is not something *given to* the individual (Broom and Molento, 2004). One could bestow the same exact objectively described living conditions to ten different humans or animals – e.g., shelter, food, social companionship, stimulation/entertainment, and even health – and because of vast differences in preferences, likes, dislikes, etc., the result could be ten different levels of Well-Being, from very low to very high. The individual's perspective and perception has been described in the literature in animals for welfare (Sandem *et al*., 2002; Bracke, 2007; Green and Mellor, 2011; Arndt *et al*., 2022) and QOL (Bracke, 2007; Scott *et al*., 2007; Taylor and Mills, 2007), and in humans for QOL (Diener, 2006; Peterson, 2006; Scott *et al*., 2007; Taylor and Mills, 2007; Pierce and Shanan, 2023), well-being (Kahneman and Riis, 2005), and SWB (Diener, 2006; Peterson, 2006).

Based on the same set of philosophical frameworks

In discussions of definitions and principles of Well-Being concepts in animals, welfare, well-being, and QOL often share the same (or at least seemingly similar) philosophical bases. One approach has been to categorize welfare definitions (Barnard and Hurst, 1996; Duncan and Fraser, 1997) or concepts (Appleby and Stokes, 2008) into three types: (i) functioning- and health-based; (ii) feelings-based; and (iii) natural living-based. Another approach has been to separate QOL (Duncan and Fraser, 1997; Sandøe, 1999; Taylor and Mills, 2007), well-being (Appleby and Sandøe, 2002), and welfare (Appleby and Sandøe, 2002) into three theoretical foundations, the first one being solely

objective, the second one containing both objective and subjective elements, and the third one solely subjective, respectively: (i) *perfectionism and other forms of objective list theories*, which hold that there are things that are objectively good for an individual whether or not he/she realizes it and focuses on objectively measurable factors, such as health, biological functioning, basic resources, and living conditions; (ii) *desire or preference satisfaction*, which holds that satisfying one's preferences or desires is what improves one's Well-Being; and (iii) *hedonism*, in which Well-Being is based on pleasant and unpleasant affective states.

Based on the primacy of affect, and specifically on a balance of pleasant versus unpleasant affect

Notwithstanding some of the philosophical approaches above that do not focus on feelings either solely (e.g., objective list theory) or partially (e.g., desire or preference satisfaction), a large literature on Well-Being concepts emphasizes the primacy (though not necessarily exclusivity; Broom and Molento, 2004) of affective states in animal Well-Being. Reimert *et al*. (2023) write that the very need for a concept of animal welfare 'arises from animal sentience, i.e. one's ability to feel pain and pleasure, to experience pleasant and unpleasant "affective" states'. This emphasis was most prominently advanced in 1990 by Dawkins in her highly influential paper, 'From an animal's point of view: motivation, fitness, and animal welfare' (Dawkins, 1990), in which the first sentence reads, 'Let us not mince words: Animal welfare involves the subjective feelings of animals.'

More specifically, it has been suggested by many authors that it is the balance of pleasant feelings over unpleasant that corresponds to the level of welfare (Dawkins, 1990; Mench, 1998; Sandem *et al*., 2002; King and Landau, 2003; Broom, 2007; Robinson *et al*., 2016; Arndt *et al*., 2022; Reimert *et al*., 2023), QOL (Mench, 1998; Broom, 2007; Taylor and Mills, 2007; Green and Mellor, 2011; Yeates, 2011), well-being (Mench, 1998), SWB (King and Landau, 2003; Robinson *et al*., 2016), and happiness (King and Landau, 2003; Robinson *et al*., 2016). The *affect balance model* was first proposed by Bradburn (1969) to explain psychological well-being in humans. Since then, the model has been applied to other Well-Being concepts in humans, including most recently to happiness. Lyubomirsky *et al.* (2005) concluded that 'happiness is best regarded as a state in which people feel a preponderance of positive emotions most of the time'. Happy people, said the researchers, do not experience positive affect 100 percent of the time; rather, they also experience infrequent – though not absent – negative emotions, such as sadness, anxiety, and anger. Current evidence suggests that in both animals and humans, an increase in the positivity of the affect balance is linked to increases in all Well-Being concepts (Fig. 1.1).

A bipolar continuum phenomenon

The nature of biological and psychological phenomena may be dichotomous or a continuum. The dichotomous structure works as an all-or-nothing process using a threshold above which the individual 'has' the condition, whereas for the continuum the individual experiences progressive degrees of the condition. It is not uncommon to encounter language in the literature that implies Well-Being concepts are threshold phenomena, such as 'to have (or not have) quality of life', 'for welfare to exist', 'to reach quality of life', and 'preserving or ensuring well-being'. However, because there now appears to be a consensus that all Well-Being concepts exist on a continuum (Broom and Molento,

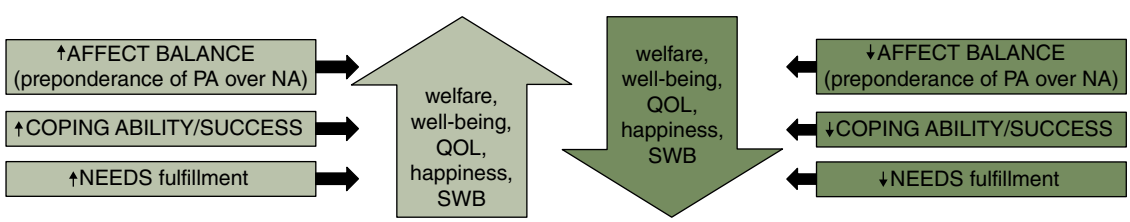


Fig. 1.1. Effects on Well-Being. Changes in these factors will cause all Well-Being concepts to vary in the same direction: When any of the factors is increased, all Well-Being concepts increase; when any are decreased, Well-Being concepts decrease. PA, positive affect; NA, negative affect; QOL, quality of life; SWB, subjective well-being.

2004; Nordenfelt, 2006; Broom, 2007), it appears the language implying Well-Being concepts to be a threshold phenomenon is likely nothing more than a bit of careless locution.

But why, then, would it be correct to say that one can 'achieve' happiness? A key problem involved with the continuum-threshold question becomes evident when the issue of polarity is added in. If it is agreed that Well-Being concepts are continuum phenomena then it needs to be clarified whether the continuum is unipolar (all-positive or all-negative) or bipolar (both positive and negative). Empirically as well as intuitively, judgments of one's own life can range from very good to very poor (Galtung, 2005; Diener, 2006; Broom, 2007), constituting a bipolar nature. The problem is one of terminology, and the clearest example is the term happiness (see Fig. 1.2). The word happiness refers to a positive state, so the only way to conceive a bipolar continuum for the happiness concept is to create a separate term to represent the negative counterpart of happiness, i.e., unhappiness, which includes such affects as sadness, misery, and the like. Less commonly, the same has occurred in the human literature for well-being, where 'ill-being' has been used as the negative counterpart (Galtung, 2005; Diener, 2006; Nordenfelt, 2006). In contrast, welfare has no separate term for the negative side of the continuum and has a history of different emphases. Prior to the 20th century, welfare referred primarily to the positive side of the continuum (Merriam-Webster, 2018), then during the 20th century it reflected more the negative side (Nordenfelt, 2006), and presently it is viewed as balanced between the two sides. The reason at least some of the Well-Being concepts can seem to be both a bipolar continuum (e.g., happiness to unhappiness) and a unipolar threshold phenomenon (e.g., one can 'attain' happiness) can be attributed to the ambiguous terminology.

Coping ability

Coping refers to the animal's ability to lessen the negative psychological impact of a stressful stimulus; the degree of success thereby dictates the level of psychological discomfort experienced. In humans, one proposed definition for well-being is the balance point between an individual's resource pool and the challenges they face (Wassell and Dodge, 2015), although the authors then refined the idea to include happiness as a domain of well-being. In animals, the individual's ability to cope successfully with challenges (internal as well as external) has been linked to welfare (Broom, 1986; Hubrecht, 1995; King and Landau, 2003; Broom, 2007; Green and Mellor, 2011; Robinson *et al*., 2016), QOL (Wojciechowska and Hewson, 2005; Broom, 2007), SWB (King and Landau, 2003), and happiness (King and Landau, 2003). For example, Hubrecht (1995) states that welfare problems arise when coping ability is exceeded. Evidence suggests that Well-Being is promoted by successfully coping with life's problems, not from experiencing no problems that demand coping behavior (Boissy

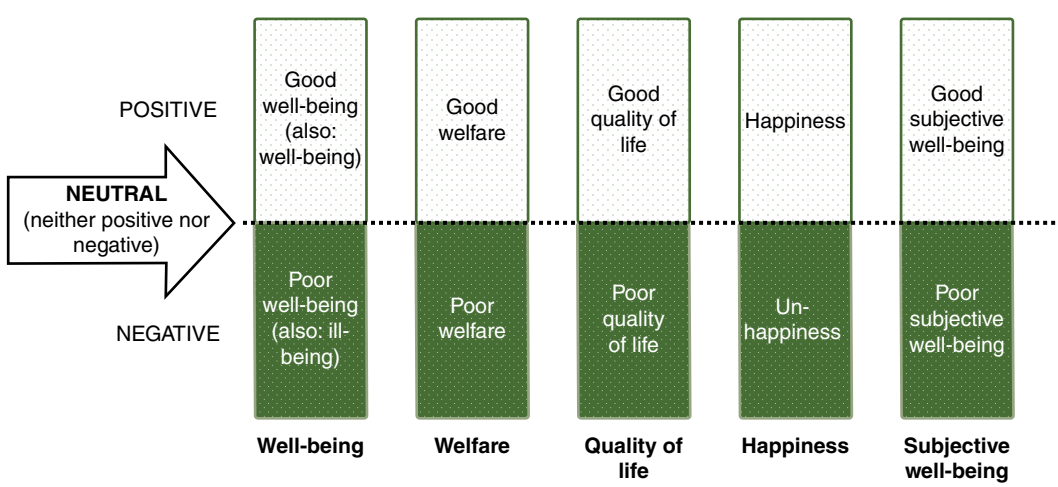


Fig. 1.2. Different terminology for positive and negative aspects of Well-Being states.

et al., 2007). This is consistent with the research mentioned earlier that people who report being the happiest do occasionally experience negative emotions (Lyubomirsky *et al*., 2005).

Coping has been considered so important to Well-Being that some researchers regard it to be the central determinant of Well-Being concepts, such as Broom's (1986) definition that 'the welfare of an animal is its state as regards its attempts to cope with its environment'. As shown in Fig. 1.1, all Well-Being concepts rise and fall with, respectively, improvement and deterioration in the individual's ability to cope (Hubrecht, 1995; King and Landau, 2003; Broom, 2007; Green and Mellor, 2011).

Meeting of needs

Another common feature shared by the range of Well-Being concepts briefly mentioned in the section above on philosophical frameworks is the meeting of needs. Broom (2007) notes the connection between needs and feelings (unpleasant feelings are often associated with unsatisfied needs, whereas pleasant feelings occur when needs are satisfied). He further suggests that when needs are not satisfied, welfare (and QOL, which he considers the same) will be poorer than when they are satisfied (Fig. 1.1). Taylor and Mills (2007) include the fulfillment of health, social, and environmental needs in their definition of QOL.

Methods of measurement

The measurement of Well-Being concepts in humans and animals is very much a work in progress. In animals, many literature reports have described methods for measuring aspects of the various Well-Being concepts: welfare (Mason and Mendl, 1993; Wojciechowska and Hewson, 2005; Broom, 2007; Robinson *et al*., 2017), QOL (see Chapter 7, this volume), SWB (Weiss *et al*., 2011), and happiness (Robinson *et al*., 2017). Importantly, the overlap of these methods across the Well-Being concepts is extensive. Lists of the factors being assessed include physiologic measures (e.g., concentrations of glucocorticoid levels, leukocyte count, and heart and respiratory rates), health parameters, level of physical and social functioning, and behavioral indices (e.g., documentation of abnormal behavior such as stereotypies, subjective mood assessment, preference and motivation testing, operant tests, aversion techniques, cognitive bias testing, consumer demand theory tests, and success in achieving goals). Furthermore, it is widely accepted that for all Well-Being concepts none of these methods of measurement is sufficient by themselves; rather, measurement should be performed using a combination of different methods. In all, the resemblance of assessment methods across Well-Being concepts is such that if one were to be given a description of the factors being measured but not told which Well-Being concept is entailed, it would be exceptionally difficult to deduce which concept is being measured.

General descriptions

While less scientific, general descriptions of 'the good life' (Yeates, 2017) in animals are, in general, equally appropriate for all Well-Being concepts. Consider, for example, the following description of an animal faring well:

> The animal is free from distress most of the time, is in good physical health, exhibits a substantial range of species-typical behaviors, and is able to deal effectively with environmental challenges. There are few, or brief, unpleasant feelings, and a predominance of pleasant feelings.
>
> (modified from McMillan, 2004)

Is it possible to know what Well-Being concept this is describing? As is the case with methods of measurement, this description alone will leave the reader very hard pressed to correctly name the concept being depicted. Numerous additional examples can be found. Consider this edited quotation by Webster *et al*. (2004): 'Our operational definition of animal [blank] is encapsulated by the following minimalist statement: "Fit and Feeling Good".' It seems likely that if a group of animal welfare scientists and veterinarians were asked to fill in the blank, the answers would include a variety of Well-Being concepts. (The actual answer is welfare. The description from McMillan 2004 was for psychological well-being.) Another description is 'high level of biological functioning, freedom from suffering, and positive experiences' (Mench, 1998). When Duncan and Dawkins (1983) reviewed the literature on animal welfare to identify any common threads among the different descriptions, they found that a broad working description of welfare would be one that encompassed the notions of 'the animal in complete mental and physical health, the animal in harmony with its environment,

the animal able to adapt to an artificial environment provided by human beings without suffering, with the animal's feelings, somehow, taken into account'. Similarly, the OIE's (2016) *Terrestrial Animal Health Code* describes an animal as having good welfare if it is 'healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear, and distress'. Based on current knowledge, none of these descriptions for welfare would differ appreciably if used for QOL, well-being, SWB, or happiness. And finally, an increasing number of researchers have suggested that Well-Being concepts can be viewed succinctly as an animal's enjoyment of its life (Reimert *et al*., 2023).

As is now evident, the extensive overlapping of attributes of the main Well-Being concepts of welfare, well-being, QOL, happiness, and SWB strongly suggests that several, if not all, of these concepts are the same phenomena. As such, an argument could be made for thinking of the concepts as interchangeable, even if different terms are favored in different contexts. However, before doing so we should consider potential differences and the potential value of differentiation.

1.2.2 Distinctions between Well-Being concepts

Some distinctive elements have been described in the literature that appear to maintain some difference between the concepts. Some observations regarding the use of Well-Being terms in humans are offered first. Of these, some are differences in *tendencies* rather than strict dichotomous distinctions, but there would be a potential (and, for some, potential appeal) for such differences to be reinforced and demarcated more strongly by more rigid conceptualization and definition.

Distinctions in the human literature

The terms welfare and well-being have been compared in humans. The term 'well-being' in humans typically refers to the subjective experiences of the individual – the overview of how good one's own life is (Nordenfelt, 2006). In contrast, as briefly mentioned earlier, the meaning of 'welfare' in humans has undergone a substantial change in meaning over the past 100 or so years. The term derives from the Middle English phrase *wel faren*, meaning to fare well (Merriam-Webster, 2018). The first known use of the term was in the 14th century, at which time it meant 'the state of doing well especially in respect to good fortune, happiness, well-being, or prosperity' (Merriam-Webster, 2018). While the timing is unclear, at some point a second meaning for welfare arose: aid in the form of money or necessities for those in need. Developments during the 20th century placed increasing emphasis on this second meaning, in particular the establishment of a welfare system in the 1930s in the USA. Since then, welfare has taken a central place in sociological theory, where it is almost universally used as a term referring to social resources such as institutions, financial assistance, housing, food resources, and the like (Nordenfelt, 2006) (with some clear exceptions, such as 'child welfare', which refers to resource provisions but also to the child's physical and psychological well-being). Welfare is now rarely used today in the human healthcare sector (Nordenfelt, 2006). In animals, welfare has fully retained the original meaning of faring well.

At first glance it seems that QOL differs from SWB and happiness in humans, but on closer consideration this appears to be attributable to the separate contexts of their use. Whereas QOL is used predominantly in the health field, SWB and happiness are much more common in the psychological fields (Nordenfelt, 2006). However, any actual distinction between the terms is very difficult to discern. Diener (1984, 2006) has contrasted QOL with SWB (which he equates to happiness) in humans and offers the explanation that QOL usually refers to the desirability of one's life, and often emphasizes external elements of that life, such as environmental factors and income. Accordingly, QOL describes more *the circumstances of* a person's life than the person's *reaction to* those circumstances, and, as a result, appears to be more 'objective'. This is in contrast to SWB, which is based on subjective experience. The problem with this apparent distinction, however, is that SWB/happiness also refers to the desirability of one's life (King and Napa, 1998). Moreover, as Diener (2006) notes, some scholars use a broader definition of QOL, which includes the individual's reactions to the objective life circumstances, further heightening the resemblance of QOL to SWB/happiness. Finally, evidence in humans and animals strongly suggests that QOL cannot be, at least solely, the conditions of one's life. The clearest demonstration of this is the scenario mentioned

earlier that if many different individuals (human or animal) were provided with the same objective life circumstances the result would be a range of levels of QOL. For instance, if the same house, food, human companionship, playtime, and physical health were to be provided to an extremely pampered pet dog, an average middle-class American pet dog, and a starving dog from the streets of El Salvador, we could expect QOL levels of, respectively, low, satisfactory to good, and exceptionally high.

Distinctions in the animal literature

TEMPORALITY A longstanding question surrounding Well-Being concepts involves time, specifically, what duration of an experience – good or bad – is necessary before it can be said that that experience affects the individual's Well-Being? Over what time frame should the affect-balance model calculation be made to be considered most representative of any of the Well-Being concepts? Is an individual's QOL affected by being in fear for five minutes? What about five hours, or five weeks, or five months? Nicol (2011) wrote that, in transporting sheep, the care on loading and unloading will have a major impact on sheep welfare. What about their QOL, or happiness? As Reimert *et al*. (2023) point out with regard to welfare, the time period 'may range from the duration of single and relatively short-term experiences to the entire life of an animal', and the statement they make for welfare applies equally to well-being, QOL, and happiness: 'Most animal welfare scientists would agree that animal welfare involves a certain time component, but what this time component truly is and how it should be included into the concept and assessment of animal welfare remains often unclear.'

Some authors have viewed this question as a source of differentiation between some of the Well-Being concepts. For example, Broom (2007) has written that, 'We do not talk about poor QoL when the experience is of pain or fear for just a few minutes; neither do we refer to better QoL because of a moment of pleasure'. This differs from welfare, says Broom, which applies to momentary as well as long-term experiences. Time, in fact, is to Broom the sole distinguishing feature: 'QoL is welfare, except that it does not refer to short time-scales' (Broom, 2007). Yeates (2011) agrees with this view, stating that QOL, unlike welfare, is explicitly considered *over time*.

But is this a true distinction between Well-Being concepts? Note that in this view the terminology difference refers to the same concept, just different in their duration. This is a distinction without a meaningful difference – what Yeates (2016) has referred to as a 'false distinction'.

PHYSICAL, PSYCHOLOGICAL, OR BOTH (FIG. 1.3) The different Well-Being concepts encompass states of both body and mind (Hewson, 2003; Morton, 2004). However, on closer examination of this notion we can see potential lines emerge between some of the Well-Being concepts. Several researchers have stated that in humans and animals there is a physical well-being (and welfare) and mental well-being (and welfare) (Dawkins, 1998; Webster, 2001; Hewson, 2003; Stafford, 2006). Indeed, it is for this reason that researchers in the human field have preferred the term subjective well-being to welfare – to avoid any confusion with solely physical changes. In contrast, there appear to be no claims that either QOL or happiness have a purely stand-alone physical form. (This becomes much less clear, however, when considering the wide variations in equating the different Well-Being concepts as presented in Table 1.1.) To use a contemporary concept as an analogy, the stand-alone *physical* form of Well-Being would be comparable to using the Five Domains Model without using Domain 5 (see Chapter 24, this volume).

The central point of contention here is the question of whether conscious experience is required for the different Well-Being concepts to apply to an animal. The question as to whether Well-Being can exist, and be altered, without the individual's conscious awareness is not new (Mason and Mendl, 1993; Appleby and Sandøe, 2002; Nordenfelt, 2006; Broom, 2007; Reimert *et al*., 2023). Is a badly injured animal's Well-Being poor even if anesthesia or a comatose state prevent the animal from suffering (Mason and Mendl, 1993) (Fig. 1.4)? Does an animal (or person) with an early and as yet asymptomatic malignant cancer have a diminished Well-Being (Mason and Mendl, 1993; Veit and Browning, 2021; Pierce and Shanan, 2023)?

Some researchers argue that consciousness is not necessary for Well-Being concepts to apply. Broom (2007) says that welfare applies to all – not just sentient – animals. Similarly, Dawkins (2015) argues that consciousness is irrelevant to much of what is done to improve the welfare of animals in zoos, farms, and laboratories, where the focus is on

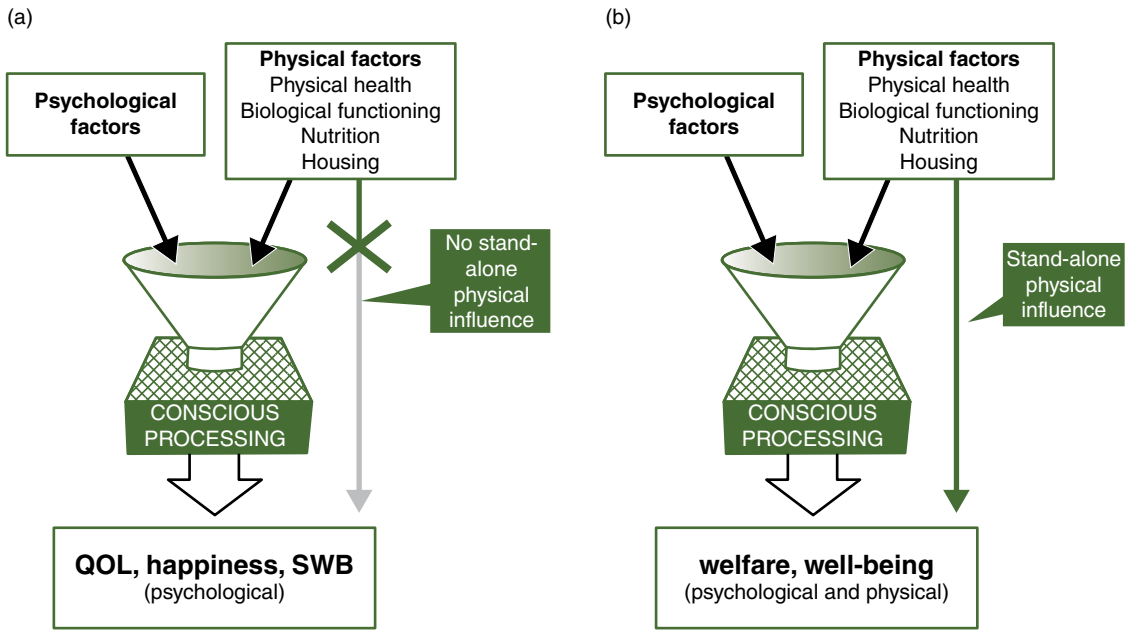


Fig. 1.3. Apparent differences in the routes by which inputs influence quality of life (QOL), happiness, and subjective well-being (SWB) (a) as compared to the routes by which inputs influence well-being and welfare (b). (a) All factors exert their effect through conscious processing. Without consciousness, nothing 'gets through' to alter Well-Being. (b) With a stand-alone physical form, Well-Being can be affected without requiring conscious processing.

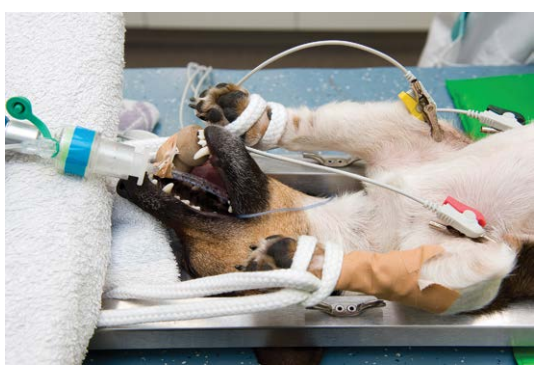


Fig. 1.4. Can this animal's QOL change while under anesthesia? If something very detrimental to the animal's health occurred under anesthesia but the animal died before regaining consciousness, did QOL go down? If during surgery a health problem were corrected (e.g., a brain tumor was removed), when does the animal's QOL increase – when the tumor is removed before regaining consciousness, when consciousness is regained, or only after consciousness is regained and the results show improvement in the animal's life? What if the same questions were asked about well-being, welfare, or happiness? (Image used under license from Shutterstock.com.)

improving the physical health of the animals by changing the conditions in which they live. Other researchers say yes, consciousness is necessary for Well-Being. Some contend that Well-Being concepts are solely about feelings, i.e., conscious experience (Appleby and Sandøe, 2002; Carenzi and Verga, 2009). Others imply that conscious experience is only part of what is important for animals, combining experiential and physical aspects. Examples include Dawkins's (2008) view that welfare is about the animal being healthy and getting what they want, and Webster *et al.*'s (2004) synopsis of animals being fit and feeling good. A disadvantage of this approach is the practicality of knowing (and agreeing) which, when, and how animals are conscious (not to mention the more detailed question of how their situations affect their Well-Being). We might theoretically limit the scope of application of Well-Being concepts, but that does not help us find the dividing lines between animals who can and cannot be said to have Well-Being. Absent a requirement of sentience, Well-Being concepts would seem to apply to corals, plants, bacteria, and arguably non-living systems.

The deciding factor is this: Having stand-alone physical criteria, as is widely claimed for welfare and well-being, means that even in the absence of consciousness the individual's welfare and well-being exist and can increase or decrease (see Fig. 1.3). On the other hand, lacking a stand-alone physical form means that factors related to the physical body exert their effects *on* or *through* conscious experience, and that without consciousness the physical factors are irrelevant as there is no condition of Well-Being (at least at the time when an animal is unconscious) to influence. For example, Reimert *et al*. (2023) wrote that factors such as a comfortable shelter, feed provision, and health 'have an impact on animal welfare only insofar as they impact the affective states of that animal'. Perhaps, based on the above considerations, we might distingush wholly subjective concepts of happiness and QOL from the combined objective–subjective concepts of welfare and well-being. It seems reasonable to see that an injured animal (or person) in a coma has reduced welfare and well-being (both having physical as well as psychological forms), but it is much more difficult to argue that such an individual has a poor QOL or unhappiness (both lacking a purely physical form). (Again, the caveat here is that some authors have equated welfare and/or well-being with QOL; Table 1.1.)

But does this truly distinguish these Well-Being concepts from one another? An answer can be found in the notion raised earlier: Well-Being concepts may be about the quality of one's *life conditions* or one's *life experiences*. Those concepts focusing on the quality of one's life conditions will exist in conscious as well as unconscious animals, whereas the concepts focusing on the quality-of-life experiences will exist only in conscious animals.

PREDISPOSITIONS, RISKS, AND ENDANGERMENT Related to the issue of consciousness and asymptomatic disease is how we should regard the Well-Being effects of predispositions, risks, and endangerment. Consider, for example, an individual with an inherited predisposition to developing a particular disease. Or suppose an individual were to be endangered by a caregiver, such as a parent dangling their infant over the ledge of a 4th floor balcony. Similarly, think of a dog riding unrestrained on the back of a flat-bed truck. In these cases, the individual may be completely unaware of the danger involved, but clearly the risk for that individual being harmed is increased. The question, then, is what happens to this individual's welfare, well-being, QOL, and happiness? Are they equally affected (or unaffected)? For the endangered child, would we say that this child's welfare is impaired, or *potentially* impaired? If the latter, does that mean his welfare is, right now, unaffected and thus no different than a non-endangered child? The point here is not that the questions have no simple answers, but that the questions only make sense for welfare and well-being, and not QOL and happiness. There is no possibility of one's happiness or QOL being lessened by being at risk but not being aware of that risk. In fact, it is entirely possible that the dog riding freely on the back of a truck, although endangered, experiences an *increase* in happiness.

OBJECTIVITY Timmins *et al*. (2007) have written that whereas welfare usually refers to the observable and measurable experiences of an animal, QOL is related to the animal's mental state, which is determined by feelings and emotions. Broom (2007) holds a similar view, suggesting that welfare is more scientifically quantifiable than QOL. It is interesting to note that these views appear to connote the opposite of those of some researchers in the human field, such as Diener's (1984, 2006) position that QOL is more objective than SWB.

1.3 Summary View of the Terminology in Animals

Given the current use of Well-Being terms in the animal literature, there seem to be good reasons for equating welfare and well-being. There are also good reasons for considering QOL to be closely related to welfare and well-being, with the distinguishing point that welfare and well-being do, and QOL does not, have a pure stand-alone physical form as well as a psychological form. Indeed, we might argue that QOL represents the experiential aspects of welfare/well-being.

Happiness (including unhappiness) and SWB have been explicitly equated in the human literature and because their recent entry into the animal literature was based on the human usage, the two terms are considered equals for animals. Because happiness and SWB also lack a stand-alone physical form, they, like QOL, retain a degree of distinction from welfare and well-being. However, in humans and animals, SWB has been equated with

well-being, which creates a logical contradiction with the above summation: since because SWB equals happiness but happiness does not equal welfare, *and* well-being equals welfare, we are led to the conclusion that well-being both is and is not equal to welfare.

There are other ways to examine the comparability of the terms. One is by using the thought experiment that opened this chapter. Another is to see what occurs when one Well-Being term is used in the evaluation of another. For example, one QOL questionnaire popular (though not validated) among US veterinarians is Villalobos's (2004) 'HHHHHMM' scale, in which seven factors – Hurt, Hunger, Hydration, Hygiene, Happiness, Mobility, and More good days than bad – are each scored and then summed to a single score. Consider the factor Happiness. If the animal receives a score for this factor, are any of the other scores necessary? Or does Happiness tell us all we need to know? These types of questions offer informative perspectives and insights as to how the various Well-Being terms compare and contrast.

1.4 Is There a Solution?

The reasons for the confusion in Well-Being terminology cannot be fully explained by conceptual analysis, as they vary in accordance with personal preference, geographical differences in language development, and separate literatures and research. Of particular importance is the differing uses of terms for addressing quality of one's life conditions versus quality of one's life experiences, but other causes may also have contributed to the ambiguity. Is there a solution?

The most obvious solution is to refine the concepts and their definitions in order to distinguish and differentiate the terms (Dodge *et al*., 2012) and then to adhere to those definitions in using the terms. With this aim in mind, the situation at present is not promising. The ideal objective for rectifying the terminology inconsistencies in animals can be seen as two-fold: (i) unify the like concepts under a single term, and (ii) clarify the difference(s) between the unlike terms. Numerous impediments stand in the way of achieving these outcomes. Foremost may be simply the comfort level people feel in using particular terms. There is no obvious reason for one concept to 'claim and defend' a particular conceptual space. Often two terms have equally valid claims. For example, Broom (2007) wrote 'it is generally better to use the term "welfare" rather than "quality of life"…in scientific publications'. However, Taylor and Mills (2007), in the same issue of the same journal, wrote that because of its 'individual-centered approach', QOL may be preferable to welfare. Another challenge is that different terms may simply be used in different contexts, making it even less likely to foresee consistent uses of terms across fields. One example is that, in the field of veterinary medicine, the preferred term for animal Well-Being among companion animal veterinarians (and pet owners) is QOL, whereas for large animal (farm) veterinarians it is welfare. The use of quality of life, for example, is so entrenched in the fields of human as well as companion animal medicine that it would seem unrealistic to expect any receptiveness to the entire field abandoning the term. At the same time, a third challenge is that many people simply do use the terms somewhat interchangeably (e.g., horse owners: Smith *et al*., 2022).

Rather than attempting drastic changes to terminology, a more reasonable goal would be to work toward eliminating the separate literatures that have developed by merging the different Well-Being concepts into a single field – even if a single name cannot (yet) be agreed upon. We can see all the terms as a 'cluster' of ideas with 'family resemblance' within a wider family that includes other such terms as 'health', 'flourishing' (Fowers *et al*., 2023, 2024), and related to others such as 'sustainability' (e.g., Ronen and Kerret, 2020), 'protection', and even 'good' and 'goodness'. Perhaps we should be more relaxed and pluralistic about the terms, focusing instead on the content. Such an inclusive approach might help to bridge silos between disciplines, geographies, and languages, and to include concerns for equality, sustainability, and anthropogenic harms (Mead *et al*., 2021; Yeates, 2024).

Progress can begin with the minimalist step of making certain that any publications on Well-Being topics be assigned the keywords of all current Well-Being terms. This will assure that, at the least, literature searches will capture all the relevant work published under the different names. Authors can then strive to be clear on what they mean by the terms they use, in particular whether the focus is on life conditions, life experiences, or a combination of the two. This does place more responsibility on those comparing data from different studies, but – given the variation in the use of terms (and in assessment domains and methods) – this responsibility

seemed inevitable and well-placed (in that researchers and clinicians should understand what data they are applying).

Can we work with different terms for the same thing, that is, agree to disagree? It looks like, for at least the time being, we will have to.

Note

[1] It is worth pointing out that this choice reflects a North American bias just as the equally suitable choice of 'Welfare' as the umbrella term would reflect a European bias. However, introducing a new term altogether simply adds to the list of overlapping terms, and a key objective is to decrease, not increase, the number of terms used in this area of study.

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2 The Philosophical and Biological Evolution of Feelings in Well-being

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2.1 Introduction

The foundations for feelings to be considered as the basis for animal well-being or welfare were laid in the 19th century. Unfortunately, the development of these foundations was greatly hampered through much of the 20th century due to the rise and popularity of Behaviorism. Once back on track, however, the primacy of feelings for individual welfare has received growing support during the past four decades. This chapter explores how feelings constitute the foundation for mental health in all sentient animals. The role of states of displeasure and suffering, including pain and discomfort, frustration, fear, maternal separation, and various forms of deprivation in reducing well-being are described. States of pleasure are obviously important for animal welfare, but have not been investigated to the same extent as the negative affective states associated with stress and suffering. An understanding of feelings will help us to design optimum environments for animals as well as develop best practices of care.

2.2 Early History

A short consideration of the history of how animals have been dealt with by various moral philosophers sets the scene for how they are regarded today. Much of this early history is taken from Preece (2002). Of the early Greek philosophers, Aristotle (384–322 BC) is the one who made specific reference to animals. He believed that the ability to reason is the highest of all abilities and it is this that sets human beings (actually Greeks!) above all other creatures. Aristotle also introduced the teleological argument of 'things being there for a purpose', e.g., 'the purpose of rain is to water the plants'. From these two ideas, a great hierarchical structure was built in which those with more reason should control those with less, with Gods being superior to men and controlling them, men being superior to women, Greeks being superior to other races, human beings being superior to animals, and so on. According to this structure, human beings had absolute authority over all animals.

This view continued to be held for about 2000 years. In the medieval period, Thomas Aquinas (1224–1274) rediscovered Aristotle's writings and agreed that it was the ability to reason (or rationality) that distinguished human beings from all other animals. However, he gave Aristotle's ideas a Christian twist: he postulated that animals do not have immortal souls. He also claimed that human beings had no direct obligations to animals; however, they might have indirect moral obligations in that people who mistreat animals may: (i) pick up cruel habits and then treat other human beings badly; and (ii) perpetrate a property wrong against the owner of the animal. According to Aquinas, animals lack any moral standing, having only instrumental value.

Jumping to the 17th century, René Descartes (1596–1650) is often thought of as the father of modern philosophy. He is usually singled out for special blame for introducing the idea of animals as 'automata' or machines. However, in a more considered review of Descartes' works, Cottingham (1978) points out that even though Descartes states that animals have no thought or language he does

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not actually say that they have no feelings or sensations. Indeed, Kenny (1970) translates Descartes as saying, 'Similarly of all the things which dogs, horses and monkeys are made to do, are merely expressions of their fear, their hope, or their joy; and consequently they can do these things without any thought.' Present-day scholars continue to argue about what Descartes really meant by this. The fact that he was a vivisectionist, and did not *treat* animals as if they were sentient, suggests that he thought that 'fear', 'hope', and 'joy' were in some way unconscious emotions. 'Unconscious emotion' is a difficult concept to understand and is currently being debated (e.g., Őhman *et al.*, 2000; Winkielman and Berridge, 2004). Like Aristotle and Aquinas, Descartes believed that rationality distinguished human beings from other animals and he added that language, which he regarded to be a uniquely human attribute, is the only real test of rationality. However, as suggested by the translated passage above, his translators and interpreters may have gone too far in blaming him for regarding animals as 'machines', as he does seem to allow that animals might have emotions and might be driven by these emotions.

Thomas Hobbes (1588–1679) was an English philosopher living at the same time as Descartes. In 1651 he wrote the famous book *Leviathan* which formed the basis for Western political philosophy. *Leviathan* concerns the structure of society and legitimate government, and is regarded as one of the earliest and most influential examples of social contract theory. Hobbes' contention was that human beings act out of self-interest and that this leads to co-operation and social contracts. Since, in Hobbes' view, animals have no language, they cannot enter into social contracts with other animals or with human beings, and are therefore not worthy of moral consideration. So, whereas Descartes thought that language was important as a sign of rationality, Hobbes thought that it was necessary for the formation of social contracts. However, their conclusion was the same: animals do not have language, therefore they do not merit moral consideration.

John Locke (1632–1704) was an English philosopher and considered to be the first of the British Empiricists. Empiricism emphasizes the role of experience, particularly sensory perception, in the formation of ideas. Locke postulated that when people are born, their minds are 'blank slates' or 'tabula rasa'. This contradicted the previous belief that people were born with innate ideas. Locke also developed Hobbes' ideas on social contract theory. He was one of the earliest and most influential thinkers of the Enlightenment contributing to political philosophy and liberal theory. It is in Locke's writings that we get a first glimpse of a change of view with regard to animals. Locke says that there is evidence that animals (or what he calls 'brutes') have the capacity to remember. He also allows that animals seem to have some very simple ideas and they can compare one thing to another – but only very imperfectly. To some extent they can compound (put ideas together) but Locke draws the line at abstract thought, stating clearly that animals cannot form abstractions. So, Locke concludes that there are huge differences between human beings and other animals, but that animals do have some simple mental capacities. This is a big departure from animals being 'automata'.

The German philosopher Immanuel Kant (1724–1804) was very important in the development of moral philosophy. He wrote a highly influential little book called *Groundwork of the Metaphysic of Morals*. Kant believed that morality is a case of following absolute rules. For example, he thought that lying was morally wrong under any circumstances. Kant's philosophy was that one should treat a human being as an end in itself and not as a means to an end. He developed the philosophy that human beings have intrinsic (or inherent) value (and not merely instrumental value). The reason they have intrinsic value (once again) is that they have rationality and in particular they can reason about ethics. Animals, on the other hand, cannot reason (particularly about ethics!), and therefore have only instrumental value.

In this way, these five philosophers, Aristotle, Aquinas, Descartes, Hobbes, and Kant, developed a position that has dominated the traditional Western view of how animals should be treated. The position was based on two claims:

1. Human beings have a special attribute that makes them distinct from all other animals. (A factual claim.)
2. Having this special attribute makes human beings objects of direct moral concern. (A moral claim.)

The special attribute was rationality, and, in particular, having language and being able to engage in ethical thought. The traditional Christian view incorporated an additional distinction, namely, animals did not have immortal souls. John Locke

has been omitted from this list because he was the first to realize that the distinction between animals and human beings was not as clear cut as the others suggested.

2.3 The Rise of Utilitarianism

With the emergence of 'The Enlightenment' period in Europe, things started to change. The Scottish philosopher David Hume (1711–1776) wrote, on learning in animals, 'It seems evident, that animals learn many things from experience, and infer that the same events will always follow from the same causes'. He went on to say, 'Is it not experience, which renders a dog apprehensive of pain, when you menace him, or lift up the whip to beat him?' (Hume, 1739). He thus began to dispute the previous views that animals have no moral standing. Because Hume was a hard-line atheist, the question of anyone having an immortal soul did not arise.

Jeremy Bentham (1748–1832) was an English social reformer who was very concerned about the conditions that many workers were forced to accept during the Industrial Revolution. He worked closely with James Mill, a like-minded Scottish social reformer. In contrast to Kant, Bentham thought that it was the consequences of actions that were important. So, for example, telling a lie might be morally acceptable if the consequences of doing so were better than not telling a lie. He had little to say about animals, with the exception of a brief mention in one of his books. In it he rejected both of the previous claims about animals – that they cannot reason, and that they have no language – outright, and went on to argue that rationality is not the relevant matter. In a well-known passage, he wrote, 'The question is not, Can they reason? nor, Can they talk? But, Can they suffer?' (Bentham, 1823).

John Stuart Mill (1806–1873), the son of James Mill, was a close friend of Jeremy Bentham. He developed Bentham's ideas into the philosophy of Utilitarianism or The Greatest Happiness Principle (Mill, 1910). According to this principle, 'Actions are right in proportion as they tend to promote happiness, wrong as they tend to produce the reverse of happiness'. 'Happiness' was defined as pleasure and the absence of pain and 'unhappiness' as pain and the privation of pleasure. Bentham and Mill did not wish their new theory to have the title 'The Greatest Happiness Principle' and they searched around for another name. They came across the word 'utilitarian' in the writings of a Scottish novelist, John Galt, and they asked him if they could use this for the name of their theory, to which Galt agreed.

The person who has vigorously promoted a utilitarian approach to animal welfare is the Australian philosopher Peter Singer (b. 1946), Ira W. DeCamp Professor of Bioethics at Princeton University. He published *Animal Liberation* in 1975 followed by multiple subsequent editions and a 'renewed' text and title in 2023, *Animal Liberation Now*. This was – and remains – a very influential book. Singer (1975) argues that most animal use (including animal agriculture) is deeply objectionable. So, he is arguing about the facts. He says that he is not against using animals or even against killing them, if, and only if, they have a good quality life and a painless death. Interestingly, Singer is also regarded as the father of Animal Rights, although he himself is most definitely a utilitarian. The question a utilitarian asks is, 'What course of conduct promotes the greatest amount of happiness for all those who will be affected?' A utilitarian approach has proved to be very useful in dealing with various moral dilemmas in human affairs. However, when animals are involved, it becomes extremely difficult to weigh the happiness of human beings against the suffering of animals. For example, how does one balance the suffering of laboratory rabbits being used for the production of antibodies against the happiness of human beings being protected from some dangerous disease by these same antibodies?

2.4 The Emergence of Animal Rights

The idea of giving animals 'rights' is very recent, having been proposed in the last quarter of the 20th century by Tom Regan (1938–2017), who was Professor of Philosophy at North Carolina State University. Using much of the evidence produced by Singer in *Animal Liberation*, Tom Regan developed the philosophy of Animal Rights and in 1983 published *The Case for Animal Rights*. In this book he argues that we are all subject of a life, conscious beings, have individual welfare, want and prefer things, and believe and feel things. Therefore we (and all sentient creatures) have inherent value. Regan builds his argument as follows, 'Individuals who have inherent value have an equal right to be treated with respect… It follows that we must never harm individuals who have inherent value'

(Regan, 1983). According to Regan, killing is the biggest harm we can do to another individual. The term 'harm' is not always straightforward to understand. A seven-year-old boy being carried kicking and screaming into a clinic to have a flu shot would certainly say he was being harmed. Presumably the parents would say he was not being harmed, but, rather, benefited, by being protected from flu. Exactly the same argument could be made for a cat being taken very reluctantly to the veterinarian to receive some treatment. So, who decides what 'harm' means?

Regan was a respected philosopher. His *Case for Animal Rights* is very well argued. His views have dominated Animal Rights philosophy; however, this may not be ideal, as a philosophy of animal rights does not need to be as extreme as that proposed by Regan. In fact, when people who call themselves 'animal rightists' are closely questioned, very few of them have adopted all of Regan's philosophy. The majority of them actually believe in some form of 'limited rights' for animals. For example, Tannenbaum (1995), a philosopher who has written a textbook on veterinary ethics, has argued that some form of 'limited rights' might be acceptable. A 'Limited Rights' philosophy could be built up as follows: Laboratory animals have a right not to be subjected to painful procedures without an analgesic. Farm animals have a right to be free from severe frustration (or be free to express strongly motivated behavior). Companion animals have a right to regular exercise and stimulation. The problem with this approach is that one has to have 'rules' in place to cover every conceivable situation. It is often easier to take a utilitarian stance and ask, 'What happens to overall happiness if action X is taken?' If the answer is that happiness will be increased (or suffering will be diminished) then that is the ethically correct thing to do.

The major weaknesses of Animal Rights would seem to be:

1. The concept of 'inherent value' is unclear. For example, where on the phylogenetic scale does inherent value appear? According to Regan (1983), it is only the higher mammals that have inherent value.
2. It does not resolve conflicts between individuals.
3. It does not protect the welfare of all animals. It is a philosophy that dictates how humans interact directly with animals, namely, 'Do not use them'; it therefore does not protect animals that may be harmed indirectly by human activities, such as by habitat loss from urban, industrial, and agricultural development, and environmental pollution and destruction of oceans, lakes, rivers, land, and air.

2.5 Utilitarianism or Animal Rights?

Which philosophy should a person who is interested in improving animal welfare follow, Utilitarianism or Animal Rights? These philosophies are different in a crucial way, that is, they are different types of philosophies. Utilitarianism is a teleological theory, i.e., a theory that deals with ends or final purposes. In the case of Utilitarianism, the end being sought is the greatest happiness. Animal Rights is a deontological theory, i.e., a theory that deals with that which is binding. It deals with actions, not ends. Both philosophies use the same evidence that the higher animals are 'subject of a life', are conscious, sentient creatures, experience individual welfare, can suffer, want and prefer things, and believe and feel things. However, this evidence leads them to different positions. A strict Utilitarian believes that animals are worthy of moral consideration, therefore we should try to maximize their total happiness. A complete Animal Rightist believes that animals have inherent value, therefore they should not be used by human beings at all.

2.6 The Science of Animal Welfare

Animal welfare did not begin to be considered scientifically until the last quarter of the 20th century. This requires some explanation since there is evidence of some acceptance of sentience, at least in mammals, for hundreds of years. 'Sentience' simply means capable of experiencing feelings and is the fundamental requirement for an organism to have inherent value. By the time of the Renaissance, there is good evidence from the writings of Leonardo da Vinci, Erasmus, Thomas More, Montaigne, Shakespeare, Francis Bacon, and others, that animal sentience was accepted as part of secular knowledge (Preece, 2002). Many of the great artistic works of this age also portray people treating animals as if they were sentient. Some great works of art also depict animals as if they were sentient. However, as previously mentioned, it was not until John Locke (to a minor extent) in the 17th century, David Hume in the 18th century, and Jeremy Bentham in the 19th century that sentience

in animals came to be accepted by philosophers. Even then, some eminent philosophers like Immanuel Kant who lived into the 19th century believed that animals had only instrumental value.

But what of the scientists? It has already been stated that Descartes, living in the 18th century, did not treat the live conscious dogs he was dissecting as if they were sentient. In fact, it is not until the middle of the 19th century that we find scientists making explicit reference to feelings. William Youatt (1776–1847) was the son of a surgeon who lived in the southwest of England and was educated for the ministry. However, at the age of 34, he gave up his ministry and became assistant to a veterinary surgeon in London. He took classes at the newly founded Veterinary College (later to become the Royal Veterinary College), but he became dissatisfied with the quality of instruction, and he left without a diploma. In those days, formal qualification was not very important, and Youatt soon gained the reputation of being an outstanding veterinarian. He was very prolific and wrote textbooks that are still cited today. Youatt also founded and acted as editor of *The Veterinarian* (a professional journal for veterinarians) from 1828 until he died in 1847. However, his humanitarian approach to animals and his understanding of what animal welfare is all about is revealed in a book originally published in 1839 (republished in 2004), titled *The Obligation and Extent of Humanity to Brutes, Principally Considered with Reference to the Domesticated Animals*. In this book, Youatt (1839) writes of animals' senses, emotions, consciousness, attention, memory, sagacity, docility, association of ideas, imagination, reason, instinct, social affections, and the moral qualities of friendship and loyalty. He certainly thought that animals have feelings! More than 30 years before Darwin's (1872) *The Expression of the Emotions in Man and Animals*, Youatt wrote of the intellectual faculties, 'We are endeavouring to shew that the difference [between humans and animals] in one of the most essential of all points, is in degree and not in kind'. He also wrote, 'We are operating on animals that have, probably, as keen feelings of pleasure and of pain as ourselves'. He condemned as cruel and inhumane many practices that are still being criticized today, including too early training of racehorses, steeple-chasing (a British sport in which horses are raced over a track with high brushwood fences), transport methods for newly born calves, raising of veal calves, slaughterhouse management, tail-docking and ear-cropping of dogs, using live bait for fishing, and force-feeding of capons (castrated male chickens) and turkeys to produce *foie gras*.

The person usually credited with transforming biological concepts completely is Charles Darwin (1809–1882), who published *The Origin of Species* in 1859 (Darwin, 1859). (But remember that Youatt was making similar suggestions more than 30 years before this.) Some scholars believe Darwin had material left over from *The Origin* that he incorporated into *The Descent of Man* (Darwin, 1871) and *The Expression of the Emotions in Man and Animals* (Darwin, 1872). In both of these books, he suggests that the emotions had also evolved, and he gives good descriptions of the expression of these emotions in various species. However, he says nothing about the subjective experience of having emotions. This was left to a prominent biologist and follower of Darwin, George John Romanes (1848–1894), who was explicit about the subjective experience of emotions. In a book entitled *Mental Evolution in Animals*, he wrote that 'Pleasures and Pains must have been evolved as the subjective accompaniment of processes which are respectively beneficial or injurious to the organism, and so evolved for the purpose or to the end that the organism should seek the one and shun the other' (Romanes, 1884). Later he stated, 'Thus, then we see that the affixing of painful or disagreeable states of consciousness to deleterious changes of the organism, and the reverse states to reverse changes, has been a necessary function of the survival of the fittest'. So, by the 1880s, Romanes was describing emotions almost exactly as would a modern-day animal welfare scientist (e.g., Duncan, 1996).

Why did it take so long for feelings to be accepted as critical for welfare? The reason for the resistance to these enlightened 19th-century views lies in the rise of 'Behaviorism', a very important school of psychology, especially in North America. Behaviorists spoke out strongly against paying any attention to 'feelings' or 'consciousness' right through the 20th century into the 1970s. For example, one of the founding fathers of Behaviorism, William James (1904), said, 'Consciousness…is the name of a non-entity, and has no right to a place among first principles. Those who still cling to it are clinging to a mere echo, the faint rumour left behind by the disappearing "soul" upon the air of philosophy… It seems to me that the hour is ripe for it to be openly and universally discarded.' Another founder, J.B. Watson (1928), stated, 'The

behaviorist sweeps aside all medieval conceptions. He drops from his scientific vocabulary all subjective terms such as sensation, perception, image, desire and even thinking and emotion'. One of the chief proponents of Behaviorism was B.F. Skinner, known for inventing the 'Skinner box' or operant conditioning chamber widely used in psychology laboratories. He wrote, 'We seem to have a kind of inside information about our behavior – we have feelings about it. And what a diversion they have proved to be! … Feelings have proved to be one of the most fascinating attractions along the path of dalliance' (Skinner, 1975). William James, J.B. Watson, and B.F. Skinner were well-respected scientists and there is no doubt that their views had an inhibiting effect on any consideration of feelings through most of the 20th century.

There was, however, the occasional behavioral scientist brave enough to tackle the topic. For example, Buytendijk (1953), a Dutch phenomenologist, carried out an interesting experiment in which he showed that blinded *Octopus* could tell the difference between being touched and reaching out and touching something, whereas *Asterias* (starfish) could not. Buytendijk interpreted this to mean that the octopus with its large neural ganglia had some cognitive representation of the world and its place in it, whereas the starfish, with its nerve net, had no such representation and could only react in a stimulus–response way.

Even the European-founded discipline of Ethology eschewed any consideration of feelings and subjective experiences through the first 70 years of the 20th century. This pattern was broken when an American ethologist, Donald Griffin, astounded his audience at the 1975 International Ethology Conference by giving a plenary session talk on animal awareness. A year later he published a book entitled *The Question of Animal Awareness* on the same topic (Griffin, 1976) and suddenly there was a burgeoning literature on animal subjective feelings.

Much of the present-day interest in animal welfare can be traced back to Ruth Harrison with publication of her book *Animal Machines*, in which she was very critical of intensive farming methods (Harrison, 1964). She visited various types of farms to observe personally how animals were treated. She criticized broiler chicken farming on grounds of high density, large group size, and the constant search for a cheap product. She visited packing stations (broiler slaughter plants) and was shocked by transport methods, rough handling, and the lack of humaneness of the slaughter process. She was concerned over the very artificial environment of the battery cage system for laying hens, as well as the lack of space, the low light levels, and the disposal of the spent hens. With regard to veal calves, she spoke out against transport methods, the crates the calves were kept in, the high levels of anemia, the darkness, and the fact that the calves were not given any solid food. She also criticized intensive rabbit production, broiler beef production, and fattening pig production on similar grounds. She concluded that quality was being sacrificed for quantity in animal production and that humanitarianism and quality of product were being outweighed by economic interests.

Following the publication of *Animal Machines* the public outcry was so intense in the UK that the British Government set up a Committee under the chairmanship of Professor Rogers Brambell to investigate the treatment of animals used in food production. In 1965, this Committee published a Report commonly known as *The Brambell Report* (Command Paper 2836, 1965), which was highly critical of intensive farming methods, although some of its claims were not based on hard evidence. Animal welfare then began to be investigated scientifically. When scientists first started this work in the late 1960s and 1970s, it was generally accepted that an animal's welfare would be a reflection of the animal's physiological stress level; low stress would indicate good welfare and high stress would indicate poor welfare (Bareham, 1972; Bryant, 1972; Wood-Gush *et al.*, 1975; Freeman, 1978). Thus, throughout the 1970s it seemed that 'welfare', whatever that might be, was a consequence of certain physiological processes and its assessment a simple matter of developing a reliable measurement of stress. Interestingly, in her book *Animal Machines*, Ruth Harrison laid much more emphasis on animal suffering than on the physiological stress response of animals in intensive agriculture (Harrison, 1964). *The Brambell Report* also acknowledged that feelings were an important feature of welfare (Command Paper 2836, 1965). In my view, the Brambell Committee were very far-sighted in claiming that:

> Welfare is a wide term that embraces both the physical and mental well-being of the animal. Any attempt to evaluate welfare, therefore, must take into account the scientific evidence available concerning the feelings of animals that can be derived from their structure and functions and also from their behavior.

Nevertheless, in spite of these allusions to the feelings of animals in general and the suffering of animals in particular, the widespread view that welfare was intimately connected with stress persisted within the scientific community. This view changed very rapidly with the publication of Donald Griffin's aforementioned book, *The Question of Animal Awareness* (Griffin, 1976). Suddenly it became acceptable for behavioral scientists to consider animals' subjective feelings and incorporate these into models of behavior. As animal welfare science progressed through the 1970s and 1980s, scientists began to search for a suitable definition of 'animal welfare' and different scientists came up with very different definitions. Duncan and Dawkins (1983) reviewed this topic and listed all the definitions that had been given for 'animal welfare' to that time. They concluded that it was impossible to give 'animal welfare' a precise scientific definition, stating that a broad working description would be one that encompassed the notions of: (i) the animal in physical and mental health; (ii) the animal in harmony with its environment; (iii) the animal being able to adapt to the given environment without suffering; and (iv) somehow taking account of the animal's feelings. 'Suffering' was described as a wide range of unpleasant emotional states. This broad working description of 'animal welfare' worked well at first. However, as more and more scientists became involved in welfare research, examples were found in which there was disagreement among the symptoms and circumstances. For example, cases were identified in which animals: (i) appeared normal but had sub-clinical disease; (ii) showed stress symptoms when participating in a rewarding activity (e.g., stallions mating); and (iii) were healthy, physiologically normal, but performing stereotyped movements (e.g., polar bears in a zoo environment). In each of these three cases, did the animals have good welfare or not? This led to disagreement and a protracted debate within scientific animal welfare circles over which symptoms should take priority.

Gradually, two schools of thought emerged. The Biological Functioning School argued that animal welfare is principally to do with the satisfaction of the primary needs and much less to do with the satisfaction of the secondary subjective feelings. This implies that welfare is to do with good biological functioning – with the absence of a stress response (or absence of a large stress response), with the animal being able to cope, and with the satisfaction of biological needs (for stress and coping see Broom and Johnson, 1993; Broom, 1996; for needs see Hurnik and Lehman, 1988). The Feelings School postulated that animal welfare is all to do with what the animal feels, namely, with the absence of negative emotional states that are commonly known as states of suffering, and with the presence of positive emotional states that are commonly known as states of pleasure (see Dawkins, 1980, 1993 and Duncan, 1981, 1993, 2004).

The Feelings School argue that all living organisms have certain needs that have to be satisfied in order that the organism survives, grows, and reproduces. This is as true for a pine tree as it is for a pig. If these needs are not met, the organism will show symptoms of atrophy, stress, ill health, and perhaps death. The vertebrates (and some of the higher invertebrates) have evolved 'feelings' or 'subjective affective states' to protect their needs in a flexible way. A lower invertebrate satisfies its needs by means of simple, hard-wired, stimulus–response behavior. So, a fly on a cow's back can very efficiently avoid the cow's tail swishing towards it. However, there are no feelings or learning involved, and the fly very quickly will land on the cow's back again. A vertebrate, on the other hand, has feelings that help it satisfy its needs in a flexible way. So, a bird avoids a cat moving towards it – but its avoidance is governed by fear. This response is much more flexible. A bird will learn to avoid not only a cat moving towards it, but a sleeping cat, anything that looks or behaves a little like a cat, locations that cats frequent or have a cat odor, and even locations that cats frequent at certain times of day. After much debate, there is now gradual acceptance that welfare is indeed all to do with feelings. Even proponents of the Biological Functioning School are modifying their views (see, for example, Broom, 2014).

The increasing acceptance that animal welfare is all to do with feelings brings with it an apparently insurmountable problem. This is because feelings are subjective:

> Only I can know what my subjective feelings are.
> Only I can know what I experience when I see the colour red.
> Only I can know what I experience when I feel hungry.
> Only I can know what I experience when I feel a toothache.

The subjective nature of feelings means that they are not directly accessible to scientific investigation.

However, in the animal welfare debate we do not need to know *exactly* how the animal feels – the important factor is whether a feeling is negative or positive, and its intensity. In other words, we don't need to know whether rabbit fear feels exactly like human fear, but simply that rabbit fear is an unpleasant feeling that can vary in intensity and motivate the appropriate behavior. So, we can never know what a piglet feels when it has its tail docked. Is it like having a finger amputated, or receiving a very bad burn, or experiencing toothache? We can never know. But if we can show that a procedure is aversive to the piglet, and the piglet shows much less reaction when it is given an analgesic before the procedure, then we can conclude that tail-docking reduces its welfare.

2.7 Understanding States of Suffering

Many states of suffering have now been investigated indirectly in this way to find out how negatively the animal feels (for more on suffering, see Chapter 11, this volume). Pain and discomfort, frustration, fear, maternal separation, and various types of deprivation have all been investigated in animals in some detail. For example, in a series of experiments, hens were thwarted in many different ways while attempting to feed, behave sexually, nest (Fig. 2.1), incubate eggs, and brood chicks, and their behavior was observed and catalogued (Duncan, 1970). When frustration was severe, the symptoms were stereotyped back-and-forward pacing whereas when it was mild, there was an increase in 'displacement' preening (an unusual type of hurried preening occurring out of context).



Fig. 2.1. Hen pushing open a weighted door to reach a nest-box. (Author's own image.)

If two or more hens were frustrated simultaneously, then, in addition to the other responses, the dominant birds showed an increase in aggression towards the subordinates. When this list of behavior patterns was compared to the behavior of hens in battery cages it was found that the symptoms of frustration in the caged hens were not very common. However, there was one notable exception: most birds in battery cages showed symptoms of severe frustration in the 1–1½ hours before they laid an egg, suggesting that they did not regard the cage as a suitable nesting site. In later experiments, it was shown that hens in the pre-laying phase would work as hard to reach a suitable nesting site as they would to reach food when they had been deprived of food for 28 hours (Follensbee *et al.*, 1992). It has also been shown that the performance of nest-building behavior in hens is more important than the actual construction of a nest (Duncan and Kite, 1989; Hughes *et al.*, 1989). It should be noted that these experiments do not tell us what a hen actually feels when it is denied a nesting site; they do, however, tell us that access to nest site matters substantially to a hen and that its welfare is greatly reduced by not having a nest and being able to perform nest-building behavior.

This technique of 'asking' animals what they feel about the conditions under which they are kept and the procedures to which they are subjected has now been used to investigate different states of stress and suffering in a wide variety of species. For example, it has been shown that when a group of broiler chickens is given a choice of two rations, one of which contains an analgesic drug, lame chickens in the group consume more of the medicated ration and in a quantity sufficient to alleviate their lameness. Non-lame birds do not eat much of the medicated diet presumably because its taste is slightly aversive (Danbury *et al.*, 2000). This indicates that the lameness is caused by pain and that, if given the opportunity, the birds will self-medicate to alleviate the pain.

Fear has also been examined by asking animals what they feel about it. For example, it has been shown that Rainbow trout (*Oncorhynchus mykiss*) will quite quickly learn to avoid a frightening stimulus if given a warning signal in a shuttle tank (Yue *et al.*, 2004). This was taken a stage further when it was shown that cichlid fish could learn to operate an underwater push-door, which would allow their motivation to be measured (Galhardo *et al.*, 2011).

In all studies of this type, assessing strength of motivation is crucial. Dawkins (1990) proposed

using an approach taken from microeconomics. According to this approach, consumers will buy some commodities even when the price increases or their income decreases; this is described as 'inelastic demand' and these commodities are known as 'necessities'. For other commodities, consumption decreases as price increases; these commodities are said to have 'elastic demand' and are called 'luxuries'. This approach seems to make good sense; however, there are numerous problems associated with it. For example, how do we allocate rewards into discrete amounts (Mason *et al.*, 1998; Kirkden *et al.*, 2003)? In one experiment, dairy heifers were given free access to bedded stalls for nine hours per day. They had to work for further access to the stalls. It was found that they would work quite hard to gain access to the stalls if each additional period of access was 30–80 minutes; access to stalls showed inelastic demand. However, if each period was limited to 20 minutes or less, they were much more reluctant to work; in other words, they showed elastic demand (Jensen *et al.*, 2005). It is also difficult, if not impossible, to use these techniques when the behavior pattern in question shows a distinct diurnal rhythm. For example, nesting motivation in hens shows an extremely strong diurnal rhythm and, when it is triggered, appears to be all-consuming for a period of about two hours prior to egg laying (Duncan and Kite, 1989; Hughes *et al.*, 1989). Roosting behavior in chickens also shows a very strong diurnal rhythm with birds being extremely motivated to move to a roost well above ground level at the end of the day (Olsson and Keeling, 2000, 2002). Therefore, when a hen is in 'nesting mode' or 'roosting mode' it is impossible to titrate this motivation against any other. To some extent, the same holds true for dust-bathing in chickens which shows a peak in motivation in the middle of the day – but only every other day (Hogan and van Boxel, 1993) and the effects of external motivating factors are superimposed on this diurnal pattern (Duncan *et al.*, 1998). Fraser and Nicol (2018) discuss the problems associated with preference and motivation testing in some detail.

Investigations into states of suffering including pain and discomfort, frustration, fear, maternal separation, and various types of deprivation have all been carried out in a wide range of species (see, for example, Viñuela-Fernández *et al.*, 2018; Boissy *et al.*, 2018; Mason and Burn, 2018; Chapter 23, this volume). There are other states of suffering, experienced by human beings, such as boredom, which have proved more difficult to investigate in animals. There have been some attempts to define and investigate boredom (e.g., Wemelsfelder, 2005; Mason and Burn, 2018), but this state of suffering is notoriously difficult to unravel and explain.

It should also be remembered that there may be states of suffering experienced by animals but *not* experienced by human beings. It has already been emphasized that states of suffering (and states of pleasure) are *subjective*, that is, accessible only to the organism experiencing them. However, when the sensory systems involved in the animal are very different from those of human beings, then the problem is confounded even further. For example, animals with sensory capacities outside the human range may be exposed to human-produced noises, such as high frequencies from machinery, of which we are unaware but which might be aversive to animals. So, mice, dogs, and cats can all hear frequencies much higher than those perceived by human beings and could be disturbed by, for example, fan noises. Marine mammals use underwater vocalizations for communication, with different species using different frequency ranges (e.g., Nowacek, 2005), and with some using echolocation to find objects in their environment. Human-produced underwater noises such as ships' engines and sonar transmissions could well interfere with these processes, and this might lead to suffering. But what would this suffering *feel* like?

In a famous paper entitled 'What is it like to be a bat?' the philosopher Thomas Nagel has argued that the essential part of consciousness is that there is something that it feels like to be a conscious thing (Nagel, 1974). He then takes the extreme example of a bat, which experiences its world through echolocation, and argues that, of course, human beings can never know what the bat's experiences are like. We have a good idea of the suffering involved when a person suddenly loses her sense of sight. But what would the experience be like for a bat who suddenly loses its sense of echolocation? Human pollution of rivers and lakes may result in water with low oxygen content or less than optimal pH value, which could have a very negative effect on fish welfare. We, as humans, have no conception at all of what the suffering might be like from living in an environment of too low or too high a pH. As a final example, if a bird of a species that normally migrates in autumn is kept in a cage during that time, the bird remains highly motivated to fly (as judged by its repeated attempts

to escape), and thus may experience suffering (Dawkins, 1990). Without the motivation to migrate, how could we understand what this suffering would feel like?

2.8 What about States of Pleasure?

Compared to the number of investigations into negative emotional states in animals, there has been very little research into states of pleasure. This is understandable, and also the case in humans, since there is a clear priority – and evolutionary dictate – for individuals to be rid of unpleasant affective experiences (e.g., pain, nausea, hunger, fear, depression, and the like). Accordingly, it has historically been believed that bigger welfare gains could be made by reducing suffering than by increasing pleasure. However, this chapter has argued that many of these gains have now been achieved and that it might be possible to improve welfare even further by encouraging pleasurable states. It has been suggested that negative feelings such as pain, fear, and frustration have evolved to motivate behavior in 'need situations'; that is, where immediate action by the animal is required. Positive feelings such as pleasure and happiness have evolved to motivate behavior in 'opportunity situations' when the benefits of performing the behavior may be further in the future (Fraser and Duncan, 1998). It has been assumed that some patterns of behavior such as cats purring, dogs tail-wagging, lambs gamboling, and so on, are signs of positive feelings. However, there is little in the way of detailed investigations. The results from a study of dust-bathing behavior in chickens strongly suggested that dust-bathing is motivated by pleasure, whereas previously it had been thought it was driven by negative feelings associated with dirty feathers (Widowski and Duncan, 2000). A proper understanding of animals' positive emotions is also important because it may not always be possible to fully eliminate negative feelings. So, it may be possible to counter some negative emotions by promoting positive feelings simultaneously – a spoonful of sugar to make the medicine go down. Using this technique of giving desirable treats, Temple Grandin has been able to persuade very flighty antelopes in a zoo to repeatedly enter a chute and accept injections (Grandin *et al.*, 1995).

2.9 Grey Areas

A crucial welfare question is, 'When in ontogenetic development do feelings become functional?' We cannot simply take birth or hatching as a starting point. A newly born precocial animal such as a guinea pig has fully functional feelings and is able to suffer in many different ways. Presumably, it would also be capable of suffering *in utero* for some days before birth. On the other hand, a newly born altricial animal such as a kangaroo is embryonic by comparison and not as capable of suffering. Similarly, a newly hatched domestic chick has well-developed feelings and is capable of suffering more than a newly hatched starling (*Sturnus* spp.). Moreover, feelings do not suddenly become switched on, they develop gradually, and different feelings develop at different times and different rates. The question, 'When does it matter to the animal?' has still to be elucidated. This is an area in dire need of more research.

Another crucial welfare question is, 'Where on the phylogenetic scale do feelings become important?' It has already been stated that all the vertebrates have feelings. It is possible that the mammals and birds are more sentient than the reptiles, amphibians, and fish, but there is currently no hard evidence to back this up. But what about the invertebrates? There is good evidence that the Cephalopods (octopus, squid, etc.) are highly sentient (see, for example, Godfrey-Smith, 2016), and perhaps even more sentient than the cartilaginous fishes (sharks, rays, etc.). It is also generally acknowledged that the Decapods (shrimps, lobsters, crabs, etc.) have some sentience (see, for example, Rowe, 2018). There is continuing debate about sentience in other invertebrate groups. For example, Griffin (1984) has argued that some insects, and in particular honeybees, show behavior that can only be explained in terms of consciousness and sentience. However, it can be argued that sentience is not required to explain honeybee behavior and that a computer could be programmed to behave in this way.

In conclusion, a proper understanding of negative and positive feelings will help us to design optimum environments for animals as well as develop best practices of care.

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3 The Relationship Between Mental and Physical Health

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3.1 Introduction

The processes that lead to mental and physical health operate over a vast time scale. Living animals interact with their environments on a time constant of milliseconds. When animals act on their environment, their environment responds (Fig. 3.1). Animals perceive this response through variable combinations of their senses, which transmit the received information chemically, electrically, and hormonally to various parts of the brain. The brain then compares the received information with predictions it makes based on its history (genetic, epigenetic, and environmental), the context of the interaction, and its expectation (predicted response versus received response) and decides on the next action (Pezzulo *et al*., 2018). In contrast, the nervous system, including the brain, that subserves these processes developed slowly, over millions of years, sculpted by mutation, variation, and natural selection (Darwin, 1859; Cisek and Hayden, 2022).

Animals evolved to perceive environmental events as either threats or opportunities to survive long enough to transmit their DNA to the next generation. In a world containing more threats than opportunities, animals have developed several responses to environmental threats. The threat response pattern chosen seems to depend upon the ratio of the animal's perception of threat to their perception of control (pT/pC) in the environment. When this ratio exceeds one, the brain activates the central threat response system (CTRS), which directs variable combinations of its downstream effector systems to mount an appropriate response to the threat (Goldstein, 2021). Acute activation of the CTRS can restore the animal's homeostasis, albeit sometimes requiring a change in activities of the threat response systems ('allostasis'). In contrast, chronic activation of the CTRS can negatively affect both mental and physical health ('allostatic overload') (McEwen, 2017; Westropp *et al*., 2024).

3.2 Mental and Physical Health

In the wake of World War II, the World Health Organization stated as the first principle of its constitution that 'Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (World Health Organization, 1948). Although the definition was applied to humans and has been critiqued and defended by others, it is a reasonable starting place for a definition of mental and physical health for mammals in general (Schramme, 2023). Broom observed that views on the concept of health differ among food animal producers, ethologists, and some veterinarians (Broom, 2006). He observed that '...for most people, health refers to the state of the body, brain, and mind in response to the effects of pathogens, parasites, tissue damage or physiological disorder' – physical pathology. However, studies of animals confined in zoos, production facilities, and people's homes have found that the entirety of the environment can also affect animals' mental health. This chapter will focus mainly on companion animals, specifically, cats and dogs.

Defining the concept of 'mental health' is particularly tricky because the mental processes that affect health appear to be an emergent property of

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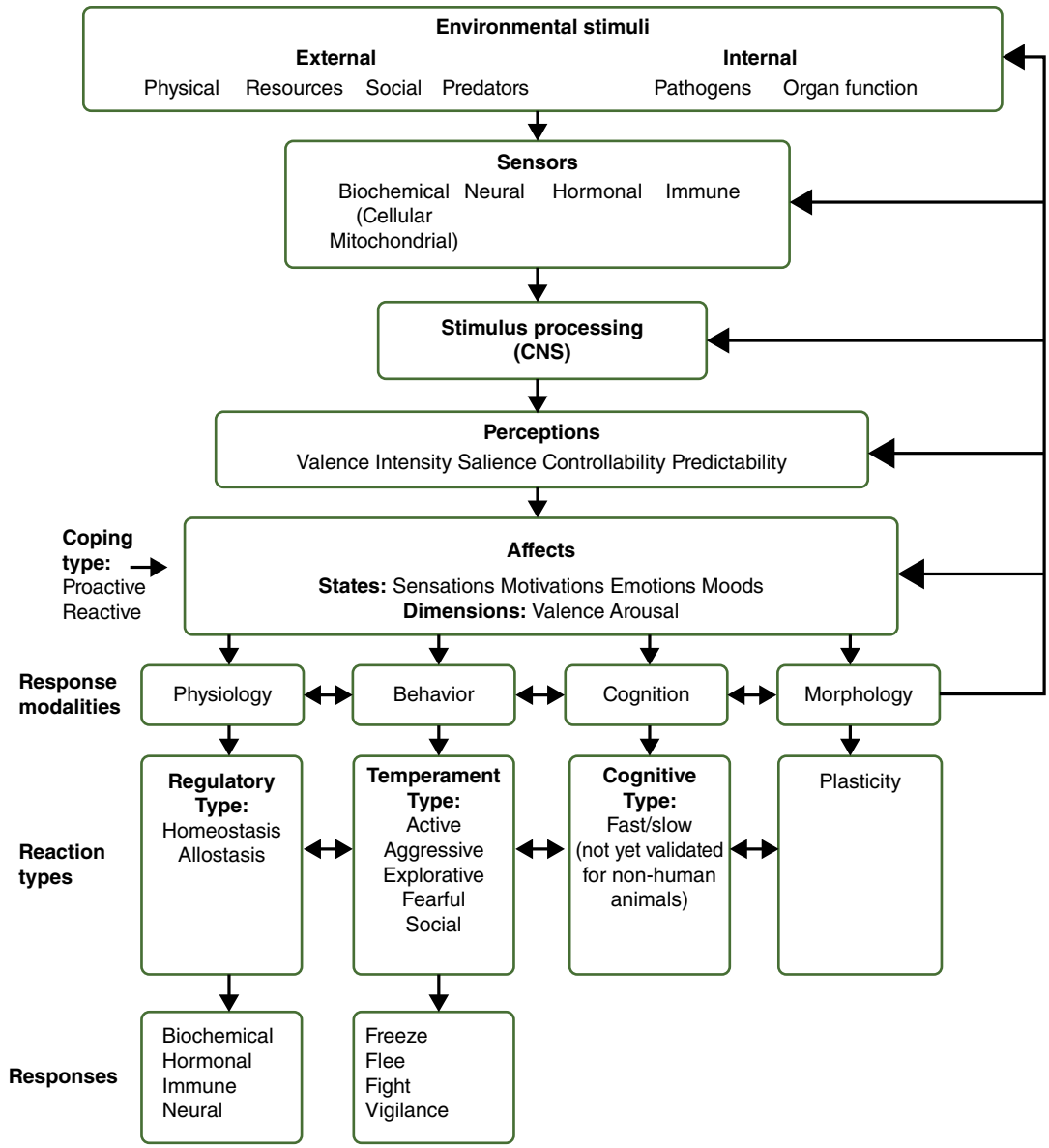


Fig. 3.1. A simplified representation of environmental stimuli processing by animals. External and internal stimuli activate variable combinations of sensors, which transduce the stimuli into signals interpretable by the central nervous system (CNS). The CNS creates prediction perceptions based on input, which are then compared with subsequent input to determine responses and their associated affects. Responses vary based on the nature of the stimuli and the animal's reaction types. (Adapted and redrawn from Colditz and Hine (2016), with permission.)

brains that cannot (yet) be measured directly. To date, they can only be inferred from the behavior of animals, some physiological measurements, or potentially from the evaluation of neural processes (Cisek and Green, 2024). Just as other organ system functions are emergent properties of their cell biology, we perceive animal mental processes as emergent properties of the brain, generated by and different from it (Nieder, 2022; LeDoux *et al.*, 2023). From this perspective, mental health implies

brain health, which results from variable contributions of genetic, epigenetic, and environmental interactions on animals. The challenge for writers in these domains is daunting; to paraphrase Kozak, 'Behavioral science studies what the brain does; genetics, cell and molecular biology, endocrinology, neuroscience, immunology, and physiology study how the brain does it' (Kozak and Cuthbert, 2016).

The National Institute of Food and Agriculture (2016) states that 'animal well-being is a complex topic'. In addition to optimizing their list of '... environmental conditions, such as temperature, humidity, duration of daylight, bedding, size and shape of living quarters, or the number of other animals sharing an environment', we add the ability to engage in species-typical behaviors and to maintain pT/pC less than one. Behaviors often associated with poor mental health include aggression, withdrawal, hiding, and sickness behaviors, whereas those often associated with good mental health include play, exploration, and the like, the specifics of which will depend on the species and environmental context. Although behaviors may appear maladaptive when they develop secondary to a physical condition, one must be careful to avoid thinking that all behaviors associated with poor health or welfare are inappropriate or dysfunctional. For example, piloerection and lack of grooming contribute to greater well-being by increasing insulating ability and water conservation and decreasing heat loss and energy expenditure. The increase in metabolic energy expenditure during a febrile episode can be made up later, after the inappetence due to lack of desire to hunt or forage for food that occurs during this episode has subsided, which may have served to protect the animal from predation (Hart, 2010, 2011).

The word 'stress' also means different things to different people. In the context of mental and physical health, we define stress as the impact of the (internal and external) environment on the organism. The eminent neuroendocrinologist and stress scientist Bruce McEwen (2017) described three categories of responses to stress: good, tolerable, and toxic. Good responses, defined as brief and mild-to-moderate in magnitude, occur when an individual's pT/pC permits it to perceive opportunities, take risks, rise to challenges, and feel rewarded by (often) positive outcomes. These responses are part of normal development and help develop threat-coping skills when they occur in safe, predictable environments with stable and supportive relationships. Examples of events resulting in positive responses in young companion animals include low-stress visits to a veterinarian and exposure to novel situations and foods. These responses are addressed in the discussion on resilience (Section 3.3.2).

Tolerable stress responses occur with exposure to experiences that present greater threats, such as boredom or environmental instability (for example, pet animals living in a disruptive or chaotic household), serious illness or injury, or exposure to a natural disaster. As with good responses, recovery to normal is more likely when these events occur in an otherwise safe environment. The essential characteristic that makes this level of threat intensity tolerable is the extent to which the environment permits adequate perception of control and adaptive coping.

In the most threatening environments, where the animal's perception of threat exceeds its perception of control, a toxic response can result (McEwen, 2017). Toxic responses, including activation of the CTRS, especially when frequent or sustained, are the most dangerous to the animal's long-term health and welfare. Examples of early life threats that can result in toxic responses include severe nutritional deprivation (Bouret *et al.*, 2015), separation (Lippmann *et al.*, 2007), or life-threatening maternal or personal threats. This level of perception of threat is most damaging to mental and physical health when it is sustained (National Scientific Council on the Developing Child, 2005/2014).

Understanding the relationships between mental and physical health also requires consideration across levels of analysis. These include the interactions of the macro- and micro-environments with the individual's genetic, epigenetic, molecular, cellular, physiological, social, and behavioral domains. These relationships are depicted in Fig. 3.1.

3.3 Risk and Protective Factors

Risk and protective factors influencing both mental (Lunansky *et al.*, 2021) and physical (Blazer *et al.*, 2015) health have been described. *Risk factors* increase the probability of negative outcomes in individuals faced with adversity, whereas *protective factors* help individuals navigate adverse life events more successfully. These factors occur in environmental, behavioral, and biological domains and include predisposing, precipitating, and perpetuating risk factors, as well as preventive and palliating protective factors (Table 3.1; see also Chapter 12, this volume). The approach may be useful in

Table 3.1. Potential risk and protective factors for mental and physical health in animals (Westropp *et al*., 2024).

Factor	Risk			Protective	
Domain	Predisposing	Precipitating	Perpetuating	Preventive	Palliating
Environmental	History of threatening environments Negative early life experiences	Recent adverse experiences Inter-individual conflict High healthcare utilization Natural disaster	Unsafe environment Barren or unstable housing	History of supportive environments Positive early life experiences	Safe environment Effective environmental enrichment
Behavioral	Negative temperament (shy) Low stress tolerance	Avoidant behaviors (withdrawal, hiding, defensive aggression)	Insufficient perception of control and predictability	Positive temperament (bold) Resilience High stress tolerance	Perception of control and predictability
Biological	Genetic (breed) susceptibility Weak family health history	Illness or infection Abuse or trauma	Inactivity Insufficient sleep/ rest	Genetic (breed) resistance Strong family health history	Physical activity Sufficient sleep/ rest

identifying intervention strategies for other chronic physical and mental conditions in veterinary patients; an example of the application of these factors to interstitial cystitis (IC) in pet cats has been published (Westropp *et al*., 2024).

Predisposing factors increase susceptibility to mental and physical health problems, whereas preventive factors are protective by mitigating or counterbalancing predisposing factors. They include environmental history, early life experiences, personality traits, genetic vulnerability or resilience, and family medical and mental health history. Although generally less modifiable than precipitating, perpetuating, and palliative factors, identifying predisposing and preventive factors may facilitate early identification of susceptible individuals, regardless of species, to permit earlier interventions (Bryan and Beitz, 2021) and inform epidemiological studies and health promotion interventions. Across domains, the balance of these factors 'sets the stage' for the effects of other factors on mental and physical health.

Precipitating risk factors are those associated with the onset of a health problem. Any unexpected sensory stimulus that results in a threatening appraisal of the world can cause diminished mental and/or physical health. Examples include injury or sudden illness, abuse, adverse environmental experiences, and inter-individual conflict. Perpetuating factors are risk factors that prevent or delay recovery from established mental and physical health problems.

Finally, palliating factors reduce the severity or unpleasantness of a disease or its symptoms without knowing or removing its causes. The goal of protective palliating factors is to normalize the activity of the CTRS. Palliating includes creating surroundings that reduce perceptions of threats like conflict and provide safety, predictability, choice, and positive social support, as well as providing opportunities for voluntary physical activity, restful sleep, and a healthy, nutritious diet.

3.3.1 Environmental factors

The impact of environment on clinical signs was dramatically demonstrated during research using cats with IC as a model for a chronic primary pain condition of the same name in humans (Buffington, 2004; Westropp *et al*., 2024). Two important initial observations were: (i) many of the cats had a variety of comorbid disorders, which had often preceded the onset of the lower urinary tract signs; and (ii) all of the signs essentially resolved within two months of housing in an environmentally enriched research colony.

After observing the remarkable recovery of cats with IC donated to the colony, Dr Judi Stella discovered that various 'sickness behaviors' occurred in some cats, both those with IC and healthy controls, after exposure to 'unusual external events' (Stella *et al*., 2011). Sickness behaviors are variable combinations of nonspecific clinical and behavioral

signs, including diarrhea, vomiting, fever, lethargy, and somnolence, as well as decreases in general activity, body-care activities (grooming), social interactions, and food and water intake (Dantzer *et al*., 2008). Sickness behaviors are thought to reflect a change in motivation of the organism to one that promotes recovery by inhibiting metabolically expensive activities (e.g., foraging, reproducing) and favoring those that contribute to recovery (e.g., reduced activity, hiding). These behaviors are well-documented physiologic and behavioral responses to injury and infection found in all animal species studied (Hart, 1985, 1988).

Stella recorded sickness behaviors referable to the gastrointestinal tract, urinary tract, and skin, as well as behavior problems, for some 18 months. The unusual external events, including changes in vivarium caretakers or routine, and lack of interaction with Dr Stella, were identified during three of these months. No instances were identified during the remaining months, which were considered control months. She found that exposure to these events (especially of older cats), but not disease status, significantly increased total number of sickness behaviors when results were controlled for other factors. Older cats in both groups were at a slightly greater relative risk for upper gastrointestinal tract signs (1.2-fold) and avoidance behavior (1.7-fold). Exposure to unusual external events also significantly increased the relative risk for decreased food intake (9.3-fold), for no eliminations in 24 hours (6.4-fold), and for defecation (9.8-fold) and urination (1.6-fold) outside the litter box. Thus, some of the most commonly observed abnormalities in client-owned cats, including upper gastrointestinal signs, house-soiling, and inappetence, were observed after exposure to unusual environmental events in healthy cats and cats with IC housed in the colony.

Sickness behaviors in response to aversive environmental events result from CTRS-mediated activation of inflammatory pathways in peripheral blood mononuclear cells (Bierhaus *et al*., 2003; Marques-Deak *et al*., 2005; Bierhaus, 2006; Reed and Raison, 2016). Bierhaus *et al*. (2003) reported that subjecting human volunteers to a laboratory stress test rapidly increased circulating concentrations of catecholamines, cortisol, and the transcription factor nuclear factor kappa beta (NF-κB) (Bierhaus, 2006). They also showed in cultured mouse cells that only norepinephrine induced NF-κB, that NF-κB-dependent gene expression was reduced by both alpha1- and beta-adrenergic inhibitors, and that the increase in NF-κB response could be reduced in the presence of the α1-adrenergic inhibitor prazosin.

Raison and Miller (2013) speculated that behavioral responses like depression and sickness behaviors may have provided early mammals an evolutionary advantage in their interactions with pathogens and predators. They proposed that early evolutionary pressures from agonistic interactions with pathogens and predators resulted in an inflammatory bias that included an integrated suite of immunological and behavioral responses that conserved energy for fighting infection and healing wounds while maintaining vigilance against attack.

This idea was extended by Steve Cole, who developed the Conserved Transcriptional Response to Adversity (CTRA), a biomarker based on the differential activation of transcription factor families (Cole, 2019). This activation results in upregulated transcription of pro-inflammatory genes and downregulated transcription of Type I interferon antiviral genes, with consequent reductions in the risk of inflammation-related (injury) resulting from interactions with pathogens and predators at the cost of increased risk of viral ('social') infections.

Environmental threats, in addition to inflammation, can also induce oxidative stress by activating the CTRS. Recent studies have provided evidence that mitochondria can be targets of the CTRS and mediators of threat pathophysiology (Picard and McEwen, 2018a,b). Mitochondria can respond to various products of the CTRS, including norepinephrine (Zhang *et al*., 2017), glucocorticoids, estrogen, angiotensin, and cannabinoids (Picard and McEwen, 2018a). In response, mitochondrial energy production is reduced, production of reactive oxygen species and cytokines increases, and gene expression in the nucleus is affected through epigenetic modulation.

A recent study provided an example of the effects of CTRS-induced autonomic dysregulation on mitochondrial function in the rat urothelium (Kullmann *et al*., 2019). In this study, adult female Wistar Kyoto rats were exposed to 10 days of water avoidance stress, after which their bladders were harvested for Western blot and single-cell imaging in culture. Mitochondria in urothelial cells from stressed rats were ~ 30% more depolarized than those in control rats, and evidence consistent with altered cellular metabolism and impaired cellular function was reported. Stimulating the cells

with α-adrenergic receptor agonists increased reactive oxidative species production, suggesting a direct catecholamine action on the cells, whereas adrenergic receptor antagonists prevented most of the stress-induced changes.

3.3.2 Behavioral factors

Personality and temperament are complex traits that significantly influence pets' interactions with their environment, humans, and other animals. Personality describes the enduring set of traits and styles that animals exhibit and their natural tendencies or personal inclinations. In contrast, temperament is a component of personality that is partially genetically determined, present from early infancy, and considered more stable than other personality characteristics (Bergner, 2020; Strelau, 2020). A complex interplay of biological and environmental factors shapes a pet's personality and temperament. Genetics plays a significant role, with certain breeds predisposed to specific behavioral traits. For example, herding dog breeds often exhibit strong prey drive and a tendency to nip, whereas retriever breeds are generally known for their sociable and trainable nature (Spady and Ostrander, 2008; Serpell and Duffy, 2014). Moreover, individual variation within breeds can be substantial.

Neurochemistry also plays a crucial role in shaping personality and temperament. Central nervous system concentrations and interactions among neurotransmitters like serotonin, dopamine, and norepinephrine can influence mood, reactivity, and overall temperament. Similarly, hormonal balances, particularly of hormones like cortisol, catecholamines, and sex hormones, can affect pet behavior and stress responses. However, minimal evidence currently connects some classic physiological measurements with behavior (Rayment *et al.*, 2020). Brain structure, size, and function also contribute to personality development (Hecht *et al.*, 2019; Horschler *et al.*, 2019), and different brain regions' size and activity, such as the amygdala, which is involved in emotional processing, can also influence personality and temperament (Drzewiecki and Fox, 2024).

Environmental factors are equally important in shaping a pet's personality (Foreman-Worsley and Farnworth, 2019). Early life experiences, particularly during the critical socialization period, between about 3 and 12 weeks of age for puppies, impact behavior (Freedman *et al.*, 1961; Appleby *et al.*, 2002; Casey *et al.*, 2014). The quality of maternal care, exposure to various stimuli, and interactions with humans and other animals during this period all contribute to personality development. Training and education also play a significant role in shaping a pet's behavior. Consistent, positive reinforcement-based training can promote confidence and reduce anxiety, whereas inconsistent or punitive training methods may lead to fear and aggression (Ziv, 2017; Vieira de Castro *et al.*, 2020). The environment and resultant influences can also impact personality development. Such things include whether they reside in an urban or rural setting, the presence of other pets or children, the amount of space and freedom to explore, and human interaction, including the quality and quantity of time spent with owners and the owner's personality and behavior, daily routines, including exercise frequency and type, opportunities for mental stimulation, and sleep patterns (Dodman *et al.*, 2018; Finka *et al.*, 2019; Finka, 2022; Bender *et al.*, 2023).

Personality and temperament traits thus are crucial in determining pets' overall health and well-being. As our understanding of the human–animal bond deepens, so does our appreciation for the individuality of each pet and how unique personality traits can impact the health and quality of life of both the human and the animal (Bräm Dubé *et al.*, 2020). Understanding how these traits impact various aspects of animal health and exploring the factors that shape them can help us develop more targeted approaches to their care, potentially improving outcomes both in our daily interactions with pets and their veterinary care.

Susceptibility

The various personality traits pets exhibit can significantly affect their physical and mental health. Traumatic experiences, such as abuse, neglect, or accidents, particularly early in life, can increase CTRS reactivity, resulting in profound and lasting effects on a pet's personality and health (Pipan *et al.*, 2012; Mills *et al.*, 2014; Piotti *et al.*, 2024; Chapter 12, this volume). A pet's level of reactivity can affect its physical health; highly reactive, anxious dogs may experience frequent spikes in stress hormones, potentially impacting cardiovascular health. They may also be more prone to noise phobias, leading to acute stress during events like thunderstorms or fireworks displays. Chronically

anxious pets may have suppressed immune function, making them more susceptible to infections and illnesses. Alternatively, they may experience inflammatory conditions or develop compulsive behaviors like excessive licking, leading to skin problems.

A pet's energy level and exercise habits also impact its physical health. Pets who do not receive adequate activity are at risk for obesity, which can lead to a host of health issues, including joint problems, diabetes, and heart disease (Chandler *et al*., 2017). Obesity can also be seen from a One Health perspective, as correlations between pet obesity and owner factors have been identified (Suarez *et al*., 2022). We also know that animals, like people, may eat to 'self-medicate' in stressful environments (McMillan, 2013), which can lead to obesity. Conversely, dog ownership can help encourage people to be more active, improving the quality of life and health for themselves and their pets (Tóth *et al*., 2023). In cats, Wall *et al*. (2019) reported that many risk factors, including owner characteristics, affect obesity, concluding that a range of interventional strategies may be needed to prevent the condition. Studies of humans have reached similar conclusions, for example, Yárnoz-Esquiroz *et al*. (2022).

Sociality also affects both physical and mental health. The display of aggression, which is most frequently based in fear and anxiety, has clear implications for physical health. Animals displaying aggression are at higher risk for injuries from fights or confrontations and may also have chronically elevated stress hormones, potentially leading to other health issues (Amat *et al*., 2024). The social isolation often resulting from aggressive behavior can reduce opportunities for exercise and positive interactions, further impacting physical and mental health. However, when an owner manages a dog with aggression by limiting its walks, the dog's welfare may actually improve because it avoids encountering triggers away from the home. In contrast, sociable pets often have lower circulating stress hormone concentrations due to positive interactions, which can boost immune function (Corsetti *et al*., 2018). They also tend to have more opportunities for physical activity and mental stimulation through play. (See Chapter 9, this volume, for a more extensive discussion of the benefits of social relationships.)

Curiosity and intelligence can be double-edged swords for pet health. Curious and intelligent pets often engage more with enrichment activities, promoting cognitive health. However, they may also require more mental stimulation to prevent boredom-related behavioral issues, and their curiosity could lead to such problems as chewing on household items or accidental ingestion of harmful substances if not adequately supervised.

A dog's attachment style to its owners, including the owner's and dog's temperament and the dog's breed group, can also significantly impact its stress levels and overall mental health (Bender *et al*., 2023; Kujala *et al*., 2023). Pets with anxious attachments may be prone to separation anxiety and associated health issues, whereas those with secure attachments often have better overall well-being.

Resilience (see also Chapter 13, this volume)

Resilience, the animal's ability to resist the deleterious effects of exposure to acute and chronic threats, is a particularly impactful factor for mental health (Russo *et al*., 2012; Colditz and Hine, 2016). Based on research in humans (where the concept has received the most study), resilience is the rule rather than the exception. More than two-thirds of the general population experience a significant traumatic event at some time in their lives, and as many as 20% of US residents may experience one in any given year (Galea *et al*., 2005). Despite this high frequency of exposure, the prevalence of pathology resulting from the experience in the general population has been estimated to be only 5–10%, depending on the exposure type, intensity, and duration (Norris *et al*., 2002).

The mechanisms underlying resilience are not entirely known but likely involve variable combinations of passive (genetic) and active (environmental) CTRS-associated differences conferring increased resistance to the pathological effects of exposure to chronic threat (Russo *et al*., 2012). Studies in humans and rodents have found some differences in genes underlying CTRS responsiveness, although the associations are relatively weak. In contrast, it has long been known that neonatal rats exposed to intermittent foot shocks subsequently respond more effectively when confronted with novel situations compared to their non-stressed counterparts, a phenomenon known as 'stress inoculation' (Levine, 1962). The body of research developed since this seminal study has found that exposure to moderate degrees of threat during early life, adolescence, and adulthood can

reduce vulnerability to threat and broaden the range of tolerable threat for animals (Bock *et al*., 2014; Guardini *et al*., 2016; McEwen, 2017; see also Chapter 12 of this volume).

Epigenetic modulation of gene expression related to early life experiences also appears to play a role in this 'inoculation'. Recent studies have reported that epigenetic changes in dopamine function in the hippocampus might modulate the outcome of adverse early life exposure (Roth, 2013; Köhler *et al*., 2019). In the Köhler *et al*. (2019) study, mouse pups were separated from their mothers for three hours on two days at 14–16 days of age (short-term) or a full 21 days starting at day one (long-term). The pups were then subjected to a forced swim test (threat). The researchers found that both long- and short-term separation resulted in changes in dopaminergic molecular pathways, some of which were epigenetically regulated, that either increased (long-term) or decreased (short-term) depressive-like behaviors later in life. Recent studies have revealed even greater complexity as more circuits and mechanisms are uncovered (Yuan *et al*., 2023).

Neural effects of early intermittent separation also include increased cortical volume and synaptic function, decreased glutamatergic tone in the nucleus accumbens, and normalization of neuronal excitability in resilient animals. Strategies like environmental enrichment (EE) can confer resilience by normalizing hypothalamic–pituitary–adrenal (HPA) axis function (Russo *et al*., 2012). Resilience can also affect immune function and vice versa (Dantzer *et al*., 2018); interested readers are referred to the cited references for more details.

A pet's adaptability influences its ability to cope with changes in its environment or routine. Resilient pets, as seen in other species, tend to experience less stress during changes, which can positively impact their overall health (Tiira, 2019). Less adaptable pets, which a recently developed resiliency scale may identify, may suffer from chronic stress in changing environments, potentially affecting their appetite, sleep patterns, and overall well-being (Mackay *et al*., 2023).

3.3.3 Biological factors

Genetic influences

Genes play a role in animals' mental and physical health. The influence of temperament and personality, which have a strong genetic basis, have been discussed above (Section 3.3.2). The many mammalian genomes now published have led to the hope that genetic causes for many chronic diseases will be identified, permitting more targeted disease treatment and prevention strategies. Unfortunately, most genome-wide association studies in humans have failed to find large single-gene effects (Rappaport, 2018). Genetic relationships between health and disease are complex and appear to result from relatively small effects contributed by many genes.

Although we cannot yet directly treat gene-related health problems, they need to be understood. For example, diseases such as syringomyelia in Cavalier King Charles Spaniels may present as a primary behavior problem of 'compulsive circling' and 'fly biting'. Painful conditions, such as hip dysplasia and other genetically related diseases, also can negatively affect an animal's welfare, not only from the pain itself but from the inability to take part in enjoyable activities. Moreover, some breeds are genetically predisposed to display specific abnormal behaviors, such as Doberman Pinschers and the repetitive behavior of self-sucking, primarily due to behavioral predispositions or brain malformation (Dodman *et al*., 2010; Ogata *et al*., 2013).

Genes influencing physical characteristics of animals can also directly affect behavior. For example, animals bred to particular conformational standards, such as corkscrew tails in English Bulldogs or polled-ness in Hereford cattle, may have difficulties communicating with a conspecific. If their signaling is misinterpreted by other animals, it could result in heightened displays of aggression, some of which could directly affect their welfare or the welfare of others in their groups.

In addition to the individuals' genetics, their mental and physical health is influenced by the environmental influences they are exposed to during life (the 'exposome'; Wild, 2005), plus their gene–environment interactions. Rappaport (2016) used published data from Western European monozygotic twins to estimate the proportion of disease risk attributable to genetics, plus shared environments, for 28 chronic diseases by calculating 'population attributable fractions' (PAFs). He reported that genetic PAFs ranged from 3.4% for leukemia to 48.6% for asthma, with a median value of 18.5% and an interquartile range of 9.9% to 24.2%. Cancers had the lowest PAFs (median = 8.3%), whereas neurological (median = 26.1%) and lung

(median = 33.6%) diseases had the highest PAFs. The effects of genetic and shared environmental exposures on the development of the chronic diseases studied tended to be modest, with 75% of the phenotypes having PAFs less than 25%. Only two genetics-related PAFs were greater than 40%: thyroid autoimmunity (42%) and asthma (49%).

McEwen (2017) also reviewed evidence suggesting that different alleles of commonly occurring genes within the CTRS influence how individuals respond to environmental experiences. Rather than the label of 'bad genes', 'reactive' or 'context-sensitive' may be better descriptors of these alleles exacerbating negative effects of threatening environments on mental health outcomes because in positive, nurturing environments these same alleles may lead to successful outcomes, particularly during development (Boyce, 2016).

Early life and epigenetic factors

A momentous recent advance in our understanding of the origins of mental and physical health occurred with the documentation of the developmental origins of health and disease (Hanson and Gluckman, 2015). Although the effects of early life events on health and disease had long been surmised, recent developments can be traced to David Barker's 1990 hypothesis of the fetal and infant origins of adult disease (Barker, 1990). Since then, examples of the effects of early life events on health, disease, and productivity have been reported in cats (Buffington, 2009), livestock (Reynolds *et al*., 2010; Gotoh, 2015), rodents (Anacker *et al*., 2014), and human beings (Anda *et al*., 2006).

Evidence from clinical, epidemiological, and experimental observations has demonstrated how evolutionarily conserved developmental processes can interact with environmental cues, often transmitted from the mother via the placenta to the offspring, to attempt to match the fetus's physiology to its postnatal environment. The sequence of events that has emerged from this research proposes that when a pregnant female is exposed to a sufficiently harsh and salient threat, the neuroendocrine products resulting from the activation of her CTRS can cross the placenta and affect the course of fetal development (Westropp *et al*., 2003; Meaney *et al*., 2007; Cottrell *et al*., 2014).

The biological purpose of transmitting environmental cues to the fetus may be to guide the development of fetal CTRS and their associated behaviors to increase the probability of survival (Matthews, 2002; Gluckman and Hanson, 2006a). The fetus may use cues from its intra-uterine environment to make predictive adaptive response 'decisions' (Gluckman and Hanson, 2005). In other words, if a threatening or nutrient-limiting environment is perceived, the developmental trajectory of the fetus may change in response to the available information to enhance reproductive fitness in the predicted environment. Sensitizing the CTRS may be part of a more general 'survival phenotype' that includes smaller (or larger) size at birth (Parlee and MacDougald, 2014). Although the phenotype does not appear to affect reproductive capacity, it has been associated with a variety of adverse health outcomes.

Studies of the enduring effects of stressful developmental experiences on health have now been published in various mammalian species, including rodents (Molet *et al*., 2014), carnivores (Buffington, 2011), food production animals (Reynolds *et al*., 2010; Merlot *et al*., 2013), nonhuman primates (Meyer and Hamel, 2014), and humans (Griffiths and Hunter, 2014). Such problems can arise when the actual adult environment does not match the predicted one; studies have found that cardiovascular disease, type 2 diabetes, metabolic syndrome, respiratory, gastrointestinal, urinary tract, dental, and mood disorders all can result from a mismatch between the predicted and actual environment the animal inhabits (Gluckman and Hanson, 2006b; Godfrey, 2006). Cognitive function is also affected by both genetic (Matzel *et al*., 2006) and developmental (Chwang *et al*., 2006) influences.

One mechanism underlying the sensitization of the CTRS involves a process called epigenetic modulation of gene expression (Hunter and McEwen, 2013). Whereas research in genetics evaluates the genes one *has*, research in epigenetics evaluates the genes one *expresses*. Our interest in epigenetics developed from a serendipitous finding in cats with IC. During a study of the effects of a corticotrophin-releasing factor antagonist on HPA axis function, we observed that the cats with IC being studied had normal adrenocorticotrophic hormone release but limited adrenocortical release of cortisol (Westropp *et al*., 2003). This study led to a histological examination of these cats' adrenal glands. The glands appeared normal histologically, with no evidence of hemorrhage, inflammation, infection, fibrosis, or necrosis. Morphometric evaluation, however, identified reduced size of the

fasciculata and reticularis zones of the adrenal cortex. Unexpectedly low plasma cortisol concentrations have also been observed in human beings with chronic pelvic pain (Raison and Miller, 2003; Buffington, 2004). The most parsimonious explanation found to date for these findings in the absence of a genetic disorder is a developmental event that results in the perception of threat in a pregnant animal that was sufficiently intense that it 'sensitized' the central threat response system of the offspring (Griffiths and Hunter, 2014; Gatchel and Neblett, 2018).

Epigenetic modulation of gene expression was presciently described as the 'epicenter of modern medicine' more than 15 years ago (Feinberg, 2008). This general biological process results in such commonplace outcomes as sex- and organ-specific patterns of gene expression that lead to an organism's final phenotype by silencing genes not appropriate to the particular tissue environment (Dieckmann and Czamara, 2024).

The effects of environmental threats to the mother on fetal development seem to depend both on the timing and magnitude of exposure to products of the maternal CTRS response in relation to the activity of the developmental 'programs' that determine the maturation of the various body systems during gestation and early postnatal development (Gluckman and Hanson, 2005). For example, the small adrenal cortices found in some cats with IC suggested that the event occurred during adrenocortical maturation. If the developing fetus had been exposed before initiation of adrenocortical maturation, the effect may not have been observed, whereas if it had occurred after adrenocortical maturation, adrenal size and subsequent adrenocortical responses to the CTRS might have been increased (Matthews, 2002).

What influences the outcome of a fetus is not always directly related to what 'should' affect it. As an example, the negative effects of restricting a ewe's caloric intake during pregnancy on a fetus or offspring are frequently observed (Ford *et al*., 2007). However, it has been demonstrated that *excess* energy intake can also have a negative influence on the offspring (Dong *et al*., 2008). Instead of focusing only on underfeeding, an inappropriate balance of nutrients or an overabundance of energy can also have deleterious effects.

The effects of the behavior of the dam on her offspring have been demonstrated in dogs raised to be service dogs for the vision-impaired (Bray *et al*., 2017). By observing the behavior of the dams during their offspring's first three weeks of life, testing via cognitive and temperament tests, and following up with the success, or lack thereof, of the offspring, dogs raised by dams with high maternal behavior scores had a higher chance of displaying anxiety-related behaviors and were more likely to be released from the program. The hypothesis for these results is that too *little* stress, as evidenced by higher maternal care, can deny the offspring the opportunity to learn how to effectively deal with stress.

A 'kennel-dog syndrome' characterized by extreme fear and timidity when subsequently exposed to unfamiliar social interactions or environments can occur in dogs. McMillan and colleagues (2011) compared the mental health of dogs previously housed in commercial breeding establishments for long periods with a convenience sample of dogs in home environments. They found that owners of previously kenneled dogs reported markedly higher levels of fear. For example, compared to matched controls, the odds of scoring in the upper quartiles for stranger-directed fear were more than eight times higher in previously kenneled dogs.

Two reviews have expanded our understanding of early life experiences in dogs. McMillan (2017) reviewed seven published studies and one anecdotal report of behavioral and psychological outcomes of dogs exposed to commercial breeding establishments as neonates. These studies revealed an increased incidence of behavioral and emotional problems that caused distress during adulthood compared with dogs from other sources, especially noncommercial breeders. The most consistent finding was an increase in scores in all categories related to aggression, fear, and anxiety. All published studies suggested that exposure to major stressors during puppy development from the prenatal stage through adolescence was associated with the development of many behavioral (mental health) problems.

Another review by Dietz *et al*. (2018) found similar results, concluding that 'Early life experiences, such as maternal care, attachment, and socialization, have long lasting and serious consequences for an individual's behavioral and physiological development. The complex interplay between these factors will likely affect the future dog–owner bond and the vulnerability to develop behavioral disorders.' Higher levels of maternal care during the first three weeks of life were also associated with more

exploratory behavior and fewer signs of stress in Beagle puppies (Guardini *et al*., 2016). In another study, pups that were separated from their dam at approximately one month of age, compared to those separated at two months of age, were more likely to display problem behaviors related to anxiety, such as noise reactivity and fearfulness on walks (Pierantoni *et al*., 2011). These results suggest that normal maternal care for an appropriate length of time is protective against future behavioral problems in animals (Queen *et al*., 2020) and potentially humans (Francis *et al*., 2002; Rojas-Carvajal *et al*., 2022).

In summary, the changing view in medicine for some chronic conditions from one of an isolated organ-originating disease in otherwise healthy individuals to one of a risk and protective factor perspective has important implications. First, it provides a more straightforward explanation for many previously complicated findings, including the unfortunate lack of beneficial effects of therapies directed at the peripheral organ of interest by a particular medical subspecialty. It also helps explain the presence of multiple comorbid disorders in many patients with chronic disorders but not in patients with other individual organ diseases, the unpredictable order of appearance of the comorbidities, and the altered functioning of the CTRS. More importantly, it opens new approaches to therapy that may escape consideration from the individual medical specialty perspective. However, the available data only suggest this perspective and permit the generation of testable hypotheses. One might imagine several additional complementary or alternative 'systemic' hypotheses related to variable combinations of genetic, epigenetic, and environmental influences; these remain to be explored.

3.4 Evaluating Mental and Physical Health (see also Chapter 23, this volume)

The state of activation of the CTRS can be evaluated by assessing physiological (Table 3.2) and behavioral (Table 3.3) parameters. Animals differ in their responses to threats, and not all animals display all possible signs of threat. Moreover, both increased (e.g., defensive aggression) and decreased (e.g., freezing) activity can be associated with activation of the CTRS. Thus, a thorough assessment of all parameters generally provides the best estimator of CTRS activity in any given animal in any particular context.

Table 3.2. Physiological parameters that may indicate the state of the Central Threat Response System in animals.

Parameter	Normal	Threatened
Temperature	No change	May be increased
Heart rate		
Blood pressure		
Respiratory rate		
Pupil diameter		
'Sweaty' paws	Absent	May be present
Excessive shedding		
Flushing		
Apprehensive lip licking		

3.4.1 Biomarkers

Some of the chemical mediators of the CTRS have been used as 'allostatic load indices' or diagnostic biomarkers of toxic stress responses (Seeman *et al*., 1997; Hellhammer *et al*., 2012, 2018). Molecular biomarkers are substances whose concentrations or amounts correlate with some pathological process (Ghezzi *et al*., 2018). They are used as diagnostic or prognostic indicators and to monitor the progression of pathological processes. Some common examples of biomarkers used to monitor chronic threat are presented in Table 3.4 (Edes and Crews, 2017), although many more genetic, epigenetic, neuroendocrine, metabolic, cardiovascular, immune, pulmonary, and excretory molecules have been investigated among different pathological processes and species.

No single biomarker or allostatic load index has yet been found to unambiguously identify the presence of chronic threats, for a variety of reasons. As one example, different threats – physical (e.g., cold, heat), physiological (e.g., injury, infection, inflammation), and social/emotional (e.g., competition for food, mates, or other precious resources) – result in variable outputs of the CTRS (Pacak and Palkovits, 2001). And for any given threat, responses also vary with context (Proudfoot *et al*., 2012) and among different individuals (Koolhaas, 2008).

In addition to variation across threat, context, and individuals, the relationship of the biomarker to the process of interest also can vary. For example, the biomarker may be related to the disorder's etiology or the body's response to it and may or may not have pathophysiological implications beyond the process that generated it (e.g., inflammation, oxidation). Moreover, the response may not be linearly related to the pathophysiological process. Common examples

Table 3.3. Behavioral parameters that may indicate the state of the Central Threat Response System in animals.

Parameter	Normal	Threatened
Behavioral	Affiliative behaviors – purring, rubbing, etc.	Attempts to flee
	Appetitive lip licking	Apprehensive lip licking
	Interest in eating and drinking	Decreased or absent eating or drinking
	Normal eliminations	Decreased or absent eliminations for longer than 48 hours
	Approach behaviors	Defensive aggression (hissing, growling, spitting, tail twitching, ear flicking, scratching, biting)
	Relaxed postures	Trembling, freezing, hiding, or other fearful postures
	Slow eye blinks	Averting gaze or other displacement behaviors
Sickness behaviors	Absent	Present

Table 3.4. Examples of biomarkers used to investigate pathophysiological responses to chronic threat.

System	Biomarker	Indicator of:
Neuroendocrine	Glucocorticoids	HPA activity
	Epinephrine, norepinephrine	SNS, SAM activity
Metabolic	Glucose	Rapid energy release
	Insulin	Insulin resistance
	Reactive oxygen species	Mitochondrial function
Cardiovascular	Heart rate	Cardiovascular activity
	Heart rate variability	SNS/PSNS balance
	Blood pressure	Cardiovascular activity/peripheral resistance
Immune	C-reactive protein (CRP)	Inflammation (non-specific)
	Erythrocyte sedimentation rate	Inflammation (non-specific)
	Interleukin 6 (IL-6)	Inflammation (cytokine)
	Tumor necrosis factor-α	Inflammatory (cytokine)

HPA, hypothalamic–pituitary–adrenal; SNS, sympathetic nervous system; SAM, sympathetic–adrenal–medullary; PSNS, parasympathetic nervous system.

of this are cortisol (Raison and Miller, 2003), serotonin (Andrews *et al*., 2015), and brain-derived neurotrophic factor (Logan and McClung, 2016), whose concentrations appear to depend upon variable combinations of the disorder, the stage of progression, and the tissue sampled. Indexes available on routine hemograms, such as the neutrophil/lymphocyte ratio and others, have recently been reviewed (Islam *et al*., 2024), and the CTRA (Cole, 2019), reflecting increased inflammatory and decreased viral transcription factors, have been studied for their prognostic value in animals and humans.

Chemical biomarkers also have been used to investigate the effects of environmental enrichment on mental health (Sale *et al*., 2014; Eisinger and Zhao, 2018). Some examples are presented in Table 3.5. Reported effects associated with changes in these biomarkers include improved aging, brain health, and enhanced brain plasticity, which leads to faster brain development and repair (Sale *et al*., 2014). The same caveats suggested for allostatic load indicators also apply to these chemicals.

3.5 Improving Mental and Physical Health in Animals

Animals need environments compatible with their physical and behavioral needs to enjoy mental and physical health. We define EE as the provision of resources that effectively improve the animal's mental and physical health. Provision of effective EE was originally built on the foundation of the Five Freedoms of Animal Welfare (Farm Animal Welfare Council, 1993), which include freedom from: (i) hunger and thirst; (ii) discomfort; (iii) pain, injury, and disease; and (iv) fear and distress; and freedom to (v) express normal, species-typical behaviors. The more current framework for

welfare is the Five Domains (Mellor and Beausoleil, 2015; Mellor *et al*., 2020; Chapter 24, this volume). These are nutrition, physical environment, health, behavioral interactions, and mental state, and are useful in framing the effects of our treatment of animals, compared to the Five Freedoms, which focus on avoiding the things that negatively affect welfare. The first four domains are usually related more specifically to negative or positive experiences, which then contribute to the animal's mental state. Not only must we think about the effects of the physical environment on an animal's behavior, but there is strong evidence of the effects of human behavior, including aversive training methods, personality, and even chemosignals, on dog behavior (Ziv, 2017; D'Aniello *et al*., 2018; Dodman *et al*., 2018; Jamieson *et al*., 2018; Vieira de Castro *et al*., 2020).

For confined animals (at least) these environmental needs include the availability of knowledgeable caretakers, safe resting, eating, and toileting places, choice of food and water, control of interactions with others, and enough novelty to provide mental stimulation (Veasey, 2017). Environmental enrichment is a relatively new concept based on the ancient art of animal husbandry. As shown in Fig. 3.2, a total of 3625 papers on EE were published from 1968 through 2024, the vast majority after 2000. Effective EE addresses the needs of an animal, and has been found to decrease sickness behaviors in confined domestic cats (Stella *et al*., 2011), to improve mental and physical health in a

Table 3.5. Examples of biomarkers used to investigate physiological responses to environmental enrichment (EE) (Sale *et al*., 2014; Eisinger and Zhao, 2018).

System	Biomarker	Change with EE
Growth factor	Insulin-like Growth factor 1 (IGF-1)	Increase
	Brain-Derived Neurotrophic Factor (BDNF)	Increase (depending on source)
Transcription factor	Cyclic AMP Response Element-Binding protein (CREB)	Increase
Process	Histone acetylation	Increase
	DNA methylation	Decrease
Synaptic receptors	*N*-methyl-D-aspartate (NMDA)	Increase
Neural adhesion	Neural cell adhesion molecule (NCAM)	Increase
Neurotransmitter	Serotonin	Increase
Protein	B-amyloid	Decrease
Hormone	Adiponectin	Increase
Myokine	Cathepsin B	Increase
Chemokine	Fractalkine (CX_3CL1)	Increase
Mitochondria	Reactive oxygen species	Decrease

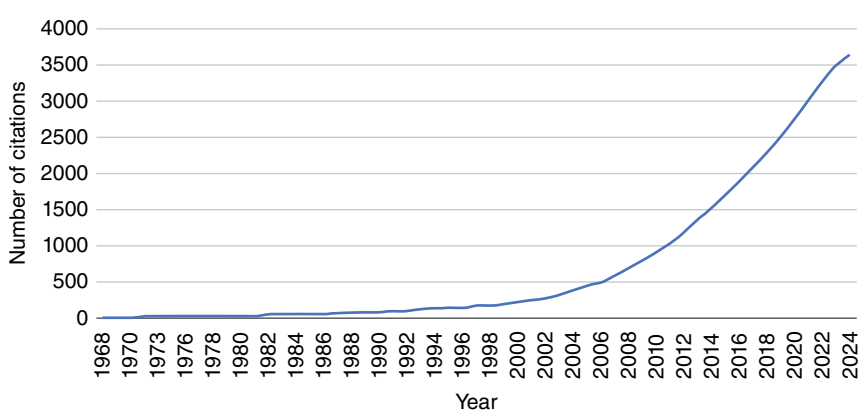


Fig. 3.2. National Library of Medicine publications of 'environmental enrichment' on PubMed. A total of 3625 articles on the topic were published from 1968 through 2024 (National Library of Medicine, 2024).

variety of species, and to normalize behavioral and physiological parameters associated with the CTRS (Sale *et al*., 2014; Mármol *et al*., 2015, 2017; Eisinger and Zhao, 2018; Montes *et al*., 2018; Sadek *et al*., 2018).

3.6 Summary and Conclusions

It is appropriate to evaluate interrelationships between mental and physical health in animals, especially as these relationships are being re-evaluated in the human literature, and to review the research in nonhuman animals. Environmental events substantially affect animals in ways that we are still trying to understand. Moreover, recent research has found both negative (threatening) and positive (enriching) environmental influences on a variety of processes affecting mental and physical health, including inflammation and mitochondrial (dys)function. Knowing this, and the fact that virtually every aspect of health and disease is influenced by mental factors, suggests that veterinarians may unknowingly encounter many other conditions influenced by the mental health of the patient (Buffington, 2018).

The expanding body of literature has now provided a greater understanding of the interactions between the environment, emotional states, and mental and physical health. One of the most evident direct and immediate applications of this knowledge is in veterinary medicine, where veterinarians can provide the best medical care only when mental health is included in their patient evaluations and treatments. Another direct and immediate application of this knowledge is in animal science, which is well-positioned to mitigate predisposing risk factors and provide protective, species, age, and context-specific palliating factors. Thus, studies across mammalian species show that while negative emotions such as anxiety, fear, anger, and loneliness can have extensive adverse effects on animal health, positive environments, which provide appropriate amounts of safety, predictability, novelty, and social interaction, can have impressively beneficial effects on both the mental and physical health of the animals in our care.

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4 Nutrition in Companion Animal Mental Health

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4.1 Introduction

Traditionally in human mental health, it was believed genetic variants that directly impacted brain development and function were the primary drivers of behavioral symptoms associated with neurological disorders. As a result, therapeutic approaches for neurological disorders were all aimed to target the brain. Through rodent studies it is now understood that in addition to variations in host genes, the microbiome is another source of variation that can explain certain phenotypic changes in behavior (Costa *et al*., 2024).

In the human scientific literature, there has been an emergence of compelling evidence for a complex relationship between the gut microbiota and brain function or what is termed the microbiome–gut–brain axis (MGBA), which refers to the bidirectional communication between the gastrointestinal tract, microbiome and the brain. In fact, the term MGBA summarizes many bidirectional pathways including the enteric nervous system as part of the autonomic nervous system, the hypothalamic–pituitary–adrenal axis (HPA), immune, and neuroendocrine systems. Studies have shown that the gut microbiota can impact cognition, mood, and overall psychological well-being in healthy states, as well as neuropsychological and neurological disorders, such as anxiety, depression, autism spectrum disorders, bipolar disorder, schizophrenia, eating disorders, Parkinson's disease, dementia, migraines, and epilepsy (Costa *et al*., 2024).

Studies of the MGBA have led to the understanding that individual phenotypes may arise from complex interactions between host genes and microbial genes. For example, an elegant series of studies using *Cntnap2*$^{-/-}$ mice as a model of autism, which had the maladaptive behaviors of hyperactivity and social deficits, determined that the maladaptive behaviors were interdependently regulated by the microbiota and host genes (Buffington *et al*., 2021). The hyperactivity phenotype of these mice was caused by host genetics, whereas the social-behavior phenotype was mediated by the MGBA. The studies demonstrated that fecal microbial transplant (FMT) rescued social deficits in the *Cntnap2*$^{-/-}$ mice, but it had no impact on hyperactivity. If germ-free mice received a fecal transplant from the *Cntnap2*$^{-/-}$ mice, the germ-free mice displayed only the maladaptive behavior of social deficits, but no hyperactivity.

It is known that the oxytocinergic system modulates numerous aspects of social behavior and is implicated in autism spectrum disorder. Previous research showed that *Lactobacillus reuteri* promoted oxytocin levels in plasma. The *Cntnap2*$^{-/-}$ mice had abnormalities in their oxytocinergic system and low levels of oxytocin in their plasma. Treatment of *Cntnap2*$^{-/-}$ mice with *L. reuteri* reversed the deficits in oxytocin-producing neurons. When young and old *Cntnap2*$^{-/-}$ mice were treated with *L. reuteri*, this specific microbial intervention selectively rescued their social deficits but had no effect on hyperactivity. The authors concluded that both the brain and gut microbiota may need to be targeted to fully and effectively reverse the core symptoms associated with some neurological disorders (Buffington *et al*., 2021). Understanding that maladaptive behavior and neurological disorders could have distinct origins (host versus microbiome) should change the way we think about and approach management of neuropsychological and neurological disorders in our veterinary patients with behavior issues.

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4.2 The Gastrointestinal Microbiome and Microbiota

The gastrointestinal (GI) or gut microbiome can be defined as the collective genetic information and all the structural elements (nucleic acids, proteins, lipids, polysaccharides), metabolites (signaling molecules, toxins, organic and inorganic molecules), and molecules produced by coexisting hosts in the GI environment. The GI microbiota consists of bacteria (the largest group), archaea, fungi, protozoa, and viruses. The total microbial load ranges from trillions to hundred trillions with about 150 times more microbial genes than host genes, i.e., human or nonhuman animal (hereafter animal) (Berg *et al*., 2020; Fernández-Pinteño *et al*., 2023). Interestingly, the critical network structures of animal microbiota are qualitatively and structurally like those of the human gut microbiomes with three primary phyla Bacteroidetes, Firmicutes, and Proteobacteria (Ma and Shi, 2024). The gut microbiota modulates physiological systems and is an essential component of development and maintenance of normal physiology and health. It participates in nutrient metabolism, multiple metabolic functions, protects against pathogens, and plays a crucial role in the immune response (Ma and Shi, 2024).

4.3 Development of Gut Microbiota and the Microbiota–Gut–Brain Axis

In healthy humans, the gut microbiota is established towards the end of gestation and through the process of parturition. The gut microbiota of an infant will differ if the newborn is delivered vaginally compared to by cesarean section. Breast feeding also has an impact on the infant's microbiota. Similarly, the microbiome in puppies is influenced by type of parturition, maternal microbiome, and the diet of the bitch directly and indirectly. At weaning with consumption of solid food and at about 4–6 months of age, the microbiota resembles that observed in adult dogs and remains largely stable in adulthood. Human studies report changes in the gut microbiota with aging, but this has not been as closely evaluated in companion animals (Balouei *et al*., 2023; Beretta *et al*., 2023).

Microbial colonization of the gut is involved in local development of the GI tract, i.e., intestinal cell proliferation, vascularization, and the enteric nervous system. It has also been shown to impact development of the brain, nervous system, local and systemic immune responses, and HPA axis (Homer *et al*., 2023). This occurs because of the numerous metabolites and compounds produced by the developing microbiota that can act via the vagus nerve, the blood brain barrier (BBB), and through modulation of the HPA axis and immune system (Chen *et al*., 2021). Some of the most important microbial products include short-chain fatty acids (SCFAs) such as acetate, propionate, and butyrate as well as neurotransmitters and their precursors (Silva *et al*., 2020; Chen *et al*., 2021; Mikami *et al*., 2023). For example, it has been shown that SCFAs act locally maintaining the intestinal barrier but also have direct effects by entering the circulation, crossing the BBB to upregulate tight junction proteins, limiting neuroinflammation by decreasing activity of microglia, stimulating neurogenesis, modulating neuro homeostasis and functions (Silva *et al*., 2020; Chen *et al*., 2021; Dash *et al*., 2022; Mikami *et al*., 2023). SCFAs also play a role in limiting immune and endocrine responses due to their anti-inflammatory properties, which include activating T-regulatory cells and decreasing the expression of proteins in the HPA axis (Caspani and Swann, 2019).

Furthermore, the microbiota produces neurotransmitters and/or their precursors (Halverson and Alagiakrishnan, 2020; Homer *et al*., 2023), including but not limited to:

- Serotonin: produced by *Escherichia*, *Enterococcus*, *Candida*, and *Streptococcus*
- Norepinephrine: produced by *Escherichia*, *Bacillus*, and *Saccharomyces*
- Dopamine: produced by *Bacillus*
- Gamma-aminobutyric acid (GABA): produced by *Lactobacillus* and *Bifidobacterium*
- Acetylcholine: produced by *Lactobacillus*
- Tryptophan: produced by *Clostridium*, *Bacteroides*, *Escherichia*, *Burkholderia*, *Streptomyces*, *Pseudomonas*, and *Bacillus*

These neurotransmitters can act locally to affect GI function by stimulating enteroendocrine cells, which regulate the enteric immune response and gastrointestinal function. Alternatively, they can influence the central nervous system (CNS). Although gut-derived neurotransmitters cannot cross the BBB, they act as signaling molecules on neuropod cells, specialized enteroendocrine cells that synapse with the vagus nerve to transmit signals to the brain (Kuwahara *et al*., 2020; Chen *et al*., 2021; Homer *et al*., 2023).

Importantly, these microbial products have neuroactive properties that influence the host's CNS, impacting emotions, mood, and behavior. Conversely, the CNS affects gut motility, secretion, and permeability, which in turn influences the microbiota. This ongoing bidirectional communication underscores the importance of nurturing a healthy gut microbiome in neonates to establish a normal MGBA (Chen *et al*., 2021; Homer *et al*., 2023; Mikami *et al*., 2023).

4.4 Dysbiosis

Health is dependent on a stable MGBA that maintains a homeostatic balance of GI bacteria. Microbial diversity and stability are often used as key indicators of gut health due to their inverse association with chronic disease and metabolic dysfunction (Martinez *et al*., 2021). Dysbiosis refers to an imbalance in the intestinal microbiota, including their metabolic activities and distribution throughout the GI tract. Other definitions of dysbiosis encompass a reduction in bacterial diversity, a loss of beneficial bacteria, and/or an overgrowth of pathogenic bacteria (Mondo *et al*., 2019).

As the gut microbiota are responsible for producing significant amounts of SCFAs, neurotransmitters, and their precursors, changes in bacterial composition can impact the concentrations of these neuroactive messengers, thereby affecting neurological functions and behavior. Furthermore, dysbiosis can directly influence the GI system through alterations in SCFA concentrations and other metabolites. Dysbiosis can lead to what is often termed 'leaky gut', a syndrome characterized by intestinal inflammation, impaired permeability, and the subsequent release of microbial metabolites, antigens, and enteric corticosterone into the systemic circulation (Halverson and Alagiakrishnan, 2020; Makris *et al*., 2021; Homer *et al*., 2023). Some of these gut-derived molecules can cross the BBB or modulate the vagus nerve, activating the HPA axis and resulting in the release of cytokines and prostaglandins, which trigger inflammatory responses. This stress response can induce physiological changes that affect behavior, including cognition, fear, anxiety, and aggression (Homer *et al*., 2023).

Since the MGBA is bidirectional, the activation of the HPA axis can influence gut motility, secretions, and permeability, thereby altering the gastrointestinal environment and exacerbating dysbiosis. The release of catecholamines may directly stimulate the growth of pathogenic bacteria, leading to the amplification and perpetuation of dysbiosis and leaky gut syndrome (Makris *et al*., 2021; Homer *et al*., 2023).

There are many potential causes of dysbiosis identified in the literature, including poor diet, dietary changes, antimicrobial use, use of other drugs, aging, hygiene practices, pathogenic infection, and even stress itself (Martinez *et al*., 2021; Naufel *et al*., 2023). Since the establishment of a healthy microbiome is closely linked to the development of the immune and nervous systems during critical periods in neonates, disruptions caused by antibiotic treatments, poor nutrition, or other factors that induce dysbiosis may result in lifelong effects on the MGBA (Sperber, 2021).

4.5 Comparative Microbiome–Gut–Brain Axis

The growing number of studies on human mental health and the MGBA offers valuable insights that can be applied to the mental health of our veterinary patients. In an extensive review, Sorboni *et al*. (2022) state:

> Several neuropsychiatric and behavioral disorders are correlated with responsive stress conditions, including chronic stress, dysregulated HPA axis stress response, and individual coping skills and strategies and resilience to stress, which are now found to be potentially modifiable targets through modulation of the gut microbiome. Through bidirectional interactions between the GI microflora and other environmental risk factors, including stress and diet, it has been proposed that targeting the gut microbiome may impact the prevention and treatment of mental and behavioral disorders.

This comprehensive review of human mental health research identifies correlations between the abundance of specific bacterial taxa and mental disorders such as bipolar disorder, anxiety, depression, autism, and schizophrenia. It also discusses the role of microbial interventions in human and rodent studies of mental health. Homer *et al*. (2023) present a comparative review assessing the similarities in gut microbiota across species, comparing gut microbiota population shifts associated with human mental disorders to those observed in animals. The authors note that while there is a substantial body of research in human medicine, there are limited studies in companion animals exploring the connection between abnormal behavioral phenotypes and disturbances in the gut microbiota.

The authors conclude that although the literature shows an association between gut microbiota diversity and abnormal behavioral phenotypes across various species, including pigs, dogs, and horses, there are insufficient data to determine whether this association is causal. Clearly, more research is needed to establish causal relationships between gut microbiota and behavioral issues in companion animals. Such research could lead to the development of novel therapeutics and preventative interventions aimed at restoring a healthy MGBA to improve the mental health and well-being of these animals.

4.6 Microbiome–Gut–Brain Axis Studies in Companion Animal Mental Health

As discussed, much of the early research on the MGBA was conducted in rodents, but studies evaluating its role in human mental health are now flourishing. In contrast, most studies on the gut microbiota in companion animals have focused on dogs with chronic enteropathy (CE). Veterinary medicine continues to struggle with understanding, classifying, and developing appropriate diagnostics and treatments for CE (Jergens and Heilmann, 2022). Similarly, mental disorders such as autism, schizophrenia, bipolar disorder, anxiety, and depression, which are recognized in human medicine, are not well defined in veterinary medicine. This may be due to the difficulty in establishing specific pathognomonic features, potentially impeding research into the complex relationship between a healthy gut microbiota and the mental health and welfare of companion animals.

Another potential obstacle to advancing the understanding of the MGBA in veterinary medicine could be due to the specialty colleges in veterinary medicine. The American College of Veterinary Internal Medicine (ACVIM) has subspecialty neurologists who are trained in the pathophysiology of the brain, spinal cord, and muscles, while the American College of Veterinary Behaviorists (ACVB) focuses on behavioral problems that may result from neurochemical imbalances, medical conditions, learned fearful associations, or conflicts over rules and social structure. According to the ACVB, 'Veterinary Behaviorists are in a unique position to diagnose medical conditions that can affect a pet's behavior, as well as treat conditions that are purely behavioral'. Most research on companion animal microbiomes has, however, been led by ACVIM subspecialists in Small Animal Internal Medicine or Nutrition. Collaborative efforts between these specialists could further our understanding of the role of the MGBA in the mental health of veterinary patients.

There are some published studies that discuss behavior within the context of GI disorders and/or microbiota. For instance, Frank *et al*. (2012) evaluated seven dogs for fly biting, a behavior previously categorized as hallucinatory, locomotory, or oral obsessive–compulsive, with potential differentials including neurological conditions, disorders of the special senses, or neuropathic pain syndromes. After thorough medical diagnostics, most of the dogs were found to have underlying GI disease. Similarly, a case of star gazing in a Yorkshire terrier was linked to reflux and esophagitis, with signs resolving following appropriate GI treatment (Poirier-Guay *et al*., 2014). Another study on excess licking of surfaces (ELS) noted that 14 out of 19 dogs with ELS had GI abnormalities, leading the authors to recommend considering GI disorders in the differential diagnosis of dogs with ELS (Bécuwe-Bonnet *et al*., 2012).

Although these studies did not specifically evaluate the microbiota, one study did analyze the microbiome in fecal samples from a small population of pit-bull-type dogs seized from an organized dogfighting operation. Among these, 21 dogs displayed conspecific aggressive behaviors, while ten dogs were deemed normal. The study reported taxonomical differences between aggressive and non-aggressive dogs. Despite the small sample size, the authors suggested that 'our findings indicate that gut microorganisms are linked to dog aggression and point to an aggression-associated physiological state that interacts with the gut microbiome'. They also proposed that microbiome analysis could potentially serve as a diagnostic tool for determining aggression in dogs (Kirchoff *et al*., 2019). Another study evaluated dogs with aggression (n = 11), phobic behaviors (n = 13), and normal behaviors (n = 18), finding no differences in hormonal levels between groups but reporting characteristic gut microbiome differences. Aggressive dogs had high biodiversity and enrichment in generally subdominant bacterial genera (e.g., *Catenibacterium* and *Megamonas*), while phobic dogs were enriched in *Lactobacillus*, which has probiotic and psychobiotic properties. The authors noted that further studies are needed to evaluate different behavioral phenotypes in dogs to better understand the role of

the microbiome and its connection with the CNS (Mondo *et al*., 2020).

Studies have also explored the role of the MGBA in cognition, aging, and performance in dogs. For example, Venable *et al*. (2016) tested the effects of airline travel stress on six dogs (aged 18 months to 8 years) trained to Federal Emergency Management Agency (FEMA) standards. Two groups of dogs (n = 3 per group) were randomly selected from FEMA canine teams in New York City, NY (CONTROL) and Miami, FL (TRAVEL). The TRAVEL dogs were flown on a commercial airline to New York. Blood and fecal samples were collected each morning before travel (d0) and search work (d1–d3). The TRAVEL dogs had significantly higher fecal scores, indicating softer stools, and their fecal bacterial communities differed significantly from CONTROL dogs, though no differences were observed during search work. The authors concluded that airline travel impacts the gut microbiota of working canines, potentially as an indicator of stress, but does not affect their performance.

Kubinyi *et al*. (2020) assessed cognition in 29 client-owned dogs using a memory test and analyzed fecal samples to determine if short-term memory and age are linked to gut microbiome composition. Older dogs had a lower proportion of *Fusobacteria*, while dogs with better memory performance had fewer *Actinobacteria*. These results align with human Alzheimer's disease studies, which report a high abundance of *Actinobacteria*. Craddock *et al*. (2022) characterized the fecal microbiota of 134 working dogs to determine its association with behavioral and performance outcomes. The study reported statistical associations between microbiome markers and various traits, including motivation, aggression, cowardice/hesitation, sociability, obedience, and body condition score (BCS). The study suggested that gut microbiome markers could potentially be used to improve care for working canines.

A study of client-owned dogs (n = 48) categorized them into higher or lower anxiety and aggression groups based on the owner's responses to the Canine Behavioral Assessment & Research Questionnaire (C-BARQ). Microbial DNA extracted from fecal samples was assessed for associations with the dog's behavioral group. Although minimal differences were found between groups based on the entire gut microbial composition, models were particularly successful at distinguishing higher and lower anxiety dogs. The genus *Blautia* was identified across all analyses, suggesting a strong link between this genus and anxiety in pet dogs (Pellowe *et al*., 2023).

Another study investigated memory performance using four litters of puppies (27 study dogs) reared and trained at the Auburn University College of Veterinary Medicine's Canine Performance Sciences Program (AUCVM-CPS) colony. The study aimed to explore the relationship between the gut microbiome and memory performance across three time points. Previous studies have indicated plasticity in canine memory performance, suggesting the influence of non-genetic factors. All four litters were produced by genetically related breeders from the same extended pedigree, partially controlling for genetic background. Memory tests and metagenomic sequencing of fecal samples collected at each time point revealed a trend of improving memory scores with age in these young dogs, but with significant plasticity. The gut microbiome data identified *Bifidobacterium pseudolongum* as correlated with elevated memory scores. A random forest regression model revealed that sex, litter, and breed had minimal predictive importance. While age had some predictive value, it was not statistically significant, whereas the abundance of 17 bacterial taxa was a stronger predictor of memory performance. The authors concluded that substantial variations in memory scores cannot be explained solely by litter, sex, breed, or environmental effects (Ma *et al*., 2024).

4.7 Microbiome–Gut–Brain Axis Studies and Canine Idiopathic Epilepsy

Typically, veterinary neurologists guide the diagnostics and treatment for veterinary patients with epilepsy, which is the most common neurological disorder in dogs. Similarly, epilepsy affects approximately 50 million people worldwide. In human and rodent studies, the MGBA appears to play a critical role in the development and progression of epilepsy. Additionally, epilepsy has been associated with behavioral comorbidities, including an increased prevalence of attention-deficit/hyperactivity disorder (ADHD) (Packer *et al*., 2019; Zhu *et al*., 2024). Packer *et al*. (2016) evaluated 21 dogs with idiopathic epilepsy (IE) to determine if these dogs also exhibited ADHD-like behavior. Owners completed a validated behavioral questionnaire measuring 11 defined behavioral factors, with three specific behaviors hypothesized to relate to ADHD:

excitability, chasing, and trainability. The highest-scoring behavioral factors were excitability and chasing, while trainability scores were low. The data from this study supported the hypothesis that dogs with IE may exhibit behaviors resembling ADHD symptoms seen in human and rodent models of epilepsy.

Reviews on IE in dogs further expand on the behavioral comorbidities, reporting ADHD/ADHD-like behaviors, cognitive issues, and fear/anxiety. Additionally, these patients often experience a reduced quality of life owing to the side effects and complications of anti-epileptic drugs, and early death. Canine IE typically has an early onset between 1 and 4 years of age, resulting in lifelong medication use that may benefit seizure control but often comes with side effects, including excessive hunger, thirst, restlessness, lethargy, and ataxia (Packer *et al*., 2019; Peek *et al*., 2024). In a comparative review of canine and human IE, Packer *et al*. (2019) present evidence from human studies on the efficacy of behavioral interventions in improving seizure control, psychiatric comorbidities, and quality of life. The authors discuss adapting these behavioral interventions for canine patients and advocate for a combined role for behaviorists, neurologists, and general practitioners. Peek *et al*. (2024) and Gernone *et al*. (2022) also provide a comparative view of human and canine IE, MGBA, highlighting the cognitive and behavioral comorbidities and emphasizing the need for further research.

As our understanding of the MGBA grows, this author proposes considering the perspective that behavior and epilepsy may be part of a continuum of neurological dysfunctions in veterinary patients. In the author's clinical experience, early nutritional intervention in dogs with IE has provided better management, such as reduced seizure frequency and intensity, and in a few cases, complete resolution of epilepsy and discontinuation of epileptic drugs. This suggests that the management of a dog with IE might also benefit from the inclusion of a nutritionist in the treatment plan.

4.8 Nutrition and Companion Animal Mental Health

The author subscribes to the well-known phrase attributed to Hippocrates around 400 BC: 'Let food be thy medicine and medicine be thy food'. The gut microbiota, often referred to as a 'vital organ', communicates with the body through neural, endocrine, immune, humoral, and metabolic pathways. These trillions of bacteria are fueled by dietary nutrients to synthesize bioactive compounds and metabolites that signal remote body organs, impacting the host's metabolism and overall function. As discussed, the gut microbiota plays a crucial role in maintaining metabolic homeostasis and organ physiological functions, forming an axis with bidirectional signaling. Meanwhile, their metabolites contribute to the host's metabolic phenotype and disease risk. Numerous studies have examined not only the MGBA but also the various 'axes' between the gut microbiota and other body systems, such as the Gut–Skin, Gut–Bone, Gut–Kidney, Gut–Heart, and Gut–Adipose axes (Ahlawat *et al*., 2021). As a clinical nutritionist, the author believes that optimal nutrition should cater not only to the patient but also to the patient's microbiota.

It is well established that the gut microbiome is highly responsive to dietary nutrients. Changes in bacterial taxa generally require significant changes in dietary macronutrients, such as proteins, fats, and carbohydrates. For example, some bacteria ferment carbohydrates and fiber, while others are proteolytic. Notably, diet-induced changes in microbiome composition are maintained only by long-term adherence to a specific diet with a consistent macronutrient profile (Pilla and Suchodolski, 2021). In a study of healthy dogs fed a specific diet of purified amino acids and starch for 32 weeks, changes in microbiome composition were reported, differing from those on a control diet. However, when the dogs were returned to the control diet, their microbiome composition quickly reverted to baseline (Allaway *et al*., 2020).

Additionally, the inclusion of micronutrients can impact bacterial-derived metabolites, including neuroactive compounds. This is an emerging area of microbiome research. Neuroactive compounds can include micronutrients as well as prebiotics, probiotics, synbiotics, and postbiotics, which can have a range of direct and indirect effects on the gut microbiota (Pilla and Suchodolski, 2021). The specific definitions of these terms are as follows (Sacoor *et al*., 2024):

- Prebiotics are defined as substrates specifically utilized by host microorganisms to provide a health advantage. Prebiotics found in complex carbohydrates, also known as dietary fibers, include phenolics, phytochemicals, conjugated

linoleic acids, polyunsaturated fatty acids, human milk oligosaccharides, and various oligosaccharides.

- Probiotics are live microorganisms that, when administered in adequate amounts, confer a health benefit on the host. These beneficial bacteria are widely used in food and beverages, including infant formulas, animal feed, and nutritional supplements.
- Synbiotics refer to synergistic mixtures of probiotics and prebiotics that beneficially affect the host by improving the survival and colonization of live beneficial microorganisms in the GI tract.
- Postbiotics are defined as: (i) 'soluble factors secreted by live bacteria or released after bacterial lysis, such as enzymes, peptides, teichoic acids, peptidoglycan-derived muropeptides, polysaccharides, cell-surface proteins, and organic acids'; (ii) 'non-viable metabolites produced by microorganisms that exert biological effects on the host'; and (iii) 'compounds produced by microorganisms, released from food components or microbial constituents, including non-viable cells that, when administered in adequate amounts, promote health and well-being' (Gurunathan *et al*., 2023).

Numerous reviews and systematic analyses in rodents and human mental health research have evaluated the effects of prebiotics, probiotics, synbiotics, postbiotics, and FMTs (Cryan *et al*., 2019; Sacoor *et al*., 2024; Tuniyazi *et al*., 2022). Unfortunately, in veterinary medicine, these interventions have been studied primarily for the treatment of CEs. However, rodent studies of prebiotic supplementation have demonstrated reductions in anxiety, stress response, and depression-like behavior (Cryan *et al*., 2019). Probiotic studies of *Faecalibacterium prausnitzii* (ATCC 27766) in rodents have shown its potential as an anxiolytic and antidepressant, leading to the concept of 'psychobiotics', defined as microbiota-targeted interventions such as 'beneficial bacteria (probiotics) or support for such bacteria (e.g., prebiotics) that influence bacteria-brain relationships' (Cryan *et al*., 2019). Various strains, including *Lactobacillus plantarum P-8*, *Streptococcus*, *Bifidobacterium*, *Lactobacillus*, and *Lactococcus*, as well as *Lactobacillus rhamnosus* HN001, have been shown to improve stress, anxiety, memory, and cognitive potential in humans (Sacoor *et al*., 2024). A systematic review of 44 studies on autism spectrum disorder in children reported that probiotics, particularly strains of *Lactobacillus*, *Bifidobacterium*, and *Streptococcus*, show promise in alleviating behavioral and gastrointestinal symptoms (Lewandowska-Pietruszka *et al*., 2023). Another systematic review of intestinal microbiota composition and function in pediatric and adult patients affected by autism spectrum disorder (ASD), ADHD, and Rett syndrome evaluated five studies on probiotic interventions with *Lactobacillus* species and FMT. The analysis reported reduced constipation and improved ASD symptoms in affected children, while perinatal administration of *Lactobacillus* sp. prevented the onset of Asperger and ADHD symptoms in adolescence. The authors also noted that probiotic treatment in early life may reduce the risk of an ADHD diagnosis at 13 years of age, while antibiotics and cesarean section delivery may increase risks (Caputi *et al*., 2024). The extensive body of research on the use of prebiotics, probiotics, synbiotics, postbiotics, and FMT in rodent and human mental health studies may offer a promising approach to understanding the biological mechanisms linking gut microbes with neurodevelopment and potentially novel therapeutic interventions for veterinary patients (Kiełbik and Witkowska-Piłaszewicz, 2024).

However, there are limited published data on the use of these products for mental health in veterinary patients. In one study, 14 days of supplementation with *Lactiplantibacillus plantarum* PS128 appeared to stabilize aggression and separation anxiety behaviors in dogs, potentially by slowing the turnover of 5-hydroxytryptophan (5-HT) in the plasma (Yeh *et al*., 2022). Researchers at Purina® have highlighted the potential benefits of *Bifidobacterium longum* (BL999) in 24 anxious Labrador Retrievers (McKinney, 2018). Another trademarked product, Relaxigen Pet®, which combines prebiotics (fructooligosaccharides), probiotics (*Lactobacillus reuteri*), postbiotics (butyric acid), L-theanine, and other natural anti-inflammatory compounds, was evaluated in 40 anxious dogs. The authors reported fewer anxiety-type behaviors in the treatment group compared to the control group (Cannas *et al*., 2021).

In a study of nine dogs with drug-resistant IE and comorbid ADHD-like, fear, and anxiety-like behaviors, three colonic FMTs were administered two weeks apart. The dogs were reevaluated at 3 and 6 months post-FMT. The study reported improvements in ADHD-like, fear, and anxiety-like

behaviors, as well as quality of life. Levels of excitatory neurotransmitters aspartate and glutamate decreased, while the inhibitory neurotransmitter GABA increased compared to baseline. Although none of the dogs were seizure-free, four dogs experienced more than a 50% reduction in seizure cluster days at the 3- and 6-month rechecks (Watanangura *et al*., 2024). Another study evaluated the effects of saline compared to oral FMT over 14 days in 20 Wolf Cyan police dogs. Growth performance, police performance, serum biochemical profiling, and gut microflora analysis were evaluated 2 weeks post-FMT. The dogs were also subjected to an hour of road transportation and evaluated for serum stress indicators. FMT appeared to reduce the diarrhea rate and stress indicators in the police dogs (Lin *et al*., 2024). These small pilot studies highlight the potential of FMT as a novel approach to improving mental health outcomes in dogs with IE and behavioral comorbidities, as well as stress in police working dogs.

4.9 Other Nutritional Strategies and Whole Diets Effects on the Microbiome–Gut–Brain Axis

There is a wide array of individual nutrients – such as tryptophan, omega-3 fish oils, medium-chain triglyceride (MCT) oil, and botanicals/botanical extracts – that has been marketed and used either individually or in various pet supplements for veterinary behavior patients. Tynes and Landsberg (2021) and Fan *et al*. (2023) provide excellent reviews of these nutritional therapies. When considering the role of the MGBA in relation to these nutrients, compounds, or supplements that appear to have beneficial effects in veterinary patients, it is essential to understand whether their mechanism of action is a direct effect on the patient, a modulation of the patient's microbiota, or both.

In the Packer *et al*. (2016) study on dogs with IE cited earlier, the researchers focused on three specific behaviors hypothesized to be related to ADHD: excitability, chasing, and trainability. The study evaluated the effects of a ketogenic MCT diet compared to a placebo diet. Dogs were randomized to receive either the MCT diet or the placebo diet for three months before crossing over to the other diet. The MCT diet led to a significant improvement in the ADHD-related behavioral factor of chasing and a reduction in stranger-directed fear compared to the placebo diet.

Another study evaluated the effects of a ketogenic MCT-enriched diet administered for one month on the fecal microbiota of epileptic (n = 11) and non-epileptic beagle dogs (n = 12). The epileptic dogs were further categorized into those with drug-sensitive epilepsy (DSE) and those with drug-refractory epilepsy (DRE). At baseline, the microbiota patterns were similar between non-epileptic beagles and dogs with DSE but significantly different from those with DRE. In both non-epileptic and DSE groups, the MCT diet decreased the relative abundance of *Firmicutes* and increased that of *Bacteroidetes* and *Fusobacteria*. However, the opposite effect was observed in dogs with DRE. These results suggest that the effects of an MCT diet may depend on individual baseline microbiota patterns and that ketogenic diets could help reduce gut microbiota differences between dogs with DRE and DSE. However, longer-term studies are needed to confirm these findings (García-Belenguer *et al*., 2023).

4.10 Relevant Human Diet Research and the Microbiota–Gut–Brain Axis

The consumption of highly processed foods by humans has increased exponentially over the decades. To understand the effects of processed foods on human health, the NOVA food classification system was developed. The terms 'ultra-processed (UPF)', 'processed', and 'minimally processed foods' were defined by the NOVA system and applied to foods and culinary ingredients according to the nature, extent, and purpose of industrial processing (Monteiro *et al*., 2018). Numerous epidemiological studies using the NOVA system have provided evidence from 45 meta-analyses encompassing almost 10 million human study participants. In addition to associations between increased UPF consumption and obesity, diabetes, cardiovascular disease, and cancers, there are also reported associations with mental health (Elizabeth *et al*., 2020; Dinu and Martini, 2023; Menichetti and Leone, 2023; Lane *et al*., 2024; Monteiro *et al*., 2024). Currently, some countries use the NOVA system and its UPF descriptor to update and develop human nutrition guidelines and nutrition policy actions (Lawrence, 2023).

A prospective cohort human study evaluated UPF consumption and dementia. The study reported that for every 10% increase in UPF intake per day, there was a 25% increase in dementia risk, whereas replacing 10% of UPF intake with an

equivalent amount of unprocessed or minimally processed foods reduced dementia risk by about 20% (Li *et al*., 2022). Lane *et al*. (2022) evaluated the association between UPF and mental disorders with a synthesis and meta-analysis of 15 cross-sectional studies and two prospective studies (n = 385,541). Higher UPF consumption was cross-sectionally associated with increased odds of depressive and anxiety symptoms, both when these outcomes were assessed together and when assessed separately. Furthermore, a meta-analysis of prospective studies demonstrated that greater UPF intake was associated with an increased risk of subsequent depression. Existing studies in humans and rodents have linked UPF to the risk of brain health, although few studies have utilized gut health to explain the mechanisms (Holder *et al*., 2019; Song *et al*., 2023).

UPF research and its impact on the MGBA and mental health may be applicable to our veterinary patients (Song *et al*., 2023; Kiełbik and Witkowska-Piłaszewicz, 2024). According to the NOVA system, a typical example of UPF is ready-to-eat breakfast cereals (Monteiro *et al*., 2018). Interestingly, Ralston Purina in the 1950s produced Chex cereals, and the company applied the cereal processing method called extrusion to develop dry dog food (Semple, 2022); therefore, dry pet food can also be considered an UPF. In the USA, most companion animals consume extruded UPF diets and treats. Unlike humans, who consume a wide array of minimally processed, processed, and UPF during their lifetime, companion animals, once weaned, typically consume only UPF diets and treats.

4.11 Chronic Enteropathy and Companion Animal Mental Health

Studies of dog and cat microbiota have primarily focused on its role in the health and disease of the GI tract, including conditions like acute vomiting, diarrhea, CEs, and pancreatic and liver disease. CEs are of particular interest, with estimates suggesting they affect 1–2% of referral practice cases and 20–30% of general practice cases. The diagnosis of CE is based on the presence of chronic GI signs (lasting ≥3 weeks), histopathologic evidence of intestinal mucosal inflammation, and the exclusion of other underlying causes. The pathogenesis of canine CE is considered multifactorial, involving complex interactions between mucosal immunity and environmental factors (such as diet and gut microbiota). These interactions can lead to a loss of tolerance to dietary and microbial components, resulting in an aberrant immune response (Jergens and Heilmann, 2022).

Studies indicate that 50–65% of dogs with CE are food-responsive (Jergens and Heilmann, 2022; Rhimi *et al*., 2022). Previously, CE was categorized as antibiotic-responsive enteropathy, but recent studies highlighting the negative impact of antibiotics on the microbiota have led to the term 'idiopathic intestinal dysbiosis' being preferred. Another classification is steroid or immunosuppressant-responsive enteropathy (SRE or IRE). SRE/IRE is a diagnosis of exclusion and is often referred to as idiopathic inflammatory bowel disease (IBD). It is estimated that 15–43% of dogs classified as SRE/IRE do not respond adequately to medical treatment and are categorized as having non-responsive enteropathy, which carries a poor long-term prognosis and a high rate of euthanasia (Jergens and Heilmann, 2022; Rhimi *et al*., 2022). Although various diet types, prebiotics, probiotics, synbiotics, postbiotics, and FMTs have been studied, interpreting results and comparing studies is challenging, making the treatment of dogs with CE difficult (Jergens and Heilmann, 2022; Rhimi *et al*., 2022).

This information on CE is included because, in the author's clinical experience, many dogs with CE also have concurrent behavioral disorders. A brief look at the pathology involved with CE includes: (i) changes in bacterial taxa; (ii) changes in bacterial functions such as the production of metabolites like SCFAs; (iii) alterations in nutrient digestion, absorption, and metabolism (e.g., hypovitaminosis B12); and (iv) altered immune functions leading to a chronic inflammatory state (Jergens and Heilmann, 2022; Rhimi *et al*., 2022). All of these factors, alone or in combination, can impact the optimal function of the MGBA; therefore, it should not be surprising that a CE patient may also experience alterations in the MGBA, potentially affecting the patient's behavior and mental health.

When presented with a CE patient, the author now always questions the client about the patient's mental health. Clinically, the author has learned that when a patient has both CE and mental health issues, the best approach is to manage both conditions simultaneously. If the behavioral component is severe, the client is strongly encouraged to work with a veterinary behaviorist for appropriate medical and behavioral modifications. The author has found the most success using formulated, complete,

and balanced homemade diets, along with a specific list of human food treats (such as fruits and vegetables) and extensive client education. The management approach is similar to that of a 'food allergy trial', where the patient is allowed only the formulated diet and specific treats, eliminating any other food sources such as pet treats, supplements, flavored medications, antiparasitic preventatives, and chews, etc.

Clients are asked to record the patient's CE signs (e.g., fecal score, appetite, body weight, body condition score) as well as the symptoms of the patient's behavior, along with current medications and the nutrition plan. During management, only one change is recommended at a time. For example, if a change in drug therapy is needed, no changes are made to the nutrition plan until sufficient time has passed to assess the response to the new medications. Similarly, if a diet change is necessary, it is implemented without altering medications so that the effects of the new diet on the patient's CE and behavioral signs can be accurately assessed. Clients should also be provided with 'rescue' medications and nutritional adjustments for inevitable setbacks, such as episodes of loose stools or excessive behavioral responses. Over time, maintaining logs of CE and behavioral symptoms may allow clients to anticipate issues, enabling them to avoid triggering events or make preemptive changes to medications, nutrition, or behavior plans.

In the author's clinical experience, these patients are not 'cured', but their management becomes more targeted, and clinical outbreaks of CE or behavioral issues are less intense and frequent. Younger patients who receive earlier interventions using nutrition, appropriate behavior modifications, and medications, along with dedicated owners, tend to have the best outcomes. This suggests a vital need for veterinarians to learn about the MGBA and its role in the mental health of companion animals.

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Part 2 The Pleasant Experiences: Mental Wellness

5 Happiness and Personality in Animals

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5.1 Overview

In many societies, and for some time, the lives of most people are no longer characterized by an existential struggle to feed, house, and clothe oneself and one's family, but by pursuit of happiness (Inglehart, 2018). More recently, in fact in some people's living memory, there has been a growing concern for the happiness and well-being of others, including unrelated individuals living in different countries, and of animals (Pinker, 2011; Inglehart, 2018).

The question of how best to ensure the happiness, whether we define it as welfare, subjective well-being, or some other term (see Chapter 1, this volume, for a discussion), of animals under our care is a pressing and relatively recent concern. This development is remarkable considering that the desire to ensure animal happiness extends not just to animals with whom we share a recent common ancestor, such as chimpanzees (*Pan troglodytes*), or a home, as with pets. The human desire for animals to be happy extends to distantly related species, animals in the wild, animals in the entertainment industry, animals used to learn more about ourselves and our world, animals that help us cure diseases, and even to the farmed animals that many of us eat.

It is hard to imagine how this strong impulse to care for the well-being of species other than our own could have arisen if it were not possible for us to perceive where individual animals stand on a continuum ranging from suffering to contentedness. Of course, it is possible that we are fooling ourselves. We may be seeing emotions that are not there or mistaking the display of one emotion for another. However, it is our view that the evidence suggests that, when we perceive an animal to be happy, sad, or 'fair to middling', we are more likely than not to be accurate in our appraisal.

In this chapter we evaluate a subset of the evidence that the 'happiness' that we see in other animals is much like the happiness that we see in other humans or experience ourselves. This evidence consists of work on the relationships between personality traits and subjective well-being. We will then discuss briefly the implications of these findings with regards to what they say about the evolution of happiness, their practical implications, and how one might be able to better understand the physiological bases of happiness. We will *not* engage in a defense of or promote the use of ratings to measure animal happiness nor will we catalog, compare, and/or rank the different ways that one can measure animal happiness. These topics are dealt with elsewhere (see Robinson and Weiss, 2023).

5.2 Psychological Constructs and Nomological Networks

Measures of height or weight are more or less a 'direct' measure of a physical property of the individual thing being measured. In the case of happiness, our measure is based on a theory of how the thing that we wish to measure is represented by things that we can measure in the world. The lack of a direct correspondence between measures of any psychological construct and the thing being measured is true whether one is interested in studying

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subjective well-being, personality, or some other psychological trait. It is also true regardless of whether the measures we use are behavioral observations, behavioral tests, ratings by knowledgeable informants, or blood tests (Cronbach and Meehl, 1955). Consequently, when measuring psychological constructs, it is important to establish the reliability and validity of a measure as this will allow one to better rule out the possibility that one is measuring something other than the construct of interest (Cronbach and Meehl, 1955). This may sound straightforward, but in most cases there is no direct measure of the construct that can serve as the criterion. Contrast this with weight. If we wanted to develop a new means to measure weight, we could check our new measure by examining its relationship with weight as indicated by a scale. In short, both 'objective' and 'subjective' measures of psychological constructs are on shaky ground.

It surprises some people to hear that the degree to which a measure is rooted in what can be 'seen' is not informative with regards to whether it measures what one wishes to measure. Moreover, the question of how, given this situation, one goes about studying psychological traits in animals, including humans, is vexing to some. It is thus worth illustrating this point with a historical example. In the 1940s, researchers became interested in locating the brain's 'satiety center'. An obvious way to identify this part of the brain would have been a series of experiments in which human volunteers either experienced some kind of 'sham surgery' control or had a part of their brain removed. After enough experiments, one of the experimental groups would report being insatiable when compared to the sham surgery group. Of course, there are ethical problems with this kind of study, and so experimenters turned to rats. These studies of rats eventually did find an area – the ventromedial nucleus of the hypothalamus – that seemed to be the satiety center. Compared to rats in the control group, the rats in the experimental group ate constantly and became obese. Similar results were produced by lesioning this area of the brain in other animals, and similar behavior was described in humans who had tumors affecting that part of the brain (Brobeck, 1946, cited in Miller *et al.*, 1950). Not surprisingly, these researchers concluded that the ventromedial nucleus of the hypothalamus was the brain's satiety center.

Not everybody was convinced by the results of these experiments that pinpointed the ventromedial nucleus of the hypothalamus as the brain's satiety center. A series of experiments by Miller *et al.* (1950) showed that this skepticism was justified. Lesioned rats were not as motivated to eat as intact rats: their bar pressing to receive food rewards did not increase as much as a function of food deprivation, they did not run down an alley towards a food reward as quickly or pull harder to get a food reward, they consumed less food than non-lesioned rats when they had to lift a heavy lid to get a food reward, and they were less likely to eat food that had been made to taste bitter.

The lesson from this episode in the history of psychology is that to measure things that do not have corresponding criteria in the physical world requires that we use multiple indicators (see Fig. 5.1), including things that we do and do not expect to be manifestations of what we wish to measure (Campbell and Fiske, 1959). We hope that the reader will allow one further elaboration. To be able to claim that one's measures are measuring what we claim they do requires setting them within

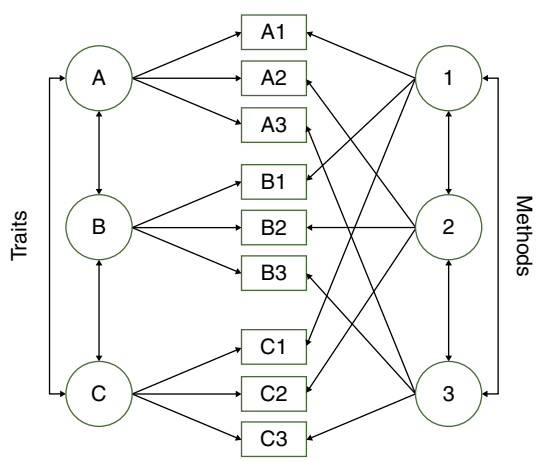


Fig. 5.1. By gathering data on multiple traits, each measured with a set of methods, one can isolate the variance related to the trait from that related to how the trait was measured and vice versa. Circles represent variance related to either traits (e.g., subjective well-being, cognitive ability, and self-control) or the methods used to measure those traits (e.g., behavioral tests, questionnaires, and behavioral observations). Boxes represent observations in a study, such as the score on a behavioral test that purportedly measures subjective well-being. (Figure by the authors and licensed under the terms of the Creative Commons Attribution 4.0 International License.)

a 'nomological network'. This means theoretically deriving and testing predictions about how constructs impinge on measures and other constructs, and testing predictions about the relationships between constructs and things in the 'real world' (Cronbach and Meehl, 1955).

In the next section we describe a measure of nonhuman animal happiness. Claiming that one has a measure of 'happiness' for a nonhuman species is still controversial. It was thus probably a good thing that this measure was initially developed to measure happiness in chimpanzees, namely as, in our personal experience, people are more willing to forgive studying such fanciful things in our closest nonhuman relatives. We will then show that, although happiness's nomological network started small, its 'roots' (Cronbach and Meehl, 1955) have since entwined more and more constructs and things in the real world, and have spread to other species. The examination of the relationships between personality and happiness played a key role in these developments.

5.3 Chimpanzee Happiness

The study of personality in nonhuman primates, including by using ratings, can be traced back to at least the 1930s (Whitman and Washburn, 2017). However, although researchers had developed and studied animal, including primate, models of negative affective states (Harlow and Suomi, 1974), studies of happiness originated later.

So far as we are aware, the first notable study of happiness in a nonhuman primate was a study of 128 zoo-housed chimpanzees by King and Landau (2003). In that study, King and Landau asked zookeepers and staff who knew the chimpanzees – often for years – to rate each chimpanzee using a four-item questionnaire. King and Landau devised the scale so that it operationalized some of the more common definitions of human subjective well-being (Diener and Emmons, 1984; Campbell, 1991; Pavot *et al.*, 1991 cited in King and Landau, 2003; Diener *et al.*, 1999). A version of this questionnaire can be found in Fig. 5.2.

The first item of this questionnaire concerned the balance of positive and negative affect:

> Estimate the amount of time the chimpanzee is happy, contented, enjoying itself, or otherwise in a positive mood. Assume that at other times the chimpanzee is unhappy, bored, frightened, or otherwise in a negative mood.

The second item asked about the degree of positive versus negative affect that a chimpanzee experienced from social interactions:

> Estimate the extent to which social interactions with other chimpanzees are satisfying, enjoyable experiences as opposed to being a source of fright, distress, frustration, or some other negative experience. It is not the number of social interactions that should be estimated, but the extent to which social interactions that do occur are a positive experience for the chimpanzee. Use as many social interactions that you can recall as a basis for your judgment.

The third item was about the degree of control that a chimpanzee had over its life:

> Estimate, for this chimpanzee, the extent to which it is effective or successful in achieving its goals or wishes. Examples of goals would be achieving desired locations, devices, or materials in the enclosure. Keep in mind that each chimpanzee will presumably have its own set of goals that may be different from other chimpanzees.

The last item was an attempt to get raters to gauge the chimpanzee's overall life satisfaction:

> Imagine how happy you would be if you were that chimpanzee for a week. You would be exactly like that chimpanzee. You would behave the same way as that chimpanzee, would perceive the world the same way as that chimpanzee, and would feel things the same way as that chimpanzee.

The overarching goal of King and Landau's study was to determine the extent to which chimpanzee happiness, as defined by ratings on this questionnaire, was surrounded by a nomological network like that which surrounds human measures of happiness. They thus addressed five questions, all bearing upon whether a consistent set of findings from the human happiness literature would be present in chimpanzees. These questions included the correlation between individuals' self-reported happiness and reports of their happiness by others; the positive intercorrelations of happiness measures, which suggest the presence of a single underlying factor; the rank order stability of happiness; and the relationships between happiness and personality (humans higher in extraversion, lower in neuroticism, and higher in conscientiousness tend to be happier (DeNeve and Cooper, 1998; Steel *et al.*, 2008)). King and Landau also asked whether their measure of chimpanzee happiness was related to independently assessed behaviors.

ASSESSMENT OF SUBJECTIVE WELL-BEING IN CHIMPANZEES

This questionnaire has four questions, all relating to the subjective well-being of the chimpanzees at your zoo. Each question asks about a different personality dimension or trait relating to subjective well-being. The following scale should be used to make your ratings.

1. Displays either total absence or negligible amounts of the trait or state.
2. Displays small amounts of the trait on infrequent occasions.
3. Displays somewhat less than average amounts of the trait.
4. Displays about average amounts of the trait.
5. Displays somewhat greater than average amounts of the trait.
6. Displays considerable amounts of the trait on frequent occasions.
7. Displays extremely large amounts of the trait.

Please give a rating for each item even if your judgment seems to be based on a purely subjective impression of the chimpanzee and you are somewhat unsure about it. Indicate your rating by placing a cross in the box underneath the chosen number. ☒

Finally, do not discuss your rating of any particular chimpanzee with anyone else. As explained in the handout accompanying this questionnaire, this restriction is necessary in order to obtain valid reliability coefficients for the traits.

Chimpanzee's full name: _____

Rater's full name: _____

How long have you known the chimpanzee?

Years: _____

Months: _____

Date (Mon/Day/Yr): _____

Estimate the amount of time the chimpanzee is happy, contented, enjoying itself, or otherwise in a positive mood. Assume that at other times the chimpanzee is unhappy, bored, frightened, or otherwise in a negative mood.

least						**most**
1	**2**	**3**	**4**	**5**	**6**	**7**
☐	☐	☐	☐	☐	☐	☐

Estimate the extent to which social interactions with other chimpanzees are satisfying, enjoyable experiences as opposed to being a source of fright, distress, frustration, or some other negative experience. It is not the number of social interactions that should be estimated, but the extent to which social interactions that do occur are a positive experience for the chimpanzee. Use as many social interactions that you can recall as a basis for your judgment.

least						**most**
1	**2**	**3**	**4**	**5**	**6**	**7**
☐	☐	☐	☐	☐	☐	☐

Estimate, for this chimpanzee, the extent to which it is effective or successful in achieving its goals or wishes. Examples of goals would be achieving desired locations, devices, or materials in the enclosure. Keep in mind that each chimpanzee will presumably have its own set of goals that may be different from other chimpanzees.

least						**most**
1	**2**	**3**	**4**	**5**	**6**	**7**
☐	☐	☐	☐	☐	☐	☐

Imagine how happy you would be if you were that chimpanzee for a week. You would be exactly like that chimpanzee. You would behave the same way as that chimpanzee, would perceive the world the same way as that chimpanzee, and would feel things the same way as that chimpanzee.

least						**most**
1	**2**	**3**	**4**	**5**	**6**	**7**
☐	☐	☐	☐	☐	☐	☐

Fig. 5.2. The subjective well-being form used to assess the personality of chimpanzees in zoos and other captive environments. (Scale by James E. King and Virginia I. Landau, and modified by Alexander Weiss and James E. King. The scale is licensed under the terms of the Creative Commons Attribution 4.0 International License. Original LaTeX file available by request from Alexander Weiss.)

The results from King and Landau's study of chimpanzees were consistent with those from the human happiness literature. First, for all four items, the interrater reliability was respectable. Second, the four items were intercorrelated and a principal components analysis indicated that a single dimension accounted for more than 70% of their variance. Third, in a subsample of chimpanzees rated twice with an average of 4.6 years separating the ratings, there was very little difference in the level of happiness and the stability was high, that is, a chimpanzee's level of happiness relative to other chimpanzees was consistent over time. Fourth, the sum of the four items from the subjective well-being scale was related to higher dominance, higher extraversion, and higher dependability (since Weiss *et al*., 2009, we have referred to the last factor as 'conscientiousness'). Higher ratings on the balance of positive and negative affect, the pleasure derived from social interactions, and global life satisfaction were related to higher dominance and extraversion. Higher ratings on the degree of control chimpanzees had over their lives and their ability to achieve their goals, that is, the third item, were related to higher dominance and higher dependability. King and Landau also did not find significant associations between any of the items or the total score and either agreeableness, emotionality (since Weiss *et al*., 2009, we have referred to this factor as 'neuroticism'), or openness. Fifth, again in a subsample of chimpanzees, there was a negative correlation between happiness and behaviors related to submissiveness, and especially avoidance, which is consistent with the relationship between higher dominance and happiness.

Before moving on, it is worth pointing out that, although the personality–happiness relationships mostly resembled those found in humans, there was a clear difference, too. Neuroticism was not significantly related to lower chimpanzee happiness (King and Landau, 2003) whereas in humans, there is a consistent and strong negative association between human happiness and neuroticism (DeNeve and Cooper, 1998; Steel *et al*., 2008; Anglim *et al*., 2020; Mõttus *et al*., 2024). Instead, dominance, a personality domain that is apparently not represented by a single factor in humans (Weiss, 2022), had the strongest relationship with happiness. Although we will revisit this matter, the likely explanation has to do with the items that defined dominance and neuroticism in chimpanzees. The neuroticism measure was based on the results of an earlier study, which showed that lower ratings on an item denoting stability and an item denoting unemotionality and higher ratings on an item denoting excitability defined chimpanzee neuroticism (King and Figueredo, 1997). Higher dominance, on the other hand, was not just defined by items indicating competitive prowess or agonistic interactions with others, but by lower ratings on several items relating to dependence, fearfulness, timidity, and cautiousness (King and Figueredo, 1997), traits related to higher neuroticism.

King and Landau's (2003) initial study of subjective well-being was followed by three studies that also examined the extent to which the nomological network that captured human subjective well-being applied to chimpanzee subjective well-being. The first examined the degree to which variation in chimpanzee happiness was attributable to genetic differences between chimpanzees and the degree to which genes for personality were genes for subjective well-being. The second investigated whether features of chimpanzees' physical or social environments were related to their subjective well-being. The third tested whether the relationships between chimpanzee personality factors and subjective well-being were replicated in an independent sample.

The first follow-on study was motivated by two previous studies of subjective well-being. One was Lykken and Tellegen's (1996) classic study of human happiness. In their study, twins were administered twice, several years apart, a personality questionnaire that included a subjective well-being scale (the Multidimensional Personality Questionnaire; Tellegen, 1982). This study had three noteworthy findings. First, 44–52% of the variability in subjective well-being was attributable to genetic differences. Second, around 80% of the variability of the stable component of subjective well-being was attributable to genetic differences between individuals. In other words, among these participants, most of the differences in happiness that were not attributable to fluctuations around an individual's average happiness were genetic in origin. Third, only a small proportion of differences in individuals' subjective well-being was attributable to things shared by people raised in the same family, or demographic indicators, such as socioeconomic status, education level, and marital status. The other previous study was of 202 zoo-housed chimpanzees and revealed that differences among chimpanzees in the personality factor dominance were the result of genetic differences; the other five factors were not

heritable (Weiss *et al*., 2000). Using the 128 chimpanzees from King and Landau's (2003) study, the first follow-on study found that about 40% of the variation in chimpanzee subjective well-being was heritable (Weiss *et al*., 2002), which is consistent with the average of heritability estimates derived from previous and subsequent studies of human happiness (Bartels and Boomsma, 2009). In addition, Weiss *et al*. found that nearly all the shared variation between chimpanzee dominance and subjective well-being was attributable to common genetic effects.

The second study found little to no evidence that physical (e.g., population density) or social (e.g., how related an individual was to group mates) characteristics of the environment contributed to subjective well-being over and above sex, age, and personality (Weiss and King, 2006). Thus, as is the case in humans (e.g., Lykken and Tellegen, 1996), factors relating to the environment did not contribute to chimpanzee happiness. That said, studies of humans conducted since suggest that the early pessimism about environmental effects may have been premature. However, because these new findings will take some time to describe, and are useful for pointing out new directions for work on animal happiness, we will return to these matters in the concluding section of this chapter.

The purpose of the third study was to determine whether the personality and subjective well-being relationships described by King and Landau could be found in an independent sample. This study of 146 chimpanzees by Weiss *et al*. (2009) differed from King and Landau's study in two ways. First, to measure personality, this study used the Hominoid Personality Questionnaire (HPQ; Weiss, 2017). The HPQ is an extended version of the questionnaire developed for King and Figueredo's 1997 study, which includes 11 additional items to better represent neuroticism, openness, and conscientiousness. Second, the chimpanzees were housed in Japanese zoos, the Kyoto University Primate Research Institute, and what is now known as Kumamoto Sanctuary (formerly Chimpanzee Sanctuary Uto). As such, this study tested whether the relationships between personality and subjective well-being generalized when raters were from a different culture. The results of this study were consistent with those from King and Landau's 2003 study of chimpanzees in zoos in the USA and Australia in two ways. First, the four subjective well-being items defined a single component. Second, dominance and extraversion were related to higher ratings on each of the subjective well-being scale's items, and the sum of these items, which represented well-being or happiness. There were differences, however. Conscientiousness was not related to any of the items; neuroticism, as one would expect based on human studies, was related to lower ratings on all the measures; agreeableness was related to higher ratings on the items and the sum score; and openness was related to all the measures save the item relating to the ability to achieve goals. Because of procedural and data analytic differences between this study and that of King and Landau, it remains unclear whether these differences reflect cultural differences in how raters interpreted the items or are attributable to procedural and data analytic differences.

The results of these three follow-on studies add support to the notion that the construct measured in chimpanzees has a nomological network resembling that of human happiness. One finding that was especially encouraging was the identification in chimpanzees of a biological explanation for the relationship between personality and happiness, which since has been supported by work on humans (Weiss *et al*., 2008, 2016; Hahn *et al*., 2013, 2016) and orangutans (Adams *et al*., 2012).

Studies so far have been able to establish that a psychological construct resembling what we refer to as happiness or subjective well-being exists in chimpanzees. The happiness found in these studies using this measure was therefore likely present in the common ancestor shared by humans and chimpanzees (Weiss and Luciano, 2015). In the next section, we explore the extent to which evidence suggests that this construct has even earlier origins.

5.4 Happiness in Other Species

As noted in the previous section, the human conceptualization of happiness appears to apply to chimpanzees. A good question to ask is how well does this conceptualization suit other species?

Before going further, it is worth reminding readers of two things. First, the personality dimensions possessed by a given species tends to differ to varying degrees from those possessed by other species. Second is the so-called 'jingle jangle' problem: different researchers often have different naming conventions for what are probably the same personality traits and/or affix the same name to what

are probably different personality traits (Thorndike, 1904 and Kelley, 1927, both cited in Block, 1995). As such, although we will introduce more than a few different personality domain labels, the reader should bear in mind the degree to which they might be aligned with the human domains associated with subjective well-being.

5.4.1 Other primates

Published research in nonhuman primates has examined at least one species belonging to great apes, Old World monkeys, and New World monkeys (no work has been conducted on prosimians, such as ring-tailed lemurs *Lemur catta*). As in studies of subjective well-being in humans (Pavot *et al*., 1991; Sandvik *et al*., 1993) and chimpanzees (King and Landau, 2003; Weiss *et al*., 2009; Robinson *et al*., 2017), the items used to measure subjective well-being in the studies described below defined a single factor.

Among great apes, other than chimpanzees the only report of correlations between personality and subjective well-being was in 140 zoo-housed orangutans (Weiss *et al*., 2006). Orangutans possess five personality domains and of these, higher extraversion, higher agreeableness, and lower neuroticism were associated with higher subjective well-being.

Among Old World monkeys, a study of semi-free-ranging rhesus macaques (*Macaca mulatta*) living on Cayo Santiago found associations between subjective well-being and higher confidence, higher friendliness, and lower anxiety (Weiss *et al*., 2011). Notably, these associations were statistically significant regardless of whether the personality factor and subjective well-being were measured at the same time or between 13.9 and 18 months apart (Weiss *et al*., 2011). A study of 55 full-term laboratory-housed rhesus macaque infants found that higher openness and dominance were related to higher subjective well-being and that higher anxiety was related to lower subjective well-being (Simpson *et al*., 2019).

A study of 66 brown capuchin monkeys (*Sapajus apella*) in research centers also found evidence for cross-time associations between personality and subjective well-being. The personalities of these monkeys were assessed as part of an earlier study, which identified five personality dimensions (Morton *et al*., 2013). The dimensions assertiveness and sociability were positively associated with subjective well-being (Robinson *et al*., 2016).

These associations were also examined in 77 common marmosets (*Callithrix jacchus*) – a New World monkey species – housed in a laboratory colony in Japan (Inoue-Murayama *et al*., 2018). This study identified three personality domains of which two, sociability and neuroticism, were positively and negatively related to subjective well-being, respectively.

5.4.2 Non-primates

Personality and subjective well-being have been investigated in felids. These studies found that the four or five subjective well-being items were intercorrelated in such a way as to define a single dimension. The first of these studies was of 25 Scottish wildcats (*Felis silvestris grampia*) living in zoos (Gartner and Weiss, 2013). This study found that, of three personality domains, self-control was consistently related to higher subjective well-being. The second study examined these associations in 16 clouded leopards *Neofelis nebulosa*, 17 snow leopards *Panthera uncia*, and 21 African lions *Panthera leo*, all of which lived in zoos (Gartner *et al*., 2016). In all three species, higher neuroticism was related to lower subjective well-being. Moreover, in clouded leopards, higher subjective well-being was also related to higher scores on a personality domain that was a blend of agreeableness and openness, and in African lions, impulsiveness was related to lower subjective well-being.

The study of personality and subjective well-being was recently expanded to include killer whales (*Orcinus orca*). This study by Úbeda *et al*. (2021) was based on 26 whales in human care whose personalities had been rated as part of a previous study (Úbeda *et al*., 2019). In this study, individuals who knew the whales rated them on a 39-item measure of welfare and on King and Landau's (2003) subjective well-being questionnaire. For brevity and consistency with the rest of this chapter, we focused on the correlations between personality and subjective well-being: higher extraversion and dominance were related to higher subjective well-being in this species.

At this point, readers may have noticed that although we noted the relationships between personality and the individual items for the study of chimpanzees by King and Landau (2003) and by Weiss *et al*. (2009), we did not do so in this section. Our reason for not doing so is for the sake of brevity. However, considering what the individual items

and the personality domains purportedly measure, these associations were mostly what one might expect. Overall, then, these findings indicate that personality domains related to being gregarious, sociable, and active are associated with higher subjective well-being and that those related to being impulsive, fearful, and vigilant are related to lower subjective well-being. In short, the links in the nomological net between subjective well-being and personality is similar across distantly related species of nonhuman primate and between primates and another mammalian order. We invite readers who wish to learn about these fine-grained associations to read the papers that we cited.

The studies reviewed here and in the previous section focused on a part of the nomological net that supports the construct validity of happiness (and personality, too) as measured in nonhuman primates, felids, and killer whales. In the next section we discuss other connections in this net, including how and whether they support the construct validity of the measures of subjective well-being used in these studies.

5.5 Other Connections

One question to address when investigating the construct validity of a subjective well-being measure is whether it is associated with other purported measures of happiness or similar constructs. These other measures may include welfare questionnaires, cognitive bias tests, motor stereotypies, and corticosteroid levels (see Bethell and Pfefferle, 2023; Capitanio *et al*., 2023; Gartner, 2023; Lutz and Baker, 2023).

5.5.1 Direct connections

Research on associations between subjective well-being ratings and other purported measures of well-being is growing. One area of this research concerns relationships between welfare and subjective well-being. A broad definition of welfare focuses on the 'five freedoms', that is, freedom from hunger and thirst, freedom from discomfort, freedom from pain, injury, or disease, freedom to express normal behavior, and freedom from fear and distress (Farm Animal Welfare Council, 2009). Using this framework, animal welfare measures have often included behavioral and physiological outputs as indicators of negative welfare states (Broom, 1991). More recently, researchers recognized the need to focus also on thriving, and have put forward ways to measure positive welfare states (Boissy *et al*., 2007; Yeates and Main, 2008; Mellor and Beausoleil, 2015; Chapter 24, this volume). In addition to recognizing the need to study positive welfare, there has been increasing interest in studying whether the needs that matter to individual animals are satisfied, that is, the animal's quality of life (McMillan, 2000, 2005).

It would be surprising if a measure of subjective well-being was not related to measures of positive welfare or quality of life. If this were found, it would cast doubt upon whether these were measures of happiness or subjective well-being. To examine this, Robinson *et al*. (2016, 2017) developed a 16-item scale to assess quality of life and some aspects of the five freedoms in captive nonhuman primates. The scale (available at: https://www.drlaurenrobinson.com/surveysdesigned/) was designed for people who worked with or are working with individual animals, such as care staff and researchers in laboratories, and was based on the idea that welfare ranges from very bad to very good (Boissy *et al*., 2007; Yeates and Main, 2008). The key section of this questionnaire included items that reflected traditional conceptualizations of animal welfare (Broom, 1991; Broom and Johnson, 1993) and factors identified as relating to quality of life (McMillan, 2005). As such, these questions were about mental stimulation, health, social relationships, stress, and the control of the social and physical environment. For example, one question was 'How frequently is this individual stressed? Stress being an unpleasant emotional experience in response to a threatening event that potentially harms the individual's health.' Another question was 'How often does the individual display signs of positive welfare?' In addition to these questions, we included one question that incorporated quality of life into assessments of welfare (see Green and Mellor, 2011):

> In this individual's life, would you say he/she experiences:
> A. considerably more negative experiences than positive experiences.
> B. more negative experiences than positive experiences.
> C. equal amounts of negative and positive experiences.
> D. more positive experiences than negative experiences.
> E. considerably more positive experiences than negative experiences.

A series of studies examined the relationship between subjective well-being and welfare/quality

of life in brown capuchin monkeys (Robinson *et al*., 2016), chimpanzees (Robinson *et al*., 2017), rhesus macaques (Robinson *et al*., 2021), and Sulawesi macaques *M. nigra* (Parry-Howells *et al*., 2023). Principal components analyses of the individual items for the quality-of-life scale and the subjective well-being scale yielded a single component that loaded on all the items. All four studies also examined the relationships between this welfare/well-being component and personality. Higher welfare/well-being was associated with higher sociability and assertiveness, and lower neuroticism and attentiveness in brown capuchin monkeys (Robinson *et al*., 2016); higher extraversion and lower neuroticism in chimpanzees (Robinson *et al*., 2017); higher confidence, openness, dominance, and friendliness in rhesus macaques (Robinson *et al*., 2021); and higher sociability and dominance in Sulawesi macaques (Parry-Howells *et al*., 2023). Finally, Robinson *et al*. (2017, 2021) and Parry-Howells *et al*. (2023) included measures of behaviors. These studies found that chimpanzees higher in welfare/well-being engaged in less frequent regurgitation, feces eating, and urine drinking, and were physically closer to other chimpanzees; that rhesus macaques performed fewer displacement behaviors (i.e., shake/shiver/twitch and scratch) and received less aggression from other macaques; and that Sulawesi macaques higher in welfare/well-being performed fewer submissive behaviors and more play behaviors.

Taken together, these studies provide strong, direct evidence for the construct validity of the subjective well-being or happiness scale. What the scale measures is psychologically indistinguishable from what an independently developed welfare scale measures, and the welfare/well-being component defined by these scales was related to personality and behavior in ways that one would expect if they were measuring these constructs.

5.5.2 Indirect connections

There is also indirect evidence that the well-being measure developed by King and Landau assesses the construct of happiness. This evidence comes in the form of similar associations between personality and other purported measures of well-being or similar constructs, such as positive affect.

Cognitive bias tests were developed for use in laboratory rodents (Harding *et al*., 2004) and have since been applied across animals ranging from honeybees *Apis mellifera* (Bateson *et al*., 2011) to chimpanzees (Bateson and Nettle, 2015) and animals housed in different environments, including farms (Baciadonna and McElligott, 2015) and zoos (Clegg, 2018). The test procedure consists of two phases (for details, see Bethell and Pfefferle, 2023). In the first phase, an animal is trained in a discrimination task. For example, over multiple trials, a rat is presented with a white card and a black card. In each trial, the rat is given a food reward if it approaches the white card and it is not given a food reward if it approaches the black card. After several trials the rat learns to only approach the white card. In the second phase, the animal is presented with a stimulus that is intermediate in value. In our example, the rat would be presented with a gray card. If the rat approaches the gray card, the rat's response is 'optimistic'; the behavior suggests that the rat expects a food reward behind the card. If the rat does not approach the gray card, the rat's response is 'pessimistic'; the behavior suggests that the rat does not expect a food reward behind the card.

The construct validity of the cognitive bias test has amassed considerable support. This support consists of evidence, for example, that indicates animals reared in poor environments or that experience a stressor are more likely to make pessimistic decisions (Mendl *et al*., 2009; Baciadonna and McElligott, 2015). These findings mirror studies of humans that show, for example, that people with major depressive disorder perceive neutral events as more threatening than do people without major depressive disorder (see Gotlib and Joormann, 2010, for a review).

One study that provides evidence that performance on the cognitive bias test is related to subjective well-being comes from a study of chimpanzees (Bateson and Nettle, 2015). Of the two males and one female studied, the most dominant male showed the least pessimism, measured by the latency to touch the intermediate stimulus, the other male showed an intermediate amount of pessimism, and the female showed the most pessimism. These findings are consistent with findings from studies based on ratings that show a relationship between higher ratings of dominance and higher subjective well-being in chimpanzees (King and Landau, 2003; Weiss *et al*., 2009; but see Robinson *et al*., 2017).

A study of 31 dogs (*Canis familiaris*) by Barnard *et al*. (2018) also provides indirect support for the

relationship between subjective well-being and cognitive bias. Choices reflecting an optimistic bias were associated with dogs that exhibited greater sociability, one of five traits measured by the Dog Mentality Assessment Test, a behavioral assay (Svartberg and Forkman, 2002), and owner ratings reflecting higher non-social fear and excitability, two of the six dimensions on Hsu and Serpell's (2003) Canine Behavioral Assessment and Research Questionnaire. A pessimistic bias was associated with the dogs being rated as higher in dog-directed aggression, dog-directed fear, and separation-related problems.

Motor stereotypies are seemingly functionless behaviors that are repetitive and unchanging (Mason, 1991; Mason and Latham, 2004). A study of over 4000 rhesus macaques whose personalities were assessed during infancy by both ratings and behavioral tests found that, along with several demographic, rearing, and housing factors, monkeys with an 'active temperament', that is, those monkeys who were less 'gentle', were more likely to display activity in response to a human intruder, and those who made more contact with novel objects were at greater risk of developing motor stereotypies (Gottlieb *et al*., 2013).

Work examining relationships between behavioral traits and cortisol in primates offers indirect evidence linking cortisol and subjective well-being. Cortisol is a corticosteroid. Higher levels of cortisol are related to activation of the hypothalamic–pituitary–adrenal axis, which aids the organism in coping with stress. High cortisol may thus indicate chronic activation of the axis, which can harm the organism. One should therefore not be surprised to find associations between higher cortisol and personality. One study that tested for an association between personality and cortisol measured brown capuchin monkey personality using behavioral observations and ratings (Byrne and Suomi, 2002). The authors of that study found that higher basal blood cortisol and cortisol reactivity were associated with an inhibited and fearful personality. Another study, this one of basal cortisol levels measured in blood, found that more excitable rhesus macaques had lower levels of cortisol in the afternoon and that more confident macaques had higher levels of cortisol in the morning (Capitanio *et al*., 2004).

That said, there is reason to be cautious when interpreting the literature on personality and cortisol. For instance, a study of common marmosets by Inoue-Murayama *et al*. (2018) found no association between subjective well-being ratings and hair cortisol and a positive association between cortisol levels and sociability.

5.6 Conclusions

If anything, the research reviewed in this chapter – and that which we did not cite – should convey that there is *at least* as much scientific evidence to support the existence of something like human subjective well-being (happiness) in some species of nonhuman animals as there is in support of the existence of this construct in humans. In addition, the parallels between human and animal subjective well-being, including how and why they are related to personality, also suggests that these constructs are similar across species. Consequently, the experience of subjective well-being along with its links to personality are almost certainly evolutionarily old. To test this, that is to rule out alternative evolutionary scenarios, such as convergent evolution, however, requires more work. Large phylogenetic studies, such as those used to study other traits (MacLean *et al*., 2014), would go some way to achieve this aim.

More critically, especially for captive animals, is the question of how these findings inform best practice. We expect that some readers will come away pessimistic. Subjective well-being in humans, chimpanzees, orangutans, and probably other species is after all influenced by genes, including genes related to personality variation. This reflects a misunderstanding about what heritability estimates mean. Heritability estimates indicate the degree to which differences between individuals are influenced by genes and not the degree to which individuals are influenced by genes (Falconer and Mackay, 1996). In other words, if an environmental intervention, such as a new enclosure, raised every individual's happiness by a roughly equal amount, the heritability of happiness would be roughly the same. That is because the differences *between* individuals, which are related to their genetic background, would still be present.

But is it possible to change happiness by means of environmental interventions? We think so and studies of animals and humans support this view. Contrary to earlier thinking on the matter, human happiness can be adversely affected over long periods of time by events such as divorce, unemployment, or widowhood (Diener *et al*., 2006). Likewise,

animal rearing and husbandry practices can make a difference (Clay *et al*., 2018). Finally, a study of happiness in 52 countries found that happiness in 45 countries increased from 1981 to 2007 and that the rate of increase was related to economic development, democratization, and greater tolerance, all of which contributed to a sense that these countries' citizens had free choice (Inglehart *et al*., 2008). These findings support current views about the role of free choice on animal welfare and the actions to take to improve welfare (see, e.g., Kagan *et al*., 2015, and Chapter 8, this volume). More importantly, perhaps, they show just how much we can potentially learn about animal happiness from studying it in humans, and vice versa.

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6 The What and Why of Fun in Animals

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Psychological concepts can be deceptively elusive, in that their meaning seems obvious yet defining them can be extraordinarily difficult. One of these is *happiness*. Another is *fun*.

Surely everyone knows what fun is, don't they? Probably. That is, until it comes time to define it. As desirable as fun seems to be for an individual, its definition, nature, theoretical basis, and affective makeup are poorly understood and warrant greater attention from academics and practitioners alike (McManus and Furnham, 2010; Reis *et al*., 2017; Oh, 2021).

In the scientific literature some authors have treated fun and pleasure as interchangeable, with amusement, enjoyment, and entertainment used as synonyms for fun (e.g., McManus and Furnham, 2010). Others have differentiated fun from other positive affective states such as happiness (e.g., Reis *et al*., 2017), and Oh (2021) specifically proposed that fun differs from the hedonic state of pleasure. Some activities, such as getting a massage or enjoying gourmet food, may be pleasurable but not (necessarily) fun. Formal definitions for fun are virtually non-existent, but Oh (2021) has stated that fun is the *involvement and immersion into an activity that is intended for pure enjoyment*. This accords well with the American Psychological Association's Dictionary of Psychology (2018), which defines fun as '*a perception of pleasure and happiness brought on by achieving one's desires from an activity*'. Ultimately, the question 'What is fun?' can be seen to have two meanings: 'What things/activities are fun, and why those ones?' and 'Fun: what *is* it and how does it feel?' Because of the paucity of empirical study of the latter, the present chapter focuses mainly on the former.

Why should we want to understand fun in animals? First, of course, is that if animals experience fun in any way like humans do then fun would be fully expected to benefit animal well-being and quality of life, as it does for humans. Additional potential value is hinted at by some recent research on human fun. For example, Cordova and Lepper (1996) reported that one of the positive outcomes associated with fun is learning. If true in animals, then incorporating fun into activities like problem-solving tasks and training could enhance the animals' ability to learn. Moreover, Reis *et al*. (2017) found that fun is enhanced when experienced with others, especially friends. They concluded that, 'Fun therefore deserves more serious scrutiny as something more than a reflection of the enjoyability of an activity or moment in time; it yields an affective state that is linked to developing and reinforcing important social bonds.' If, as in humans, fun is enhanced when experienced with companions, this might represent a benefit from fun different or greater than that from non-fun pleasures.

Once, suggesting animals might enjoy themselves was seen as anathema to science; even when I read natural sciences in the early 1970s the idea was kept in a darkened room, though by then the discovery by Olds and Milner (1954) that rats would work endlessly to electrically stimulate certain areas of their brain – and the fact that they called these brain areas 'pleasure centers' – must have opened the door a little. Now, at a time when taking a Darwinian view of animal minds is well-accepted, it seems obvious that feeling pleasure is simply part of the mechanism for ensuring animals maximize their fitness: a more flexible mechanism than hardwired specific responses, which were seen by the early ethologists as the main way evolution controls behavior. Eating when hungry, drinking when thirsty, sleeping when tired, sex when possible – these things are pleasurable, and they increase Darwinian fitness, QED. It will profit us little to

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ask, do they *feel* the pleasure of fun in the same way as us? Of course, it is tempting, when watching a dog playing a ball game with a child, to assume that the two participants are experiencing similar emotions. But we can never know, so the question transcends science (indeed, strictly speaking we cannot presume to know how the child feels). Some have attempted to argue from a similarity of neural systems to similar conscious feelings. For instance, Emery and Clayton (2015) pointed to the discovery of dopamine and opiate-receptors in parts of the avian brain considered homologous with mammalian brain areas associated with playful behavior as evidence suggestive that birds feel joy, arguing that neuroscience may eventually determine whether birds can have fun (Fig. 6.1). It will not. Similar neural mechanisms are just that; they are no guarantee of similar phenomenal experience. Equally, dissimilar neural processes do not rule out similar hedonistic experiences. Fun in other species can only be defined operationally. When, under stress-free conditions, an animal engages in actions repeatedly but not stereotypically, the actions do not contribute to immediate survival or serve a utilitarian purpose and differ in form at least slightly from actions that do, and the actions are rewarding for them in the sense that they will expend time, effort, and perhaps incur risks in doing so, then it is reasonable to presume that they are having fun. By these criteria, bumblebees have fun rolling balls (Galpayage Dona *et al*., 2022), despite the dissimilarity of underlying neural mechanisms to those of vertebrates, and there is no point in speculating on the specific details of how they feel when playing.

In contrast, asking '*Why* is this particular activity fun for that particular animal?' is now seen as a sensible question, just as it is when applied to other activities to which animals choose to allocate their valuable time and effort, such as food choices, mating, sleeping, and gaining safety; and studies of animal play have come up with some good answers to it.

In a pioneering analysis, Martin and Caro (1985) proposed to test theories about why animals play against the kill-joy explanation, that 'it passes the time'. They showed that in many cases real costs were involved, so more than time-filling must be involved. Play sometimes continues even when animals are food-deficient, and occasionally animals even risk death by playing, such as when young ibex engage in playful games on sheer cliffs (Fig. 6.2). Clearly play must have real value in evolutionary (functional) terms. Functional explanation of play starts with the simple idea that playing allows practice of real-world skills in a relatively safe environment (Wenner, 2009). The baby ibexes that have fun leaping about sheer cliffs are taking risks and are occasionally killed by falling, but the agility and skills they develop are later critical to survival when attacked by predators; the cost–benefit balance favors playful risk-taking in this case. Beyond practicing existing abilities for the honing of the nervous system and musculature, playing may help build a repertoire of action patterns greatly exceeding anything available by genetical hardwiring. Thus, a kitten may be acquiring novel approaches to the 'escape behavior' of a rolling ball of wool when it attacks the ball. If so, kittens deprived of play would grow into inefficient hunters as adults, which can be tested. Peregrine falcons and ravens – sometimes both together – give every sign of enjoying their aerial acrobatics (e.g., see Dawn Productions, 2014), allowing development



Fig. 6.1. Can birds have fun? (Image used under license from Shutterstock.com.)



Fig. 6.2. Young ibex engage in playful games on sheer cliffs. (Image used under license from Shutterstock.com.)

of tricks of flying that may one day pay in earnest. The object-play of a young chimpanzee allows the full potential of an ape's prehensile hands and independent motor control of each finger to be explored, so that when as an adult it comes time to tackle the food processing challenges of its species – some of them involving tool use – it already has an enhanced repertoire of actions to deploy, some of them 'smart' ones that go well beyond genetically hardwired skills (Fig. 6.3). Emery and Clayton (2015) speculate that the tool use seen in captive birds not known to use tools in the wild may be a form of object-play, but the pinnacle of object-play is arguably found in the New Zealand kea, which has become infamous for taking apart windscreen wipers on cars and generally destroying delicate fixtures, apparently just for fun.

If play functions to allow learning and practice of skills, then it is perhaps unsurprising that most examples come from mammals and birds, but we need to be cautious about the relative lack of evidence of play in fish, reptiles, and amphibia (see Burghardt, 2015 for some intriguing examples). It is inevitably harder to recognize the criteria that operationally define play in species that are less closely related to ourselves, and most studies of these groups are not based on the study of known individuals over long timescales. Nevertheless, the fact that in mammals play is associated with species in which young are slow to reach independence, like carnivores and primates, and in birds with altricial rather than precocial species, supports the idea mentioned earlier that fun promotes learning. This 'learning in a safe(ish) context' explanation can also apply to social play. Developing social sophistication and discovering the limits of what you can get away with are likely to pay in later life for any social animal. Of course, there may also be more direct benefits to social play. Young male baboons play roughly with male peers, thus developing motor skills and perhaps friendships with males who may one day help them in the risky process of transfer to a new social group (Fig. 6.4). Young females, however, prefer to play with the babies of high-rank females – babies who may one day be ideal allies for the youngsters, since they would be expected to acquire the (high) rank of their mother (Cheney, 1978). Social play is prominent in primates, carnivores, pinnipeds, and cetaceans – indeed, all social mammals that have been studied – but it is also found among birds, where it has been studied in parrots and cockatoos, various corvids, and Australian magpies (Kaplan, 2024).

The 'playfulness' of much of science has encouraged a further tier of explanation, in which instead of just exploring risky things safely, humans at least might benefit from playing about with things which could never be experienced: 'what would it be like to travel on a beam of light…' At least for humans, the development of creativity may therefore be another important functional explanation

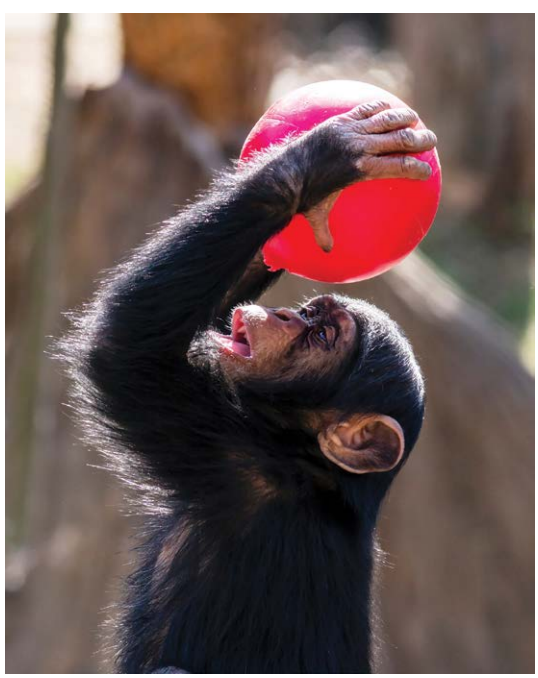


Fig. 6.3. Object-play in a young chimpanzee. (Image used under license from Shutterstock.com.)



Fig. 6.4. Young baboons playing with peers. (Image used under license from Shutterstock.com.)

for why play is fun (Bateson, 2015): building an enhanced mental repertoire, by exploring and linking concepts that might never occur together in real-life situations. In short, we are now well-provided with reasonable hypotheses of biological functions that may have led to the evolution of play, and some of these have already been tested.

We can also ask a different, though related question: '*What* is fun for them?' In some cases, the answer would be no different from asking the *Why* question. For a cursorial predator, for instance, running about and pouncing on things is presumably fun because that's what they will need to do (for real) as an adult. But if we examine the specific objects that a young ape finds it fun to play around with, that may reveal something of how the ape represents the world of objects, in the same way that the objects of an animal's curiosity can reveal its cognition (Byrne, 2013). The logic here is rather like that of the method of expectancy violation, which originated in developmental psychology (e.g., Burgoon and Hale, 1988). A strong reaction, which we can interpret as surprise, can show what an individual can distinguish and what it expected. For instance, when it was artificially arranged that an elephant came across a deposit of urine from an individual who was actually traveling well behind them (Bates *et al*., 2008), the elephant's surprise reaction showed that it did not expect that particular individual to be ahead of them, demonstrating not only that elephants can distinguish individuals by scent, but also that this elephant had a conceptualization of where that individual should be, now. The foraging group is often spread over c.1 sq.km, and elephant eyesight is relatively poor; they cannot simply rely on their vision to determine the location of their companions but must keep mental track of changes by noting calls, scents, and other cues. The surprise reaction occurred whenever one of the approximately 17 females was identified as the urine donor, implying that elephants can keep track of the locations of at least 17 independently moving individuals at once. In cognitive theory, the updatable store that keeps running track of changing information is called working memory. A working memory capacity of 17 is far greater than the typical estimate of 3 for humans. The equivalent everyday task for humans might be a primary school teacher trying to keep track of the location of 17 children exploring a busy novel environment like a museum. My wife, who was once a primary teacher, simply comments, 'Don't be silly, that's impossible'.

What things an animal finds interesting enough to play with can therefore give clues as to how those things are distinguished and categorized. This 'what?' question has not yet been explored systematically, but anecdotes of play suggest that some species may have cognitive abilities beyond those we credit them with. Baboons have been observed pulling the tails of cattle when the cow was safely behind a wire fence and could not hurt the baboon (B.B. Smuts, University of Michigan, 1988, personal communication). It is difficult to argue that the habit of pulling the tails of large herbivores has evolved in baboon ancestry because of its adaptive value. It looks instead like teasing; and teasing is fun for us because we realize how the victim feels (Reddy and Mireault, 2014). Does this mean that baboons have as-yet-unrecognized theory of mind ability, and can imagine the mental states of another individual? Baboons are Old World monkeys, the sister clade of the great apes, where at least some theory of mind abilities are already well accepted (Tomasello *et al*., 2003). Chimpanzees use objects as tools in many ways, and it is therefore no surprise to find that they often play with objects. But when an adult chimpanzee, slowly consuming the brain of a monkey it has helped hunt, carefully places small pieces of skull onto a nearby liana, one-by-one in a neat row just like we might place plum stones on the edge of a plate (personal observation at Mahale, Tanzania), it raises questions about how a chimpanzee thinks about objects. Why would making this neat pattern be fun for an adult chimpanzee? Elephants are separated from primates by over 100 million years of independent evolution. Young elephants regularly chase other animals, and not just predators like jackals that might present some small threat to them but also totally harmless species like wildebeest and egrets (personal observation). Again, an adaptive explanation of this habit as evolved preparation for adult efficiency does not work; adult elephants have no need to chase other individuals, so it would surely be a stretch to claim that elephants need such games to perfect their chasing skills or develop their chasing repertoire. So, why would chasing egrets or wildebeest be fun for a young elephant? In the future, the analysis of the specific *content* of animal fun, in addition to its distribution and functionality, may have the power to help us understand much more about how animals see their world.

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7 Quality of Life of Animals in Veterinary Medical Practice

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7.1 Introduction

The term quality of life (QOL) is now mainstream within the veterinary profession. While the previous edition of this chapter (Yeates, 2019) aimed to introduce the concept, this chapter also considers more recent evolutions of the term and its applications. An emphasis is placed on the practical application of quality of life for animals in how veterinary surgeons and animal owners might better assess and improve animals' QOL. Arguably, QOL is – or should be – the single most important factor involved in the most consequential decisions made in veterinary medical and nursing practice and policy. It can guide decisions regarding clinical diagnosis, therapeutic options, and electing euthanasia, as well as help us to evaluate societal management practices and to test novel therapies.

7.2 The Concept(s) of Quality of Life

However, there is limited consensus on what QOL is in animals (e.g., for dogs, see Belshaw *et al.*, 2015). Indeed, many reports of QOL tools do not adequately describe the concepts of QOL involved (Giuffrida and Kerrigan, 2014; Belshaw *et al.*, 2015). That said, it is reasonable to suggest that we do not need a strict 'scientific' definition (Yeates, 2013) so long as the term meets certain criteria to assure that all who use the term QOL are actually referring to the same thing.

In the absence of a consensus definition useful for nonhuman animals (see below), we might consider several characteristics that QOL has as a concept. In broad terms, we might think of QOL as what gives animals' lives – from the animal's perspective – value. Operationally, we can describe it as what animals would (most likely) want for themselves.

7.2.1 Quality of life as a holistic, pluralistic concept

Rather than narrowly, reductively, or rigidly defining QOL, it is arguably more valuable to take the most open, holistic, and pluralistic approach that is compatible with ensuring we can understand one another when we use the term. In this vein, we might consider QOL as being *the extent to which life provides whatever makes life valuable for whoever's lives are under consideration*. This means QOL – and each animal's life – has value, which is relevant for ethical decision making. It also means that animals' QOL relates to each patient as an individual (McMillan, 2000, 2003; Wiseman-Orr *et al.*, 2006). Indeed, it is about what they consider valuable (Yeates, 2016). QOL is the quality that life has that matters.

The value of a life can range from severely negative to extremely positive: QOL can be good, poor, or indifferent. QOL goes beyond those facets linked directly to survival and maintenance (e.g., eating, drinking, toileting, and grooming) to also consider less immediate matters (e.g., play, exploration, and social engagement). It includes both aspects of 'coping' and, even more positively, 'flourishing'. It covers animals' prudential motivations to avoid (e.g., suffering) and to achieve (e.g., satisfaction). It covers what animals should be free from, and what they should have opportunities for (Table 7.1).

7.2.2 QOL, components, and related concepts

The term QOL has been used in many ways, with diverse relations to various other concepts. It may be related to, or constructed from, many different

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Table 7.1. What animals should be free from and what they should have opportunities for.

Animals should be free *from* (Farm Animal Research Council, 2010)	**Animals should have opportunities *for*** (Mellor and Beausoleil, 2019)
Hunger and thirst	Selection of dietary inputs (by provision of a diet preferentially selected by the animal)
Discomfort	Control of environment (by allowing the achievement of motivations)
Pain, injury, and disease	Pleasure, development, and vitality (by maintaining and improving beneficial inputs)
Restrictions on expressing (most) normal behavior	Expression of normal behavior (by providing sufficient space, a proper range of facilities, and the company of the animal's own kind)
Fear and distress	Interest and confidence (by providing conditions and treatment that lead to enjoyment)

domains or facets that are potentially valuable (e.g., Wojciechowska and Hewson, 2005; Mullan and Main, 2007; Taylor and Mills, 2007; Hielm-Björkman *et al*., 2009). QOL can be affected by many different aspects of animals' lives, and there are varying views on what is valuable for animals, including health, resources, security, control, social interactions, and human–animal relationships. Some of these might be said to have direct, intrinsic value; others are considered indirect for what they cause or represent. In a way, the lack of clarity over exactly what constitutes QOL (e.g., objective and subjective aspects) has meant that previous work is often unclear whether what is being assessed is a *constituent* of QOL, a *factor* of QOL, or an *indicator* of QOL.

We can perhaps take a relaxed approach in practice. It may be unnecessary and confusing to differentiate too strictly what is part of QOL versus what affects it, or to be too strict on defining QOL relative to other concepts. It may not be that important whether we see one factor as a constituent component or a determinant factor, so long as we consider it in our evaluations and decision making. For example, we might see health or interpersonal relationships as part of or as factors for animal's QOL which may not matter so long as we give full consideration to animals' health and relationships.

Either way, considering QOL is helpful to ensure that an array of aspects is considered holistically, in proportion to their importance for each animal and their interactions over time. QOL is also used in ways that cover an extended time interval. This means it is not simply the addition or combination of factors, considering their duration and chronicity alongside intensity, but also their interactions and cumulation over time. Different facets interact in complex ways, so that the value of one facet may depend on others, for example, the interplay between stressors and previous exposure or learning. This plethora of factors, different definitions, and overlap with other concepts is often seen as problematic, including in humans (e.g., Karimi and Brazier, 2016).

In this framing, we can identify a wide range of aspects that might affect, or be affected by, QOL. Proximately, we can consider inputs over a given period, such as diet, environment, social companionship, and care. Ultimately, these in turn depend on owners'/stockpersons' compassion, expertise, and resources. Animals' health can be both a causal factor or component of QOL (e.g., disease may diminish QOL) and indicators of QOL (e.g., feline interstitial cystitis resulting from stress; Stella *et al*., 2011). Similarly, variations in intakes (e.g., appetence) or interactions (e.g., explorations) may be symptomatic of QOL changes. As noted above, such facets need to be considered holistically and with regard to how valuable those inputs are, as indicated by how each animal responds.

Insofar as different aspects may make life more or less valuable for different individuals, there is no single criterion for QOL. We may see widespread consistency in the negative impact of injury and disease, but greater variation in preferences, experiences, evaluations, and reactions – positive and negative – to other factors. This individuation reflects the complex interactions between personalities, preferences, previous experiences, development, learning, which results in two animals faring quite differently in the same circumstances and responding differently to analogous stimuli.

We might base our QOL assessments on animals' evaluations without necessarily reflecting their actual views naïvely. For example, one approach is to think of QOL in terms of what animals prudentially *should* be motivated to avoid or achieve, i.e., what they would want if they were perfectly rational and informed (Yeates, 2018). This does not mean that

QOL is the satisfaction of whatever motivations animals express. Animals (including humans) are not perfectly rational and happen to have many desires that conflict, for example, a dog's expressed motivation to eat chocolate might conflict with an (implicit) motivation to avoid the suffering from theobromide poisoning. If the dog were informed on the dangers of consuming chocolate, however, this motivational conflict would be, for that dog, more easily resolved. This approach is crucial in avoiding flawed QOL assessments for animals (and humans, for that matter) in deprived living conditions, who, because they know no better life, view their own QOL as satisfactory (the 'its-all-he-knows' situation). This is the 'Happy Slave Problem' (Phillips, 2006), and the implications for deprived animals is that it is possible that because these animals have an incomplete knowledge of what is possible, the animal may not be aware of a gap between his current experience and the possibilities of a life he would find more desirable. Using a measuring stick for QOL that emphasizes desires, we might imagine asking the animal if he has everything he wants – and the answer is yes. But if the animal based its response on a fully informed view, the answer would be no.

7.2.3 Emotions and motivations

There is one (and perhaps only one) aspect of animals' lives that: (i) definitely and intrinsically has value; (ii) covers a wide range, multiple facets, and extends over time; and (iii) is completely personalized to the individual: the individual's mental states (including their etiologies and symptoms). Intrinsically, the affective experience of pain is worth avoiding, and conscious desires are worth fulfilling. As noted earlier, while these mental states are subjective experiences, they may also be viewed as subjective evaluations. In other words, the value of an animal's life relates to that animal's subjective experiences.

These subjective experiences appear to play a predominant, if not exclusive, role in how animals evaluate aspects of their lives. Two subjective processes seem inherently evaluative: affective and motivational (see Berridge, 1996; Berridge and Robinson, 1998). Affect is the subjective experience of reward or its opposite: in everyday terms, 'liking' and 'disliking', such as pleasure and pain, and enjoyment and suffering. Many authors have suggested QOL represents the balance of pleasant and unpleasant feelings (Chapter 1, this volume). Motivation is the subjective preference for a particular outcome: in everyday terms, 'wanting' to achieve or avoid given stimuli or outcomes. Pleasure and reward imply positive evaluations; displeasure and aversion imply negative evaluations. To rephrase Nagel's (1974) classic question of 'What is it like to be a bat?', QOL can be viewed as 'How enjoyable is it to be this bat?'. We may see animals' mental experiences as the entirety of their QOL, with other aspects being merely determinants or indicators.

Pain is an important facet of QOL (Brown *et al.*, 2009; Belshaw and Yeates, 2018), but clearly QOL is much more than pain. QOL is about the overall – net – value of life. Pain constitutes just one form of suffering; there are many others, such as fear, anxiety, boredom, frustration, loneliness, and the like. Plus, as considered above, good QOL is not simply the absence of negatives: it also involves positive aspects of life such as pleasure, enjoyment, engagement, achievement, and flourishing.

Animals' motivations are another critical aspect of indicating animals' experiences (McMillan, 2003; Wemelsfelder, 2007), also giving an indication of their evaluations (Yeates, 2018). We might use (primarily behavioral) evidence of motivation to identify individuals' evaluations, which we might extrapolate to other situations and/or animals. We need to carefully apply such findings, since animals' motivations may depend on their context (Franks, 2019), including their QOL and anthropogenic effects (e.g., on their genetics and training), and our own limited ability to design and interpret experiments (de Waal, 2016). More generally, we might also see choice and control as improving QOL (see Chapter 8, this volume).

7.2.4 Health and welfare

Health is important for animals' QOL (Wiseman-Orr *et al.*, 2006; Reid *et al.*, 2013), but QOL encompasses more than health (Smith *et al.*, 1999). QOL is not solely an animal's physical state, nor is it restricted to an animal's biological 'function' or 'normality' – another commonly used factor in health and welfare assessments. In contributing to an animal's QOL, some health problems may be less important to that animal than some other aspects of life. Most importantly, an animal's QOL depends on how it is affected by, and responds to, any pathologies or physiological disturbances. Two

animals (or humans) may have the same degree of disease or pathology, yet experience different impacts on their QOL.

However, even allowing for individual variation in responses to health disorders, unless health – including mental health – is at least adequate, an animal is unlikely to have a high QOL. Severely poor health can be an important determinant – as well as indicator – of poor QOL. Because of the prominent involvement of QOL in veterinary medicine, however, there is a real risk of ignoring (or at least de-emphasizing) QOL factors that are not health related. We should recognize that 'health related' and 'non-health related' are interrelated characteristics and it is impossible to disentangle the QOL effects of a disease from all the other impacts on a patient's QOL, including emotional factors, environment, genetics, etc. In the absence of clear demarcations between what facets of QOL are health related or not, we risk overlooking relevant aspects of QOL that would be included in a more holistic consideration of QOL.

For animals, QOL has also been related to welfare, both in including welfare extended over time (Yeates and Main, 2009) and, conversely, described as 'a subset of welfare' (Wojciechowska and Hewson, 2005; Broom, 2007; Taylor and Mills, 2007). Others have suggested treating it as equivalent (or at least related) to other concepts such as well-being, welfare, happiness, life satisfaction, and contentment (see Chapter 1, this volume).

In fact, we might see a useful 'cluster' of concepts of health, well-being, welfare, and QOL (Yeates, 2024). Modern concepts of health are themselves broadened to include many biopsychosocial aspects of well-being and QOL. We might see the ideas as having a 'family resemblance' and use them in complementary ways – so long as we do not assume or rely on non-existent consistency, e.g., in comparing research data.

7.2.5 Relationships and instrumental value

We might also think of QOL in terms of relationships, in particular with others. In gregarious and parental care-giving animals (including humans), this is an important aspect of QOL (see also Chapter 9, this volume). Clearly the quality of positive and antagonistic relationships can be harmful or beneficial to animals' health and feelings. We might further also think of some meaningful relationships as being part of the value of life (in addition to their enjoyment or benefits), particularly with regards to companionship, parenting, and perhaps (at least for humans) ethics. A similar idea may apply to relational concepts of control, meaning, authenticity, integrity, and dignity. These might be captured in some concepts of flourishing, such as *eudaimonia*, where the value of life is more than simply its enjoyment.

However, what is important is the value of the relationship for the individual animal, not its value for others. The value that QOL denotes is independent of any instrumental value of animals' lives to humans (e.g., as a source of eggs, progeny, meat, as an experimental subject, or even as a companion). An animal's QOL is the value of its life *for that animal*, not for the animal's owner. An owner might consider an animal valuable for its usefulness and performance, and an owner might value their relationship with the animal in terms of affection, affinity, and companionship. But although these factors may be linked to other factors or signs that affect QOL, they are not themselves directly relevant. For example, a beloved or valued animal might actually have a lower QOL than another animal less loved, but better cared for, by its owner. Measures of human–animal relationships are decidedly *not* a proxy for QOL, and Serpell (2019) has recently detailed the difficulties that these relationships create in obtaining an accurate assessment of a pet's QOL.

7.3 Assessing QOL

Before applying the concept of QOL to animals, some general issues are important to consider.

7.3.1 Subjective and proxy assessments

Because QOL is an evaluative concept, it requires evaluators – or, at least, valuers – who use data to generate some assessment. Because our focus here is animal QOL, it is important to note that this does not necessarily imply that the individual forms such evaluations through some conscious and explicit cognitive process, i.e., animals do not need to comprehend the concept of QOL for their lives to have quality. Animals evaluate specific aspects or factors affecting their lives, while we might serve as proxies to evaluate their lives on their behalf (we shall consider below how these different evaluative processes might be used together to base our proxy evaluations on animals' first-person evaluations).

Insofar as QOL can be considered as the subjective assessment of how one's own life is faring, this requires us to tap into each individual animal's own evaluations. The assessment of communicative human patients is usually based on asking individuals to evaluate their own QOL. The individual has access to their own subjective states, can make relative assessments across positive and negative states, decide trade-offs, and can aggregate assessments across multiple domains.

Might animals meaningfully report their own QOL? We currently lack convincing evidence that they can do so explicitly, as this would require not only that the animals communicate their QOL assessments, but also that we can clearly comprehend what they are communicating. Fortunately, however, the use of QOL with animals (and, for that matter, pre-verbal human infants and other noncommunicative humans) does not require that animals explicitly assess and communicate their own QOL. It need not be the individuals themselves who make the overall QOL assessment even if the concept is based on their subjective evaluations of QOL facets. Animal's inabilities to articulate a QOL means that we serve as proxy assessors for them with the goal of producing an objective evaluation based on their subjective states.

Ultimately, we rely on observable data from which to infer QOL. We cannot 'see into' animals' minds and need to use what we can 'see' such as their circumstances, pathophysiology, and behavior, analyzed using analogical methods. This is, of course, true for humans too – but those data might include their verbal self-reports (which we assume are more generally representations of their actual mental states). We might usefully consider factors that are observable and representative of the animals' own subjective perceptions, such as their expressed preferences, decisions, and apparent degree of satisfaction with those choices.

However, while this subjective aspect of QOL does not require the ability to provide verbal self-reports of one's QOL – the preferred method for evaluating QOL in conscious adult humans – it does restrict QOL to animals for whom aspects of their lives can have 'value' based on these positive and negative experiences. This, in turn, would suggest that QOL is limited to sentient animals. Rocks and trees do not have a QOL, but tree squirrels, rock doves, rockfish, tree frogs, and rock pythons do. What makes life valuable for patients may be explicitly self-assessed and self-reported by humans (World Health Organization, 1996). For animals (including non verbal humans), we must be more sophisticated in considering each individual's perception and evaluation of their life.

7.3.2 Evaluating multiple inputs

When making an overall evaluation of an animal's QOL, we typically aim to reach a single assessment based on a broad range of all facets of an animal's life, extended over a period of time. Sometimes, one facet may be so bad that it outweighs others. Severe suffering may preclude the possibility of significant enjoyment, predominating assessments of whether the animal's life is worth living. An animal with an extended aggressive bone tumor can be expected to have a poor QOL whether or not his bedding is comfortable. (This does not mean that his bedding should not be made more comfortable – we might still want greater precision of assessment to mitigate some of his suffering.)

The most common approach asks us to combine or aggregate all facets into a single score. Human patients may perform this aggregation for themselves. However, it appears most nonhuman animals cannot explicitly report their QOL. We must therefore infer QOL from observations about all an animal's positive and negative experiences over the specified period of time. Depending on how we do this, this aggregation adds a difficulty of combining seemingly incommensurable data into one overall evaluation (including the problem of QOL predictions, which is discussed in Section 7.4.3). One drawback of combining all facets into a single score is the potential for 'hiding' inter-observer variation in how individual facets are evaluated while risking worsened reliability. In addition, numerical scores may be arbitrary if the scale is not linked to a fixed comparison point (Craven *et al.*, 2004).

Because different factors have varying levels of importance to different individual animals, a QOL evaluation that gives the same weight to every facet for every animal may not result in an accurate QOL assessment. For example, if one animal seems fine being left alone all day and another animal exhibits great distress when alone, then a score for 'constancy of human companionship' that was weighted equally between the two animals would show the same effect on the total QOL score, when in fact the overall QOL would be impacted much differently between them. One approach to overcome

this problem is to assign 'weights' to different QOL facets based on presumed importance of that facet to that individual animal, and then aggregate these weighted facet scores into an overall evaluation (McMillan, 2003; Morton, 2007; Budke *et al*., 2008). As logical as this approach appears, the precise method for determining weights clearly involves much subjectivity, and error. These weighting approaches have been questioned in the human field (e.g., Trauer and Mackinnon, 2001).

7.3.3 Measuring quality of life

As an inherently evaluative concept, we do not have a 'natural' unit of measurement for QOL. So, while many facets can be measured quantitatively, overall QOL cannot be counted, measured, or calculated using methods like those we employ for phenomena such as blood pressure or body temperature. This is one of the reasons why it is difficult to establish any cut-off point between 'acceptable' and 'unacceptable' QOL.

We might give up on quantification and judge animals' overall QOL qualitatively. We use everyday words such as 'good/poor', 'better/worse', or 'high/low'. We use explicitly ethical words such as 'acceptable' and 'unacceptable'. We might explicitly consider whether an animal's continued life is of sufficient net quality overall to be 'worth living' (Farm Animal Research Council, 2010; Yeates, 2011).

Alternatively, we could try to use numerical representations of our relative assessments. For example, one approach to calibrating the numbers might be to evaluate QOL relative to quantity of life. The dividing line between a 'life worth living' and 'life worth avoiding' could provide a zero point, as the representation of a QOL that has the same value as nonexistence. We could explicitly evaluate periods of time in terms of their relative value, e.g., whether it would be worthwhile for the animal to make a trade-off between two periods. For example, if one month of pain would be considered comparable to one year of a different suffering, then we could argue the value of the former is, pro rata, 12 times worse than the latter. Together, these could give us a ratio scale for QOL.

7.3.4 Minimizing bias and error

While demographics may not alter owners' ideas of QOL (Strand *et al*., 2024), other factors might, particularly perhaps those relating to normalized harms or self-interest biases. As human proxies, there will be biases in our assessments (Serpell, 2019), and in our effort to be 'objective' we should strive to recognize and overcome any such biases. Systematic approaches can help identify and eliminate invalid assessment methods that might, for example, prioritize or ignore certain facets of QOL that are important for humans but not necessarily for nonhumans. It is important here to note that humans' self-assessments of QOL – which would seem to be tautologically unassailable in terms of accuracy – have nonetheless been shown to be subject to biases and changing contextual factors. Poor intraobserver reliability occurs as an individual's situation changes, suggesting that assessments are at least partly contextual. For example, human patients may shift their self-assessed responses over time (Breetvelt and Van Dam, 1991; Sprangers, 1996; Sprangers and Schwartz, 1999), as they age, or if they assess injuries as less bad than they previously seemed. This may be due to recalibration (to different benchmarks or thresholds) or reprioritization (of the various factors in their life). The crucial point is that if these errors can occur when humans assess themselves, then they may be expected to present similar problems in owners' assessments of animals (McMillan, 2007).

7.3.5 Tool validation

Practicing veterinarians seeking to select the best assessment tool(s) for use in their patients will understand the preferability of choosing tools that have been validated. The immediate problem, however, is that there are few such tools (yet) available. The lack of a 'gold standard' (Sharkey, 2013) as an independent and objective point for comparison makes it challenging to definitively validate newly developed QOL assessment tools. Consequently, many of the published tools are only partially validated (Belshaw *et al*., 2015; Doit *et al*., 2021; Fulmer *et al*., 2022). Also important for the practitioner to keep in mind is that there are important reasons for using QOL assessment tools that do not require robust validation. For example, Yeates *et al*. (2011) proposed that a valuable use of QOL assessments is to promote discussions and facilitate decisions between veterinarians and pet owners, which requires a comprehensive overview of all aspects of the animals' life rather than precise scores. This approach was not intended to be validated by

conventional measures, since the concepts were grounded in each owner's (and practitioner's) own conceptualizations and context.

7.3.6 Recognizing assessment limitations

When using tools, we should understand the underlying psychometrics and evaluative aspects – never using a score from an algorithm we cannot access and understand. One of our most important risks is mistakenly thinking a particular tool is generating an assessment of *overall* QOL when it actually only covers a significantly restricted range of facets, such as health or pain. We should certainly ensure that the impacts of pain and poor health are considered in QOL assessments, but also remember that QOL assessments are not limited to facets that are affected by health. At the same time, we should also recognize that our assessments are based on our viewpoints and values. They are never definitive evaluations of animals' QOL. Never should we believe we have 'determined' an animal's QOL with precise accuracy, especially when others' opinions disagree. Even with such limitations, however, it is still important to assess QOL as well as we can and to use those assessments to improve it.

7.4 Applications of QOL Considerations

Broadly speaking, QOL can be used in four ways: screening, assessing, predicting, and decision making. Of course, we might employ multiple uses at the same time (e.g., using current assessments to stimulate screening discussions or inform predictions). Indeed, we probably should use multiple applications; for example, euthanasia discussions can be useful to move from screening to assessments, to predictions, to decisions.

One important basic question is *who* should do the evaluating. Veterinary surgeons and nurses may have expert knowledge and experience, and may seem more 'objective'. Owners may have biases from misplaced anthropomorphism or their emotional investment, but also have direct empathetic knowledge of their animals over an extended period in their everyday environment. Where possible, evaluations should be the product of all relevant views, with each party helping others to explore, identify, interpret, and evaluate different facets and form an overall collective evaluation. Indeed, each should be reliant on the others. For example, veterinarians often rely on owners' assessments in the home environment, while owners are reliant on veterinarians to predict disease progression. Veterinary staff can help owners to explore each of the below applications, guiding them through screening to a decision.

7.4.1 Screening

QOL screening can help look for a wide variety of potential issues, among which health is a primary but not the only factor. Screening is particularly useful for identifying treatment side-effects or new conditions over time. The benefits of using QOL for screening is that it can help us consider a wide range of facets rather than simple screening for narrow predetermined concerns. Screening is especially important when outcomes are uncertain, e.g., in novel treatments or assessments for new or emerging health problems. It is important not to use screening tools for overall assessments, unless we are confident they are comprehensive and we are clear how we are formulating our overall assessments.

7.4.2 Assessment

There are now a number of tools available for assessing overall QOL and they are compiled in Table 7.2, as well as proposals for the development of QOL tools (e.g., Mullan, 2015). In some fields of practice, tools are in relatively earlier stages of development. For equines, one literature review (Long *et al.*, 2022) identified 11 equine welfare assessments but no QOL assessment tools, other than broad approaches described by Parker and Yeates (2012). Similarly, QOL assessment tools are being developed for zoos (Campbell-Ward, 2023), but few have been published. For dogs and cats, there have been a wider range of assessment tools and applications published, as well as several reviews of those tools (e.g., Doit *et al.*, 2021; Fulmer *et al.*, 2022).

Assessment of QOL can target overall QOL or only particular facets of QOL. We might make QOL assessments as a comparison (e.g., to an earlier time of life or to another treatment group) or against some particular predefined criteria. Many QOL assessment tools ask people to rate animals' QOL subjectively. Others ask assessors about multiple facets, with or without some overall mathematical assessment.

As mentioned earlier, 'health-related' and 'non-health-related' factors in QOL are inextricably linked. Nonetheless, multiple assessment tools for

Table 7.2. Assessment tools and general discussions about overall quality of life.

Animal	Reference
Cats	Rochlitz, 2007; Tatlock *et al*., 2017a,b
Dogs	Hewson *et al*., 2004; Wojciechowska and Hewson, 2005; Wojciechowska *et al*., 2005a,b; Hewson *et al*., 2007; Morton, 2007; Mullan and Main, 2007; Yeates *et al*., 2008; Schneider *et al*., 2010; Lavan, 2013; Schmutz *et al*., 2022
Kenneled dogs	Kiddie and Collins, 2014, 2015
Shelter environments – dogs	Valsecchi *et al*., 2007; Lamon *et al*., 2021
Shelter environments – cats	Lamon *et al*., 2023
Companion animals	Schneider, 2005; Yeates and Main, 2009; Belshaw, 2018
Farm animals	Botreau *et al*., 2007
Zoo animals	Föllmi *et al*., 2007

health-related QOL (HR-QOL) have been developed, and they have been shown to have important uses. Philosophically, they may provide a 'bridge' from thinking about specific biological functions or clinical measures, begging to expand our concerns more widely. Practically, QOL assessment using these tools can focus more extensively on a specific population (e.g., those with a specific medical disorder), potentially identifying factors that might be overlooked with assessment tools for overall QOL or increasing the granularity and precision on a subset of factors. Many assessment tools designed for assessing specific health problems in animals have been published in recent years and are compiled in Table 7.3.

Additionally, as horizon scanning, some future ideas might use 'big data' and/or personalized data from individual animals. A recent step in that direction is the NewMetrica QOL tool (Reid *et al*., 2018; Davies *et al*., 2021), which analyzes owner data via an online algorithm, to generate assessments of each dog's or cat's QOL across domains such as energy, happiness, comfort, calmness, vitality, and emotional well-being (with slightly different domains for each species). The future might combine such algorithmic analysis with data from new technology (e.g., wireless GPS collars) to minimize owner biases. One risk of such new methods might be that the algorithmic analysis displaces expertise, possibly bypassing owner and veterinarian insights. Another risk is that such methods, especially where commercially based, may not be properly validated, or those validations (and the underlying algorithms) made public. A recent tool development has focused explicitly on wider sample sizes, with the expectation that, because much of the variation in particular QOL domains occurs only in a small (5–10%) subset of the population, assessments need to evaluate a large sample of the general population to have sufficient statistical power to identify measures and background variances (Schmutz *et al*., 2022).

7.4.3 Predictions

QOL assessments are not restricted to the present; decisions in animal care necessarily involve predictions of *future* QOL. In such cases we are trying to predict the possible outcomes for each care option – whether between different foods, exercise regimes, adoptive homes, or medical treatment – in terms of the animal's subjective experiences. Predictions we make regarding QOL should come with the understanding that we are trying to estimate probabilities and we should recognize our degrees of confidence and confidence ranges in any prediction. Most importantly, we should attempt to predetermine any factors that would prompt us to revise our prediction, particularly when later assessments suggest that previous predictions were imperfect.

Knowing that assessments of an animal's *current* QOL are challenging, we can expect predictions of QOL to be even more difficult since we are actually trying to assess *future* QOL (McMillan, 2007). However, we still need to make decisions based on looking ahead. In effect, we need to decide how to maintain or improve QOL in circumstances of uncertainty. This may mean we should make 'balance of probability' decisions (although 'probability' is perhaps the wrong word – 'balance of confidence' might be better). We should take a precautionary approach, giving animals 'the benefit

Table 7.3. Assessment tools for specific health disorders in the veterinary literature (includes validated and nonvalidated).

Health disorder	Species	Reference
Cardiac disease	Dogs	Freeman *et al*., 2005; Freeman *et al*., 2020
Cardiac disease	Cats	Freeman *et al*., 2012
Epilepsy	Dogs	Lord and Podell, 1999; Chang and Anderson, 2005
Spinal cord injury	Dogs	Budke *et al*., 2008; Levine *et al*., 2008
Cancer	Dogs and cats	Lynch *et al*., 2011; Giuffrida and Kerrigan, 2014
Cancer	Dogs	Giuffrida *et al*., 2018
Cancer-related pain	Dogs	Yazbek and Fantoni, 2005
Hematological cancer	Dogs	Wiseman-Orr *et al*., 2008
Neoplastic hemoperitoneum	Dogs	Crawford *et al*., 2012
Receiving chemotherapy	Dogs and cats	Vøls *et al*., 2017
Cancer treated with chemotherapy	Small animals	Iliopoulou *et al*., 2013
Palliative chemotherapy for lymphoma	Dogs	Mellanby *et al*., 2002
Chronic renal failure	Dogs	Jacob *et al*., 2004
Chronic kidney disease	Cats	Bijsmans *et al*., 2016
Idiopathic Fanconi syndrome	Dogs	Yearley *et al*., 2004
Skin diseases	Dogs	Noli *et al*., 2011a,b
Skin disease	Cats	Noli *et al*., 2016
Atopic dermatitis	Dogs	Favrot *et al*., 2009; Ahlstrom *et al*., 2010; Linek and Favrot, 2010
Atopic and allergic skin disease	Dogs	Cosgrove *et al*., 2015
Pain from chronic degenerative joint disease	Dogs	Wiseman-Orr *et al*., 2004, 2006
Osteoarthritis, degenerative joint disease	Cats	Klinck *et al*., 2010; Benito *et al*., 2012; Scott *et al*., 2021; Yeowell *et al*., 2021
Diabetes mellitus	Dogs	Graham *et al*., 2002; Niessen *et al*., 2012
Diabetes mellitus	Cats	Niessen *et al*., 2010
Obesity and overweight	Dogs	German *et al*., 2012; Yam *et al*., 2016
Feline infectious peritonitis	Cats	Ritz *et al*., 2007
Congenital portosystemic shunt	Dogs	Greenhalgh *et al*., 2014
Intestinal disease	Dogs	Marchetti *et al*., 2021
Brachial plexus injury	Dogs	Menchetti *et al*., 2020
Presbycusis	Dogs	Fefer *et al*., 2022
Intracranial disease	Dogs	Weiske *et al*., 2020
Chronic kidney disease and Feline infectious peritonitis	Cats	Chen *et al*., 2024
Obesity	Cats	Hanford and Linder, 2021
Hypersomatotropism	Cats	Corsini *et al*., 2022
Aging	Dogs	Rodger *et al*., 2021; Chen *et al*., 2023
Progressive disease, unspecified	Companion animals	Villalobos, 2004
Geriatric health disorders, unspecified	Geriatric zoo animals	Föllmi *et al*., 2007
Health disorders, unspecified	Dogs	Reid *et al*., 2013
Health disorders, unspecified	Cats	Freeman *et al*., 2016; Noble *et al*., 2019
Health disorders, unspecified	Farmed pigs	Wiseman-Orr *et al*., 2011a,b

of the doubt', at least in terms of their capacity and likelihood to suffer, to minimize the risks of causing them harm. Our decisions should always retain some humility, insofar as we might cross-check them with others' suggestions, and build in conditions and caveats (e.g., prompts for reassessment and re-prediction of QOL). In particular, we should build in subsequent QOL reviews to compare later assessments with prior predictions and re-predict as needed.

7.4.4 Treatment decisions

If QOL is what animals should want for themselves and we should aim for their QOL, it is entailed that we should want for animals what animals should want for themselves. QOL should be the single most important factor involved in the most consequential decisions made in veterinary medical practice – guiding decisions regarding diagnosis, therapeutic options, and review.

These decisions should be based on predictions of what we think the animal's QOL will (or for comparing options, would) be. In making these decisions, we should decide what is best – overall – for each individual patient (i.e., treat the patient, not the disease). We should avoid biases about what is good for the owner or the breed – in particular, we should avoid deciding to let animals have a poor QOL because of benefits to humans. We should also consider how trade-offs between positive and negative aspects of an animal's life might result in a net benefit to the animal, for example, vaccinations and careful exposure to certain stimuli might involve a degree of unpleasantness but lead to better later coping or responses.

QOL assessments are particularly pertinent in treatment decisions involving euthanasia (Persson *et al*., 2020; Deelen and Meijboom, 2021; Bubeck, 2023; Cooney and Kipperman, 2023; Selter *et al*., 2023), where decisions about extending the quantity of life are contingently related to the expected quality of that life (Yeates, 2022). Similarly, it may be applicable to questions of, on the one hand, 'advanced' veterinary care (Quain *et al*., 2021) and, on the other, to contextualized care decisions. In fact, all veterinary treatment should be aimed at (within other moral and legal boundaries) protecting or improving animals' QOL. QOL provides a way of assessing whether a specific quantity of an animal's life is, or is expected to be, good (see Fig. 7.1). Life is valuable where the QOL is good, and worth avoiding where the QOL is poor. So improving QOL is always good, and increasing *quantity* of life is only good if the expected QOL is good.

There has been some recent attention to basing decisions more formally on multiple stakeholders' QOL in decisions, particularly given the recognition of the impacts of animals' QOL compromises on owners (Belshaw *et al*., 2020; Buller and Ballantyne, 2020; Barrios *et al*., 2022), and the resultant purported moral dilemmas (Arbe Montoya *et al*., 2019). Certainly, explicit discussions about QOL may help align veterinarians' and owners' evaluations, perhaps reducing moral distress or guilt for both parties (Janke *et al*., 2021). Another approach suggested is for veterinarians to propose a range of options from which owners choose (Yeates, 2013; Stull *et al*., 2018) – hopefully ensuring all offered options are acceptable in terms of the expected impacts on the animals' QOL – and helping owners to make caring decisions. Another approach has been to move away from a patient-centered approach to a more utilitarian or communitarian one, to base decisions on the 'Family Quality of Life' across animals and their guardians (Samuel *et al*., 2012; Brown *et al*., 2023), reflecting more community-based approaches to human well-being (Atkinson *et al*., 2020).

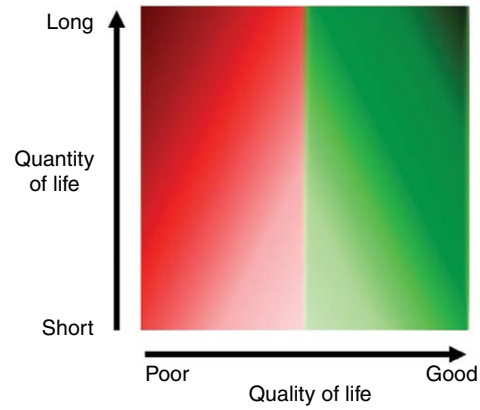


Fig. 7.1. Interrelationship of quality and quantity of life in the overall 'goodness' of life. (Red, less desirable, darkness of red indicates more negative value; Green, more desirable, darkness of green indicates higher positive value.)

7.4.5 Policy

Human QOL assessment has, at least nominally, been used to inform public policy making. We might, as a veterinary profession, consider QOL when evaluating wider ideas, such as breeding strategies, management regimes, and legislation. For example, we might assess the (predicted) QOL for each and all individuals in a given population. We could then apply different ethical frameworks to direct decisions at a policy level. One approach might be to bring together considerations of QOL and quantity of life. Human medical resource allocation

considers *quality adjusted life years* (QALYs) to assign a value to treatments based on their extension of life (when QOL is good) and/or improvements to QOL (discounting euthanasia). This might also be used for animals, recognizing that we could score QOL negatively (i.e., worse than death) and permit euthanasia. An alternative approach might be to set an overarching policy that, as a minimum, no animal should have a life worth avoiding. Ethically, these approaches might reflect utilitarian (either hedonic, after Bentham, 1781, or preference-utilitarianism, after Singer, 1993) or Rawls's (1971) Maximin principle (cf. Yeates, 2010).

At a societal level, there is increasing attention to non-monetary methods of valuation, including of nature and of economic policy. Some of these are based on considerations of QOL (or similar concepts). As such, there is no obvious reason to exclude animals' QOL from these concepts and their measurement (methodological challenges notwithstanding). Modern policy might, insofar as it is based on protecting or maximizing well-being or QOL, be based on protecting or maximizing the well-being of all sentient creatures. This faces challenges of finding commensurate ways to assess well-being across species (and geographies, contexts, and individuals), which is one of the desirable aims of moving away from proxy measures such as wealth that provide unreliable (and unfair) assessments of well-being. It may also reinforce the recognition that people and animals often share QOL factors (Strand *et al*., 2024).

7.4.6 Communication

As mentioned earlier, one constructive use of QOL is to facilitate important discussions with pet owners. At least some owners appear to want more support on QOL assessment (e.g., Christiansen *et al*., 2016). Some might be switched off by ideas of 'welfare' or clinical parameters, but QOL may provide a concept that both specialists and owners can understand. Owners' thinking – like veterinarians' – may be helped by explicit considerations of their animals' motivations (e.g., to make euthanasia decisions before their animals stop eating) and more empathy. Our considerations of QOL might also alter how we think about patients and clients ourselves. Rather than taking paternalistic approaches, or uncritically ceding to owners the absolute right to make decisions about their 'property', we can more readily come to an agreement that all of our decisions are directed at the same goal: improving the animal's QOL. This can help ensure that our conversations with owners are supportive and affirm their confidence that their thinking is also focused on their animals. To this end, QOL assessment involving owners can help to increase owner interest in animals' QOL, facilitate discussions and lead to more relevant decisions to improve pets' care (Mwacalimba *et al*., 2020). Better shared consideration of QOL should thus lead to better QOL for the animal patients.

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8 The Mental Health and Well-being Benefits of Personal Control in Animals

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The value of perceived control in the lives of humans and nonhuman animals (hereafter animal) has been the subject of investigation for more than a half century. What began as a concept of control in life overall (Rotter, 1966) has been subsequently characterized to also include control over specific domains of one's life and even a specific aversive event. Each of these conceptualizations of control have demonstrated links to animal mental health and well-being.

It has long been known that stressors come in a vast array of forms, and while the various factors that make stressors more or less impactful on the individual are not fully understood, the concept of control has emerged as a central element (Steptoe and Poole, 2016). Stressors differ in the degree to which they can be controlled, and the relation between control over an aversive event and the amount of stress or pain the event produces has formed the basis for control becoming a dominant idea in psychological theory and research (Wallston, 2004; Thompson, 2005). Common sense would suggest that to the extent that individuals believe that they can prevent, terminate, or lessen the severity of aversive events, the less reason they would have to worry about or fear them (Rodin, 1986). In humans, control is now a major concept in a number of theories of emotional well-being and happiness (Thompson and Kyle, 2000), and Larson (1989) has written that the ability to yield control for the short term and endure life's inevitable occasions of discontrol without substantial distress could reasonably be seen as a defining criterion of mental health.

Research has found control to be crucial for a wide range of animal species, including apes, rodents, birds, and fish, suggesting that the organism's desire to influence the impact of aversive and appetitive interactions with the world is central to animal life (Franks and Higgins, 2012). However, one of the defining features distinguishing captive and wild environments is the reduced amount of control captive animals have over what happens to them and the conditions that affect them (Franks and Higgins, 2012; Bassett and Buchanan-Smith, 2007; Jones and McGreevy, 2007) (Fig. 8.1). Noting this, Markowitz and Eckert (2005) have questioned how we can expect animals in our charge to be mentally healthy if they perceive that actions they take do not matter.



Fig. 8.1. Captive animals very often have little or no control over their lives. (Image used under license from Shutterstock.com.)

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This chapter will focus on the importance of the perception of control in animals, drawing on the human literature to inform and supplement our understanding where communication barriers impair our ability to obtain relevant information from the animals.

8.1 Defining and Characterizing Control[1]

In the presence of an aversive stimulus[2], control may be defined as the perception[3] that one has the ability to produce a response that can influence the aversiveness of an event in a way that maximizes desired outcomes and/or minimizes undesired ones (Thompson, 1981; Peterson, 1999; Thompson, 2005). Such a response allows the individual to, at will, terminate the event, make it less probable or less intense, or change its duration or timing (Thompson, 1981; Foa *et al*., 1992) (see Fig. 8.2). (Agency, typically defined as a sense of control over actions and their consequences (Wiech, 2023), has often been used interchangeably with perception of control, although some authors distinguish the two terms (e.g., Pacherie, 2007; Lunardo and Saintives, 2020).)

Choice has frequently been considered an important feature of control. For example, it has been argued that choice is the means by which organisms exert control over the environment (e.g., Owen *et al*., 2005; Ross, 2006; Leotti *et al*., 2010) and Lunardo and Saintives (2020) state that being choiceful in one's actions represents an antecedent of perceived control, mirroring Rotter's (1966) earlier observation that people report that the acquisition of choice leads to an increased sense of personal control. Leotti *et al*. (2010) maintain that although much of the cognitive processing for behavior involving choice occurs below the state of explicit awareness, all voluntary behavior involves choice nonetheless. Accordingly, to choose is to express a preference, and that preference is for options that are conducive to achieving favored rewards.

8.2 Locus of Control

Rotter (1966) presented evidence that people differ in the extent to which they believe that valued outcomes are determined by forces within or outside their own control. He termed this construct the *locus of control* (LOC), where the locus referred to whether persons perceive that rewards follow from, or are contingent upon, their own behavior or attributes – an *internal* locus of control – as opposed to the belief that rewards are controlled by forces outside of themselves and tend to occur

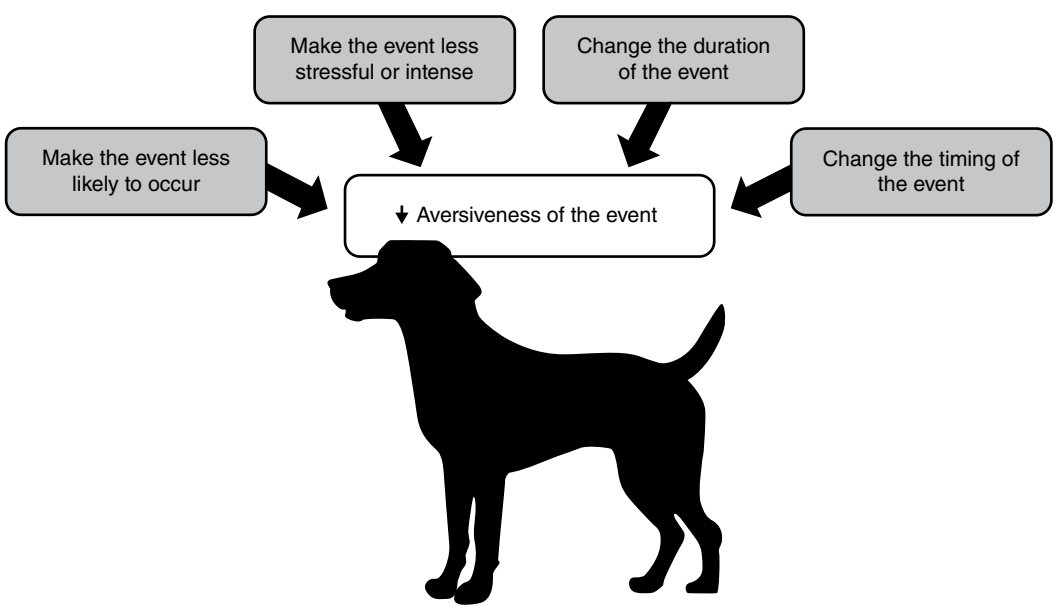


Fig. 8.2. Different ways the perception of control are believed to decrease the aversiveness of unpleasant stimuli and events.

independently of their own actions – an *external* locus of control (Rotter, 1966).

Rotter (1966) further noted that one's sense of control applies to both individual aversive experiences and life overall. This has created confusion in the literature, as 'perceived control' is often used without clarification as to whether the writer is referring to a specific event, a particular domain of life, or life in general (Thompson, 2005; Steptoe and Poole, 2016). Yet because the scope of control can differ, one could have a high degree of internal LOC in life yet have no perceived control over a specific situation, and, conversely, have a high degree of perceived control over a specific situation but a low degree of internal LOC (i.e., an external LOC) for life overall. In Rotter's (1966) original conceptualization, LOC referred nonspecifically to either control over specific events or control in life events overall; however, the latter is now the generally accepted interpretation of LOC.

The extent to which the construct of the LOC exists in animals is an unanswered question. Little direct evidence exists, and tests designed for determining LOC in children are not useful for animals as they ask the child whether they attribute causes of imaginary events to internal or external forces. Importantly, however, LOC is conceived as a generalized expectancy construct, meaning that it represents individuals' expectations about receiving desired reinforcements (Rotter, 1966; Wallston, 2004). This in turn raises the consideration of another psychological attribute for which expectancy is a central element: optimism (Peacock and Wong, 1996; Gruber-Baldini *et al*., 2009). Optimism consists of the expectation that good things, rather than bad things, will happen and is considered an aspect of personality (Bollini *et al*., 2004; Gruber-Baldini *et al*., 2009). While retaining certain conceptual differences, optimism and LOC have been found to be moderately related and overlapping concepts (Peacock and Wong, 1996; Klein and Helweg-Larsen, 2002). The primary difference is that LOC is the belief that one has control over desirable outcomes, whereas optimism is the expectation of positive outcomes regardless of whether or not they are a result of one's own actions (Peacock and Wong, 1996). The trait of optimism/pessimism has been tentatively identified in animals over the past decade in the studies of cognitive and judgment bias (Rygula *et al*., 2015). Still often placed in quotation marks to avoid accusations of anthropomorphism, optimism and pessimism in animals describe a system of expectations analogous to the corresponding cognitive mechanisms in humans.

The optimism connection offers a plausible link between animals and LOC, but an additional connection derives from Rotter's (1966) original proposal that the scale which measures internal versus external LOC 'appears to measure a psychological equivalent of…the sense of powerlessness'. As we will see (Section 8.7), powerlessness – or the perception of uncontrollability – has been extensively studied in animals.

However, because LOC as characterized in humans has not been definitively identified in animals, the use of this term in this chapter will be exclusive to humans. Thus, for animals as well as humans, the two types of control – that which is particular to a particular stimulus or event and that which applies to life in general – will be referred to as, respectively, *event-specific control* and *general control*[4] (both terms will refer to perceived rather than actual control). General control may be considered in humans to be analogous to LOC (Rotter, 1966; Klein and Helweg-Larsen, 2002).

8.3 The Desirability of Control

Human psychological research has found that the preference for control varies widely among individuals; some individuals appear to have a high desire for control while others prefer to wield less and even no control (Verme, 2009; Steptoe and Poole, 2016). In experimental studies it is not uncommon for some people, when given a choice between controllable and uncontrollable aversive events, to opt for the uncontrollable (Rodin, 1986). More recently, Buchanan-Smith and Badihi (2012) have identified in marmosets comparable individual preferences for making choices.

Notwithstanding the interindividual variance in the desire for control, research indicates that control is generally desired (Catania and Sagvolden, 1980; Overmier *et al*., 1980; Suzuki, 1999) and likely a psychological necessity in humans and animals (Leotti *et al*., 2010). In a series of experiments with rodents, Kavanau (1964, 1967) reported that captive rodents exercise control virtually any chance they get, apparently finding it rewarding to exert a high degree of control over their environment. If a light is turned on by the experimenter the animal will turn it off, but if the experimenter turns the light off, the animal, even though nocturnal,

will turn it back on. If the experimenter turns on a motorized running wheel, the animal immediately and invariably turns the motor off. However, if the animal is running on such a wheel and the experimenter turns the motor off, the animal immediately turns the motor back on. If mice were awakened from sleep and emerged from their nest boxes, they would soon go back inside on their own. If, however, the experimenters picked the mice up and placed them in the nest box, they would immediately come back out, even if they were placed repeatedly back in the box. In all, 'rodents repeatedly turn on and off (or otherwise modify) any suitable variable placed under their control, whether it is intracranial stimulation, a motor-driven activity wheel, lights or sound, or whether it is merely the ability to visit a nest, run a wheel, jump on and off a platform, patrol an enclosure, traverse mazes, or gnaw wood into fine fibers' (Kavanau, 1964).

As stated, one of the basic ways an organism can exert control is through choice. The desire for choice has been studied in humans and animals and results in both have shown a clear preference for choice over no-choice situations, even when the choice option requires greater energy expenditure and does not increase outcome value (Ly *et al*., 2019). When deciding between two options, pigeons (Catania and Sagvolden, 1980) and macaques (Suzuki, 1999) preferred the option that led to a second choice over one that did not, even though both options ultimately led to the same outcome and making a second choice required greater effort. Rats expressed a preference for a pathway that led to a choice between additional pathways rather than a pathway leading directly to the reward, despite the fact that all pathways eventually led to the same reward (Voss and Homzie, 1970). In an investigation of 'whether capuchin and rhesus monkeys choose to choose', Perdue *et al*. (2014) offered a choice between two icons, one which allowed the monkey to select the order of task completion, and the other which led to the assignment of a task order by the computer. In both cases, subjects still had to complete the same number of tasks and the same number of task trials; the only difference was whether the monkey chose the task order or it was assigned, thus isolating the act of choosing. All monkeys showed a significant preference for choice when the alternative was a randomly assigned order of tasks.

The desire for control also appears to at least partially explain the phenomenon of contrafree-loading, in which animals choose to work for an outcome even when the outcome is freely available (Franks and Higgins, 2012). As just two of many examples, Inglis and Ferguson (1986) found that starlings will search for mealworms hidden under plastic flaps rather than eat a dish of worms that are freely available, and Carder and Berkowitz (1970) reported that rats able to acquire free food from a dish would instead push the food dish aside in order to access a pressable lever that would cause a pellet of the same food to fall out for them to eat.

Collectively, these findings imply that the actual nature of the stimulus might not matter as long as the animal can exert some form of control over it and that exercising control can be rewarding in and of itself (Leotti *et al*., 2010). That the existence of the desire for control is found in many animal species as well as very young human infants led Leotti *et al*. (2010) to propose that this desire is innate and likely a psychological and biological imperative for survival, coinciding with Poole's (1998) earlier suggestion that control is one of the basic needs of mammals.

8.4 The Relationship of Control to Mental Health and Well-being

In humans, an extensive theoretical and empirical literature has documented consistent positive correlations between personal control and each of the principal well-being constructs, including general well-being (Larson, 1989; Peterson, 1999), subjective well-being (Spector *et al*., 2001), emotional well-being (Thompson and Kyle, 2000; Thompson, 2005), happiness (Larson, 1989; Peterson, 1999; Verme, 2009), and life satisfaction (Verme, 2009). More broadly, evidence supports the notion that a general sense of control over one's life is a contributory factor (Ly *et al*., 2019) and even a requirement (Larson, 1989) for positive mental health.

The data linking perceived control with well-being, happiness, and life satisfaction is robust; however, due to limitations in animals of self-reporting and accurate assessment of long-term affective well-being states (see Chapter 23, this volume), evidence of a connection between control and well-being in nonhuman species has relied on the demonstration of indirect links between these two concepts, specifically, correlations between control and separate elements, which, taken together, comprise mental health and well-being.

For instance, studies may focus on how control impacts the contributors and indicators of well-being, such as reduced stress, but not necessarily identify a direct impact on well-being itself. The evidence for this has emerged from two general areas: the positive effects of possessing control (discussed next), and the negative effects of being denied control (discussed later with the concept of learned helplessness, Section 8.6).

8.4.1 Effects of control in animals

Studies of the benefits of control have been conducted in a diverse range of domestic, laboratory, and captive wild animals in a variety of contexts, and have yielded a robust literature documenting a wide array of positive effects. Two recent reports (Englund and Cronin, 2023; Rust *et al*., 2024) reviewed the positive impact on welfare when control and choice were provided to animals. The positive effects include a reduced intensity of physiological stress responses (autonomic reactivity and corticosteroid levels) (Joffe *et al*., 1973; Rodin, 1986), improved coping with a stressful situation (Seligman, 1975), an increase in calm activity (Buchanan-Smith and Badihi, 2012), and a greater ability to relax and function effectively even in potentially dangerous situations (Joffe *et al*., 1973). The perception of control allays the emotions of fear and anxiety (Sambrook and Buchanan-Smith, 1997) and may delay the onset of distress (Russell and Burch, 1959; Wolfensohn *et al*., 2018; see also Chapter 11, this volume). Control appears to involve an active fear-inhibitory process such that when an animal processes that it has control over the aversive stimulus neural mechanisms are activated that reduce the generalization of fear, and the fear diminishes (Foa *et al*., 1992).

Of the hundreds of studies focusing on individual species, the following is a minute sampling. Laboratory-housed marmosets given control over supplemental lighting in their cages (the light also produced heat) showed positive welfare effects as measured by calm activity patterns, when compared to a yoked group that had no control but received the same light/heat schedule (Buchanan-Smith and Badihi, 2012). Socially housed crested macaque monkeys in a zoo environment showed positive welfare benefits (as measured by rates of self-directed and social behaviors) from voluntarily choosing to separate themselves from their group to participate in cognitive testing (Whitehouse *et al*., 2013). Hanson *et al*. (1976) found that when rhesus macaques were given control over high intensity noise levels by pressing a lever to turn the noise off they showed lower plasma cortisol levels and exhibited higher levels of social contact and less aggressive behavior than did macaques who had no control and received the same noise exposure.

Carlstead *et al*. (1993a) found that when captive leopard cats were given places to hide from larger cat species in adjacent enclosures by providing a variety of branches and hiding places, urinary cortisol concentrations and stereotypic pacing decreased. When given the choice to move freely between exhibit and off-exhibit areas away from zoo visitors, polar bears showed a significant decrease in stereotyped behaviors and increase in social behavior and play (Ross, 2006), giant pandas showed a significant decrease in agitation behaviors and urinary cortisol levels (Owen *et al*., 2005), and chimpanzees showed an increase in positive social behaviors such as grooming (Kurtycz *et al*., 2014), even when they chose to stay outside. As Kurtycz (2015) points out, 'In all of these zoo-based studies, the animals … showed positive responses to being provided with the ability to make a choice, irrespective of whether they exercised that choice'.

Greiveldinger *et al*. (2009) investigated whether the controllability of an aversive event (an airblast) affected emotional responses in lambs. The animals were divided into 2 groups: 1 group could interrupt the airblast in order to gain access to food but the other group could not. Each of the lambs that learned how to stop the airblast was paired with a 'yoked' partner not taught how to interrupt the aversive event. As compared to the lambs with no control over the aversive event, the lambs with control were more inclined to enter and stay in the test arena, and more inclined to eat there. The researchers concluded that their results showed 'that an aversive situation is perceived as less stressful by sheep when they can exert control over it and this effect depends on the degree of control'.

8.4.2 How does control exert its beneficial effects?

The neuropsychological processes explaining how the perception of control exerts its beneficial effects are still far from understood (Thompson, 2005). Miller (1979) hypothesized that individuals who believe that they have control know that an

aversive situation can be allayed at any time and thus can always be kept within the limits of what the individual can endure. The individual thereby feels comforted by the knowledge that he or she is protected against experiences becoming unbearable, allowing the individual to be relaxed and fully functional even in potentially threatening situations. From a different perspective, the benefits of control may derive from the ability to alter the various affective experiences of life. A prominent theoretical model of well-being in humans (Bradburn, 1969; Lyubomirsky *et al*., 2005) and animals (Green and Mellor, 2011; Yeates, 2011) is that well-being results from, or is otherwise associated with, a predominantly positive balance of pleasant feelings over unpleasant. In this view, control would exert its mental benefits by being a major factor in the animal's (or person's) ability to tip this balance in the desired direction.

The benefits have also been explored through the lens of coping, specifically, that exerting control is a method of coping and hence minimizing the adverse psychological impact of stressors (Weiss, 1968). Successful coping is highly dependent upon the controllability and predictability of the stressor (Ursin and Olff, 1993). Another potential mechanism contributing to the benefits of control is the association between greater perceived control and optimism. In a meta-analysis of human studies, Klein and Helweg-Larsen (2002) examined the overall strength of the relationship between optimistic bias and control and found that greater perceived control was clearly related to greater optimistic bias. They also noted, however, that 'it is not clear in what causal direction the relationship between perceived control and optimistic bias flows'.

8.5 Predictability

The question of why control should reduce the stress related to an aversive event has been approached differently by researchers who propose that the *predictability* of the event plays an integral role (Mineka and Hendersen, 1985; Foa *et al*., 1992). An event is unpredictable when its probability of occurrence is the same regardless of the events preceding it (Foa *et al*., 1992). An overlapping and complex interrelationship between control and predictability has been well-recognized, and several authors have questioned whether the two concepts are distinct and separable (Dess-Beech *et al*., 1983; Mineka and Hendersen, 1985; Foa *et al*., 1992).

The interrelationship of controllability and predictability can be summarized succinctly. When an animal is given the control to terminate a noxious event then the end of the aversiveness necessarily becomes predictable. However, predictable events may or may not be controllable (Mineka and Hendersen, 1985). In many studies, events that were uncontrollable also tended to be unpredictable, and those that were controllable were also predictable, making it difficult to discern which of the two factors was responsible for the observed effects (Foa *et al*., 1992; Bassett and Buchanan-Smith, 2007). Even so, some researchers have argued that the two are separable variables with distinguishable effects (Miller, 1979; Overmier *et al*., 1980) and in experiments that have separated controllability and predictability, controllability has been found to have effects over and above the predictability it provides (Thompson, 1981).

The effects of predictability (in some cases in combination with or indistinguishable from the effects of control) beneficial to well-being include general findings such as predictable aversive events (electric shock) are less physically and psychologically deleterious than unpredictable events (Dess-Beech *et al*., 1983; Bassett and Buchanan-Smith, 2007). Predictability effectively reduces stress (Seligman, 1968; Rodin, 1986) and unpredictability can be a cause of stress to animals (Taylor and Mills, 2007) as well as make aversive stimuli more stressful (Seligman, 1968; Sapolsky, 1994; Lecorps and Weary, 2024). For example, animals have more pronounced stress responses when aversive handling is unpredictable than when the same handling is conducted in a predictable way (Anon, 2001). Even in the absence of any stressor, the loss of predictability itself elicited a physiologic stress response in laboratory cats (Carlstead *et al*., 1993b) and dogs (Dess-Beech *et al*., 1983).

Fear and fear-related disorders are influenced by degree of predictability. For example, unpredictable shock in animals produces greater generalized fear and arousal than predictable shock, and danger unpredictability can directly produce increased generalized fear regardless of the degree of control (Foa *et al*., 1992). Studies using animal models of posttraumatic stress disorder (PTSD) have shown that the greater the degree of uncontrollability and unpredictability associated with a given stressor, the more likely the organism will be to develop symptoms of PTSD (Foa *et al*., 1992).

In contrast to the voluminous evidence of beneficial effects of predictability, some studies have indicated that predictable events can *exacerbate* stress. Based on behavioral and physiological measures, stressors in some cases have been shown to be more aversive for animals if they are predictable (Dess-Beech *et al.*, 1983; Mineka and Hendersen, 1985; Bassett and Buchanan-Smith, 2007).

The question as to how predictability exerts its beneficial effects parallels the same question for controllability. For some theorists, the benefits of one can be ascribed to the other. For example, Averill (1973) has argued that the positive outcomes of having control can be attributed to the predictability inherent in control, while others reduce the effects of predictability to the effects of added control that comes by allowing the organism to 'prepare' for the forthcoming stressful event and thereby modify its impact (Mineka and Hendersen, 1985). This might occur, for instance, when animals receiving predictable shocks would change their posture in order to minimize the experienced intensity of the shocks (Bassett and Buchanan-Smith, 2007). Another explanation for the benefits of predictability is that knowledge of when a stressful event is going to occur also informs the animal when the event is not going to occur, i.e., safe periods (Thompson, 1981; Bassett and Buchanan-Smith, 2007). This 'safety signal hypothesis' posits that the feedback about safe periods alleviates the chronic state of fear elicited by the uncertainty of when danger might occur. The animal able to predict the event can therefore relax and not feel the need to be on constant alert for the threat (Tsuda *et al.*, 1983; Mineka and Hendersen, 1985). Sapolsky (1994) explained this using a personal anecdote:

> I've never appreciated the importance of predictability as much as after living through the 1989 San Francisco earthquake. Now I think, 'Those lucky people elsewhere, they know what time of year you don't have to worry much about tornadoes or hurricanes. But an earthquake, now that could be any second, maybe even while I'm sitting bumper-to-bumper beneath this highway overpass. (p. 258)

Safety also appears to be a key feature in the idea that the predictability of daily routines provides children with consistent and predictable lifestyles, which results in fewer behavior problems (Bridley and Jordan, 2012). Luna-Cortés (2022) found similar results in dogs from Colombia and Germany; both studies showed that a consistent routine is associated with reduced behavioral problems.

Just as evidence argues for the desirability of control, substantial evidence also supports the desirable nature of predictability. Pigeons and rats showed a consistent preference for conditions allowing them to use signals to predict the presence or absence of food, compared with conditions where they were unable to predict food (Bassett and Buchanan-Smith, 2007). More compellingly, the preference for predictable over unpredictable electric shock is so pronounced that rats chose signaled rather than unsignaled shock even when the predictable shock was four to nine times longer and two to three times stronger than the unpredictable shock (Bassett and Buchanan-Smith, 2007).

8.6 Effects of No Control: Learned Helplessness

The above discussion of the effects of control in animals focused on the benefits observed when an animal perceives that it has control over aversiveness. Most research on the concepts of control (and predictability) has taken the opposite approach, that is, determining the harmful effects of *lacking* control (or predictability). This work largely falls under the banner of *learned helplessness* (LH) and encompasses the most detrimental consequences for the mental health and well-being of animals and humans.

In 1967, Overmier and Seligman (1967) introduced the term learned helplessness to explain the constellation of effects they observed in dogs exposed to an uncontrollable and inescapable aversive stimulus (electric shock). Approximately 24 hours after the shock exposure treatment 50% of the dogs, as compared to 12.5% of the unshocked control dogs, showed greatly impaired learning of a new shock avoidance task and would come to passively endure the shocks. The researchers suggested that the dogs realized that nothing they did mattered – the shocks occurred independently of any behavioral response. This, the researchers proposed, indicated that the dogs learned to be helpless. Decades of subsequent studies found that repeated exposure to inescapable aversive stimuli led to a relatively consistent combination of cognitive, emotional, and motivational deficits that do not occur if the stressor is controllable (Maier and Watkins, 2005; McGreevy and McLean, 2009). (Maier and Seligman (2016) later revised their original theory for the mechanism of learned helplessness, which, as they described it, they 'got backwards'[5].)

It quickly became established that animals and humans who experience uncontrollability in one situation become passive in that situation, but soon became evident that the deficits associated with LH generalized, extending to situations beyond the specific aversive event to others that are normally amenable to control (Peterson, 1999) (see Fig. 8.3). It is now widely accepted that LH is characterized by: (i) the triad of emotional, cognitive, and motivational impairments; and (ii) evidence of generalization to new situations, i.e., the signs occur in circumstances different from the one in which uncontrollability was first encountered (Peterson, 1999; Maier and Watkins, 2005). Indeed, Peterson (1999) has stated that, 'It is impossible to argue that learned helplessness is present without the demonstration of passivity in new situations'. The generalization of LH effects in animals has been shown to be quite broad, making coping difficult with an array of tasks and challenges, even the most routine such as competing for food or avoiding social aggression (Joffe *et al*., 1973; Seligman, 1975). Notably, this pronounced tendency for LH effects to generalize provides additional evidence for the existence of a sense of general control discussed in Section 8.2. In addition, the range of species in which LH has been identified has steadily expanded over the past 50 years (Franks and Higgins, 2012). The neurobiology of LH is complex, not fully understood, and has been reviewed elsewhere (Maier and Watkins, 2005).

To date the occurrence of LH in animals outside of the laboratory setting has been primarily speculative. Dogs in the kennel environment frequently show signs of apathy and loss of interest in surroundings, which increase with the duration of stay in the kennel (Wells *et al*., 2002), and several authors have suggested that this apathy may represent a form of LH (Wells *et al*., 2002; Taylor and Mills, 2007). Ruet *et al*. (2019, 2020) have described horses in compromised welfare situations exhibiting withdrawal, anhedonia, and unresponsiveness to the environment, and some equine researchers (Hall *et al*., 2008; McGreevy and McLean, 2009) have suggested the likelihood that these types of behavioral responses observed in the domestic horse, including reduced motivation, lethargy, and cognitive deficits, are examples of LH. In a more extreme scenario, LH appears to be the objective of traditional 'breaking' of horses (Hall *et al*., 2008) and elephants (Kontogeorgopoulos, 2009; Mason and Veasey, 2010) – a training method that frequently involves extreme forms of restraint with ties and hobbles to prevent the animal from lessening or escaping from the aversive punishment that is implemented. The animal is considered to be ready to be ridden or worked once it has ceased to resist, or 'given up'. Learned helplessness has been suggested recently to be a consequence of lack of control in captive cetaceans (Atkinson and Dierauf, 2018; Marino, 2019).



Fig. 8.3. Environments that deny the animal any meaningful control are detrimental to mental health and well-being. (Image used under license from Shutterstock.com.)

8.7 Implications and Practical Applications

8.7.1 Enhancing control in animals

Enhancing control is now well accepted in humans as a means to promote overall well-being and research continues on the best methods for increasing perceived control among those who are in low-control circumstances (Thompson and Kyle, 2000; Steptoe and Poole, 2016). Of course, the latter describes the lives of many if not most captive animals. There is now a wide consensus that positive welfare can be promoted by providing captive animals with a degree of control (Yeates and Main, 2008; Sambrook and Buchanan-Smith, 1997). However, in the endeavor to positively affect animal well-being it is important to keep in mind that, because of uncertainties such as there being substantial individual variation in the desire for control, a potential exists for misapplication of current knowledge. Accordingly, caution must be exercised in any efforts to increase control in individual and groups of animals.

Event-specific versus general control

In the approach to enhancing control in animals, it will be recalled that there are two types of control: event-specific control and general control[4]. The first type has been the focus of the vast majority of research of control in animals, during which the animal is exposed to a very specific aversive stimulus such as electric shock. Enhancement of this specific type of control involves providing resources needed for alleviation of the animal's distress about the specific aversive stimulus or event becoming too much to bear. Practical examples here include such things as hiding places to escape stressors (e.g., 'bully' animal housemates), supported by such work as a study by Kim *et al*. (2018) showing that indoor pet cats provided with places where they can retreat and conceal themselves had a decreased risk of idiopathic cystitis, as compared to cats without such safe places (see Fig. 8.4). Other easy-to-provide resources include pet doors to allow free access to outside, interactive toys to alleviate boredom, and visits to a dog park. The second type of control – general control (LOC in humans) – would, when enhanced, help alleviate general fears and worries not limited to a specific threat. Based on evidence in humans, this type of control appears to have the greatest impact on overall well-being and happiness.

Recognizing that control may be event-specific or general, it seems reasonable to develop enhancement methods for each type. But fortunately for therapeutic contexts, these two types are not separate and distinct. Evidence in animals (Peterson, 1999) and humans (Thompson and Kyle, 2000; Ly *et al*., 2019) suggests that enhancing perceived control in areas unconnected to a specific area of concern



Fig. 8.4. Availability of a secure hiding place – (a) under a bed, (b) in a closet on an upper shelf, (c) near a burrow opening – provides a sense of control over numerous sources of fear. (Images used under license from Shutterstock.com.)

(e.g., one's physical health) tend to generalize to foster an *overall* sense of control. In fact, any activities that affirm a causal relationship between one's own action and a desired outcome may increase overall perceived control (Thompson and Kyle, 2000). Therefore, at our current level of understanding it may be unnecessary to make a distinction as to which type of control we are enhancing; efforts to enhance event-specific or general control are both likely to enhance the perception of general control.

Individualizing the enhancement of control

The recognition in humans of the interindividual variability in the desire for control (Verme, 2009; Steptoe and Poole, 2016) has led some investigators to posit that control may be helpful only if it matches recipients' desires and capabilities for exercising control (Thompson and Kyle, 2000). Because this individuality of desire has also been observed in animals (Buchanan-Smith and Badihi, 2012), similar notions may be applicable to nonhuman species. However, the means to determine animals' individual preferences for control outside the laboratory setting are lacking.

8.7.2 Methods for enhancing specific and general control

Enhancing control in early life

Some researchers in the human field believe that the contribution of LOC to happiness means that efforts to improve the sense of control in children may improve the likelihood of happiness during the later years of life (Verme, 2009). Seery *et al*. (2010), referring to humans and animals, explained, 'Early life experience of low perceived control and low mastery facilitates interpreting subsequent situations as uncontrollable. In contrast, the experience of high control and high mastery has the opposite effect, facilitating future perceptions of control, which in turn can enhance coping capabilities.' However, evidence for the effects in animals is inferential, based on how the enhancement of control in very early life is associated with beneficial emotional well-being outcomes in adulthood. For example, Joffe *et al*. (1973) found that rats reared in environments where they could control access to food, water, and visual stimulation were subsequently less emotional and showed more exploratory behavior as compared to rats receiving the same food, water, and lighting conditions but without control over their occurrence. Similarly, two studies in rhesus monkeys demonstrated that an early life consisting of experiences of controllable events resulted in later reduced reactivity to stressful events (Suomi, 1991) and less fear in the presence of a toy robot, increased eagerness to enter and explore a novel and somewhat frightening playroom situation, and improved adaptability to stressful separations from peers (Mineka *et al*., 1986). Conflicting findings, where *less* control in early life led to better outcomes, seemed evident in a study by Gazzano *et al*. (2008) with puppy owners who were given advice by a veterinary behaviorist that included removal of much if not all of the young dog's control. Instructions to the puppies' owners stated that the owner should be the initiator of all dog–human interaction and should make all decisions regarding when to play with, pet, or feed the dog. When compared to dogs whose owners did not receive these instructions, the dogs whose owners received this advice went on to later exhibit fewer undesirable behaviors, including house soiling, mouthing of people, and aggressive behaviors.

Immunizing against adverse effects of uncontrollability

In a process showing similar effects as the early life exposure to controllability, but not restricted to the animal's developmental period, experience with controllable events imparts a protective effect – 'immunization' (Maier and Seligman, 2016) – against later detrimental effects of uncontrollability (Peterson, 1999). It appears that during this process the animal learns that events can be controlled, which provides positive expectations upon encountering subsequent uncontrollable events. As a result, the likelihood of LH is lessened (Peterson, 1999). Importantly, a major finding in these experiments was that the protective effects generalize, extending to situations and settings different from the ones used in the immunization procedure (Williams and Maier, 1977; Ly *et al*., 2019).

Practical applications

Recommendations for providing animals with control have been proposed. However, knowledge limitations have thus far prevented these recommendations from containing the specificity and detail necessary for reliable effectiveness. In contrast to

the situation in humans (Rotter, 1966), there is currently no method to measure perceived control in animals. This leaves the biggest questions lacking answers, such as how do we know which animals need enhanced control, and what kind(s) and how much control? As a result, many recommendations for enhancing control for animals have consisted solely of the blanket recommendations to 'provide control' or 'offer choices', e.g., 'captive animals should be provided with as many opportunities to control their environment as possible' (Buchanan-Smith and Badihi, 2012).

The complex relationship between controllability and predictability further complicates the task of developing explicit applications for animal care. Addressing this interrelationship, Bassett and Buchanan-Smith (2007) proposed that in situations where providing control is impractical, making the events as predictable as possible may serve as a viable alternative and minimize the stress associated with a lack of control. As described earlier, predictability may be effective as a 'safety signal', indicating when aversive events would not occur and during which time the animal need not be in a constant state of anxious expectancy of the events. Although the discussion below focuses on control, much research suggests that many of the same points and recommendations could apply to enhancing predictability.

Recommendations appearing in the animal welfare and behavior literature are compiled in Table 8.1. A number of methods of control enhancement are included, which range from altering the environment to managing the way humans interact with the animals, such as training methods used. In short, methods involve anything that can promote the animals' learning that their actions can improve their chances for desirable things to happen, in particular for those things that matter most, i.e., alleviating aversive experiences (McGreevy and McLean, 2009). It should be kept in mind, too, that because the effects of control can involve stimuli that are appetitive as well as aversive (Peterson, 1999) both types should be included

Table 8.1. Methods for enhancing control and predictability in the animal welfare and behavior literature.

Species	Setting	Methods	Reference
Cats	Shelter	Offer heated and unheated beds and shelves near windows, which allows the cats a choice of temperatures and a choice of a location in the sun or the shade. Provide scratch pads, climbing poles and ropes to allow a choice of height and play area.	Loveridge *et al*., 1995
Companion animals	Home, veterinary hospital	Offer meaningful opportunities to make choices (e.g., going outside or staying inside, which food to eat today, which toy to play with, etc.). Give animal 'say-so' in its life by allowing requests to be made (e.g., the pet signaling to the owner when the pet would like to go outside or on a walk, when the pet would like the owner to play, etc.). Assure that the pet has a meaningful ability to lessen the intensity of unpleasant feelings or to improve an unpleasant situation, such as boredom, loneliness, frustration, fear, or pain (e.g., by having a secure place to escape or hide, seeking out stimulation or better conditions, or actively easing any discomforts).	McMillan, 2003
Various species	Laboratories, zoos	In laboratories, teach the animals a reliable signal to indicate the onset of an aversive event, e.g., cage cleaning, or restraint for injection or blood draws (and thus the absence of such a signal indicates that the situation is safe). Implement training that uses positive reinforcement techniques to provide captive animals with a degree of control and predictability. Give animals control over environmental music.	Bassett and Buchanan-Smith, 2007
Unspecified captive animals	Unspecified	Increase the environmental complexity, which increases the animals' available choices as well as helping animals to cope better with novel or stressful situations. Provide animals with choice through the use of retreat areas, pen dividers, or natural vegetation that create opportunities for concealment from other animals or from people.	Jones and McGreevy, 2007

Continued

Table 8.1. Continued.

Species	Setting	Methods	Reference
Dogs, cats	Kennels, shelters	Increasing the complexity of the kennel may provide some control by having choices about where to sit, stand or lie. For example, provide animals with both indoor and outdoor access. Provide the ability to escape or hide from threats; including hiding places.	Taylor and Mills, 2007
Horses	Unspecified	When kept in groups and provided adequate space, allow horses to choose if and how they engage in social interactions. Allow some control over other environmental features such as lighting, feeding, flooring, and an out-in-the-open or inside environment (and design housing systems accordingly).	Hall *et al*., 2008
Unspecified	Unspecified	Provide the ability to gain control over aversive stimuli. Take extra care when training animals using aversive stimuli because of animals' imperative to achieve control over such stimuli.	McGreevy and McLean, 2009
Dogs	Home	Allow dogs to have control on walks.	McGreevy, 2010
Various species	Zoos	Provide different types of enrichment that could be interacted with as the animal chooses. Provide switches that animals could learn to manipulate to alter lighting, temperature, and humidity. Allow the animal to move between microclimates within an exhibit. Allow the animal to get water on demand by manipulating a drinker. Use instrumental learning to give animals control over their environments. For example, animals could learn to use tools that would allow them to communicate their needs, as demonstrated in a dog and chimpanzees who learned to request specific objects, activities, interactions by pressing keys on a keyboard.	Siegford, 2013
Dogs	Shelter	Provide an elevated place to retreat and the ability to move out of sight. Provide food-dispensing devices controllable by the dogs.	Moesta *et al*., 2015
Dogs	Home	As much as possible, abide by the dog's choice to participate in and to terminate activities, such as being held, training sessions, grooming, and veterinary checks. Use positive reinforcement as encouragement.	Starling and McGreevy, 2018
Aquatic animals	Aquaria	Give animals the chance to choose and control their shelters, substrates, social contact, temperature and light gradients, rest opportunities, enrichment, and interactions with people. Use positive reinforcement training to help accomplish this.	Richard, 2021

when considering the options for enhancing the degree of control for the captive animals.

In considering methods for offering control, a critical stipulation must be acknowledged. Because individuals are not always knowledgeable of risks and consequences of their actions, such as animals and children, certain constraints must be placed on the degree and range of control they are provided. As Burnett (2018) has described for children, they 'need to know where the limits are, to feel safe within them and to be able to learn that the world has rules'.

8.7.3 Therapeutic considerations

In addition to the preventive effects of enhanced control being a safeguard and improving mental health and well-being, a more recent line of research has demonstrated that if an individual has already suffered harm as a result of insufficient control over major aversiveness (as found in LH) then enhanced control may be effective in ameliorating the detrimental effects. In humans, attempts to reverse the deleterious effects of uncontrollability by reinstilling a sense of control have resulted in positive effects on psychological as well as physical well-being (Mineka and Hendersen, 1985; Peterson, 1999; Ly *et al*., 2019). In animals, therapeutic success for LH effects has been observed when individuals who have been exposed to uncontrollable stimulation are given experience with 'easy' tasks in order to re-establish a sense of control (Mineka and Hendersen, 1985). Treatments involving more active interventions, such as gently physically forcing an animal with LH to experience the contingency

between behavior and outcome (e.g., moving the animal's legs in walking-type motions in the direction of the reward), have been shown by some studies to help undo LH deficits (Peterson, 1999). Pharmacologic treatments have also been shown to be effective in reversing adverse behavioral and neurobiological changes associated with helplessness in animals (Vollmayr and Henn, 2003).

As promising as the research has been for treatment of the emotional damage of LH in animals, however, it is important to note that these findings are too preliminary to be applied to clinical cases. Crucial limitations to implementing these techniques include our incomplete understanding and ability to definitively identify LH in animals as well as our ability to predict which animals would respond positively to which techniques. Notably, the fact that such treatments can involve the infliction of stress indicates that they pose substantial risk of causing harm if misapplied.

8.8 Mental Health Implications

The mental health impact of controllability, particularly when its absence leads to LH, cannot be overstated. Indeed, the fact that LH has been used in animals to model aspects of severe psychological disorders of humans such as depression (Vollmayr and Henn, 2003; Maier and Watkins, 2005) and PTSD (King *et al*., 2001) attests to the highly injurious potential of insufficient control for the mental health and well-being of animals.

While we do not yet have a clear understanding of why and how a sense of control exerts its effects on psychological well-being, numerous studies in animals show that it is primarily beneficial and is generally desired. Evidence in humans indicates that good mental health results, at least partially, from the feelings of comfort that the perception of control provides as it promises to protect against serious adversity becoming intolerable. The individual person or animal who perceives that he or she has a meaningful degree of control is more able to enjoy their life and be less burdened by major anxieties, fears, and worries of impending danger. In the most general sense, the perception of control offers *peace of mind*.

But good mental health appears to be promoted not only by the protection against adversity. As Brando and Buchanan-Smith (2017) point out, 'some stressors are required to promote resilience and coping in animals [but] the key for good welfare is whether the animal has perceived control'. Furthermore, studies show that animals desire control for the sake of control, that is, control is rewarding in itself, and that control is desired for appetitive as well as aversive stimuli. Together, these findings indicate that the benefits to mental health and well-being extend well beyond minimizing undesirable experiences in life.

Notes

[1] In this chapter control will refer to behavioral control, acknowledging that other types of control, e.g., cognitive control (which utilizes cognitive reappraisal, calming self-talk, selective attention, imagery, and distraction (Thompson, 1981)), have been identified in humans.

[2] The effects of control have been found to involve stimuli and events that are appetitive as well as aversive (Peterson, 1999); however, the emphasis in this chapter will be control in situations of aversiveness. It is worth noting, however, that the portion of the definition of control referring to maximizing desired outcomes and/or minimizing undesired ones is applicable to control in the face of either aversiveness or appetitiveness.

[3] Research investigating whether *actual* control is required to be present or if the individual only has to think, or perceive, that it is has indicated in both animals and humans that the beneficial psychological and physiological effects of control are experienced even in the absence of true control over aversive events as well as if the individual has the opportunity to exert control but never actually exercises that option (Perlmuter and Monty, 1977; Ly *et al*., 2019). It is the mere *perception* of control, independent of whether it is exercised, that appears to be important (Bollini *et al*., 2004).

[4] Others have referred to this distinction with different terms, e.g., general or specific measures of control (Klein and Helweg-Larsen, 2002) and general and context-specific perceived control (Ly *et al*., 2019).

[5] Maier and Seligman (2016): 'The mechanism of learned helplessness is now very well-charted biologically and the original theory got it backwards. Passivity in response to shock is not learned. It is the default, unlearned response to prolonged aversive events … which in turn inhibits escape. This passivity can be overcome by learning control… So animals learn that they can control aversive events, but the passive failure to learn to escape is an unlearned reaction to prolonged aversive stimulation.'

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9 The Mental Health and Well-being Benefits of Social Relationships, Social Support, and Social Buffering in Animals

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Research spanning the past century across diverse scientific fields – e.g., ethology, evolutionary biology, neuroscience, clinical and comparative psychology, and medicine – has demonstrated the importance of social relationships for the physical health, mental health, well-being, and survival of social species (Cacioppo *et al*., 2014b; Matthews and Tye, 2019). The evolutionary value of sociality – for shared parental care, cooperative foraging and hunting, enhanced reproductive opportunities, and greater protection from predators – has been extensively reviewed (e.g., Alexander, 1974). This chapter addresses the positive effects of social affiliation that extend beyond these fitness benefits.

9.1 Physical Health Benefits of Social Affiliations

For social species, social relationships play an indispensable role in maintaining the health of the individual and the species (Vitale and Smith, 2022). In humans, hundreds of empirical investigations have demonstrated links between social connectedness and reduced health risks of all kinds and involving all major body systems (e.g., cardiovascular, endocrine, and immune), affecting both the initial likelihood of disease as well as the course of recovery among those who are already ill (Uchino *et al*., 1996; Taylor *et al*., 2005). In nonhuman social species, animals who form strong relationships and are integrated most strongly into group living are most likely to survive, reproduce, and raise offspring to reproductive age (MacDonald and Leary, 2005). Many of these benefits have been attributed to positive aspects of social connections (see Sections 9.3.1 and 9.7) while others are associated with counteracting adverse effects of social isolation on physical health, e.g., exacerbation of coronary artery atherosclerosis among female long-tailed macaques, promotion of the development of obesity and Type 2 diabetes in mice, exacerbation of infarct size and edema and decreased post-stroke survival rate following experimentally induced stroke in mice, neuroinflammation and cell death following experimental cerebral ischemia, and detrimental neurological changes (reviewed by Cacioppo *et al*., 2011, 2014b).

The survival benefits of sociality were revealed in a novel way in a recent study by Testard *et al*. (2024). They examined 10 years of data collected on rhesus macaques before and after the category 4 Hurricane Maria caused large-scale deforestation in Puerto Rico. Because tree cover provides the shade necessary for proper thermoregulation, the increased exposure to sunlight created a heightened risk to survival. In response, macaques demonstrated an increased social tolerance toward other monkeys, facilitating sharing of the scarce shade. Social tolerance predicted individual survival after the hurricane, but not before it, showing that the most tolerant animals had the highest survival.

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9.2 Mental Health Benefits of Social Affiliations

Social relationships in humans are positively correlated with improved mental health and psychological well-being (Thoits, 2011; Rault, 2012; Hostinar and Gunnar, 2015). Social connections predict decreased negative affect (Siedlecki *et al.*, 2014) and can lessen the risk of anxiety and depression (Kikusui *et al.*, 2006; Neumann, 2009; Thoits, 2011; Siedlecki *et al.*, 2014) as well as promote the positive aspects of mental health (Feeney and Collins, 2015). In studies looking at the relationship between social relationships and the more general well-being concepts, social connectivity was determined to be positively associated with improved quality of life (Bennett *et al.*, 2001), subjective well-being (Feeney and Collins, 2015), and life satisfaction (Siedlecki *et al.*, 2014).

9.3 What Creates and Maintains Social Connections? The Affective Elements

All of the different types of social affiliations – mother–infant, monogamous mating pairs, close social associates (friendships), conspecific grouping – need a psychological mechanism for monitoring and motivating the individual to form, maintain, and restore social connections (MacDonald and Leary, 2005; MacDonald and Shaw, 2005). Bowlby (1973) believed that it was essential for the survival of the ancestors of social animals to develop proximity-promoting mechanisms, and that only those who possessed such mechanisms had a meaningful chance of producing progeny to whom they might pass on their traits (Weiss, 1973).

Weiss (1973) posed the question as to what might constitute the general character of proximity-promoting mechanisms in nature and suggested that there are only a few possibilities. One would be that social proximity would elicit a sense of well-being or pleasure. A second would be that social disconnection or distance would elicit distress or discomfort, which could be reduced by reestablishing proximity (Fig. 9.1a). Bowlby's (1973) body of work along with subsequent research by others ultimately led to the current prevailing view in the scientific community that emotions play a central role in the social interactions of animals and humans (e.g., Trivers, 1971; Panksepp, 1998).

9.3.1 Positive affect

The first component of Weiss's (1973) suggested proximity-promoting mechanism is that closeness would elicit a sense of well-being or pleasure. Behavioral and neuroimaging studies in humans suggest that establishing a sense of social connection is fundamentally rewarding by generating pleasant emotions (Vitale and Smith, 2022). For example, neurobiological studies utilizing brain imaging have shown that individuals who report being socially bonded with a partner exhibit activation of the subcortical brain areas that are associated with euphoria, reward, and motivation (Ortigue *et al.*, 2010). In nonhuman studies, evidence from animal models has shown that social interactions represent a primary reward (Tomova *et al.*, 2021). Examples include Latané (1969) demonstrating

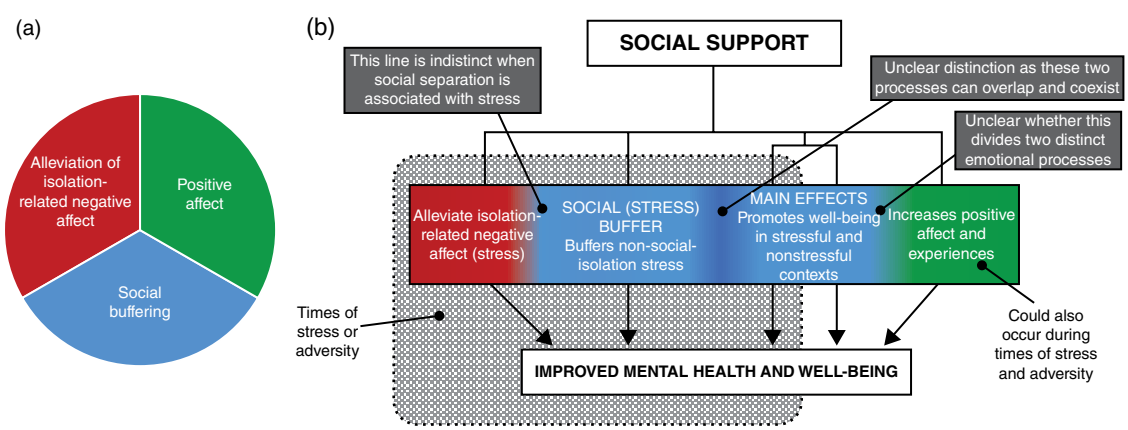


Fig. 9.1. (a) The three factors which: (i) promote social affiliations; and (ii) underlie sociality's contribution to mental health and well-being. (b) Proposed pathways linking social support with positive effects on mental health and well-being.

that repeated social encounters in rats enhanced the animals' motivation for seeking even more encounters, and Löckener *et al.*'s (2016) study showing that horses that had been housed individually in horseboxes without pasturing and access to conspecifics for six months and then allowed to be with conspecifics in pasture demonstrated, on cognitive bias testing, a positive bias, widely believed to indicate a positive affective state.

In addition, part of the pleasant experience associated with positive social affiliations consists of a feeling of security (Bowlby, 1973). It appears that evolution fashioned social animals not only to feel good when connected, but to feel safe (Cacioppo and Patrick, 2008). Research in humans has shown that there is decreased activation in brain regions associated with the processing of fear when the individual looks at a photograph of their loved ones (Bartels and Zeki, 2000), an effect Cozolino (2006) suggests may be attributable to a 'standing down' of the amygdala and the environmental processing of the posterior cingulate and other cortical areas when experiencing positive social emotions. Positive social emotions appear to relieve one from scanning the world for threats, turn off psychological alarm systems, and free the individual from worry.

9.3.2 Negative affect

Given the crucial importance of social relationships in social species, there would be a clear adaptive benefit to having a strong aversive response upon social separation as a potent motivator of social connection or reconnection (MacDonald and Leary, 2005; Eisenberger, 2012; Cacioppo *et al.*, 2014b; Vitale and Smith, 2022). Panksepp (2011) asserted that research in humans and animals now strongly supports the notion that negative affective states arising from the disruption of social relationships – whether it be through the death of or loss of contact with a social partner – is a basic emotional response of mammalian brains, and that the evolution of sociality has resulted in the creation of organisms that have a very strong need for social attachments. Social separation and/or isolation has been shown to rank among the most reliable and potent stimuli for producing a stress response in a diverse array of social mammals (reviewed by Cacioppo *et al.*, 2011; Rault, 2012; Cacioppo *et al.*, 2014a; Cacioppo *et al.*, 2015a; Vitale and Smith, 2022), and is widely used as an experimental model for inducing stress (Cacioppo *et al.*, 2014a) (Fig. 9.2).

The unpleasant affective experience(s) associated with threatened, weakened, severed, or absent social relationships involve several emotions, including loneliness/isolation, rejection, insecurity, jealousy, anger, and grief (MacDonald and Leary, 2005; Riva and Andrighetto, 2012). Accumulating research has shown that in addition to the most commonly considered emotion of loneliness, fear constitutes a major element of the negative social emotions and represents the negative counterpart of the safety/security component of positive social affect. Being socially separated presents a survival risk (e.g., from predation, health disorders), and current evidence indicates that the brain of social animals evolved mechanisms to put individuals into a short-term, self-preservation mode when they find

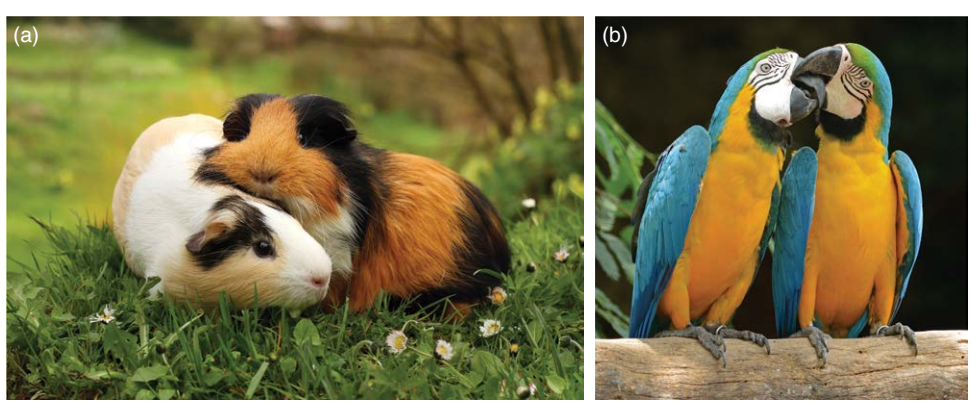


Fig. 9.2. In Switzerland a law enacted in 2008 states that animals classified as 'social species' – such as (a) guinea pigs and (b) parrots – will be considered victims of abuse if they do not live or interact regularly with others of their species (Howard, 2008). (Images used under license from Shutterstock.com.)

themselves without companionship or mutual protection/assistance (Cacioppo *et al*., 2015b). For example, it has been demonstrated in different lines of research that people in situations of experimentally induced or naturally occurring loneliness feel not only unhappy but also unsafe (Cacioppo *et al*., 2014b). As examples, loneliness in people increases attention to negative social stimuli, such as social threats, rejection, and exclusion (Cacioppo *et al*., 2015a) and lonely people exhibit increased vigilance and sensitivity to perceived social threats and attacks, which leads to self-protective behaviors (Vitale and Smith, 2022). Experimental studies of isolation in nonhuman social animals suggest that the heightened sensitivity to threats when isolated may represent an adaptation and enhancement of predator evasion (Cacioppo *et al*., 2011, 2014a). For instance, socially isolated rodents showed increased predator evasion behavior (Hofer, 2009; Kaushal *et al*., 2012), fearful withdrawal of rats in an open field increased when no other rats were present (Davitz and Mason, 1955), isolated piglets showed decreased open field activity (Kanitz *et al*., 2004), and prairie voles that were isolated from their partner and placed in an open field showed decreased exploratory behavior and increased predator evasion (Grippo *et al*., 2014).

It is now widely accepted that the feelings of loneliness and other negative social emotions serve the purpose of signaling a deficiency to the organism (i.e., that the current social bonds are not sufficient to fulfill the need of belonging) and motivating the individual to reestablish sufficient social contact (Matthews and Tye, 2019; Tomova *et al*., 2021; Vitale and Smith, 2022). The motivation function has been observed in many experimental settings; Tomova *et al*. (2021) have reviewed studies showing that even brief periods of isolation in rats increase motivation to seek out and engage with conspecifics and that animals deprived of social contact will work for contact with conspecifics without any additional rewards.

Specific adverse mental health effects include social separation in adulthood producing behavioral indicators of depression or anxiety in a number of species (Grippo *et al*., 2007). Currently, chronic social isolation serves as an animal model for studying elicitation, course trajectory, and treatment responses of affective disorders in several species (reviewed by Cacioppo *et al*., 2015b; Capitanio *et al*., 2014). For example, in prairie voles the absence of social contact can cause dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis activity and produce behaviors that mimic symptomatology of depression and anxiety disorders in humans (Smith and Wang, 2014). Taken together, current evidence indicates that social separation and isolation are risk factors for impaired mental health and the development of psychopathologies (Neumann, 2009) (Fig. 9.3).

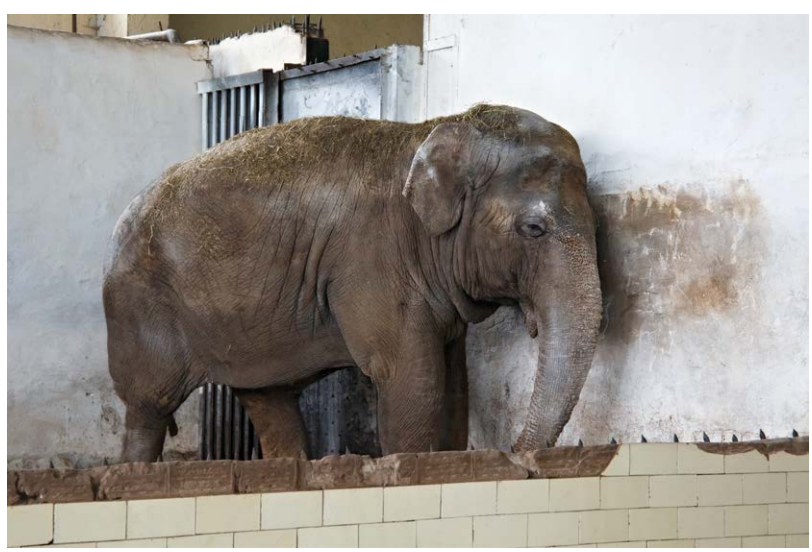


Fig. 9.3. Social animals denied companionship experience social pain and decreased physical health. (Image used under license from Shutterstock.com.)

9.3.3 Dual mechanism to promote social connections

Current evidence supports the notion that, in general, motivation in humans and animals is driven by the pursuit of rewards and/or the avoidance of aversive states (Salamone and Correa, 2012). Research in animal models has demonstrated the application of this concept to social relationships in which social motivation is driven by both positive and negative valenced states, specifically, reward togetherness and punish separation (Cacioppo and Patrick, 2008; Panksepp, 2011; Eisenberger, 2012; Tomova *et al*., 2021; Vitale and Smith, 2022). There exists wide agreement that this system of feelings is an evolutionary adaptation that motivates social animals to engage in prosocial behaviors, promotes social adhesion, enhances survival, and ultimately benefits the chances for perpetuating one's genes in subsequent generations (e.g., Panksepp, 1998; Cozolino, 2006; Eisenberger, 2012).

9.4 Social Support and Social Buffering

In research investigating the link between social relationships and psychological well-being, the concept of stress and its modulation has emerged as a prominent factor. Knowledge of the connection of social factors and stress dates back to the 1950s. In a 1959 literature review, Bovard (1959) concluded that, 'Taken together, these studies at the human and animal levels suggest presence of another animal of the same species has protective effect under stress'. Seeman and McEwen (1996) reviewed the animal and human studies between the 1960s and mid-1990s for evidence of social environment influencing neuroendocrine reactivity, including effects on activity of the HPA axis, sympathetic nervous system (SNS), and cardiovascular system. The key finding of the reviewed studies was that positive social associations can attenuate patterns of neuroendocrine responses to stressors: when animals are in the company of amiable conspecifics both HPA and SNS activity are dampened during and briefly following stressful experiences, enhancing the animal's ability to cope with and recover from such events (reviewed by Seeman and McEwen, 1996; Kikusui *et al*., 2006). Moreover, it is the intensity of the positive relationship between individuals that is the best predictor of whether a buffering effect of the glucocorticoid response of a companion will occur (Hennessy *et al*., 2020). Subsequent research has produced ample confirmation of these findings in humans and animals (Hennessy *et al*., 2009; Rault, 2012; Hostinar *et al*., 2014; Hostinar and Gunnar, 2015; Sullivan and Perry, 2015; Vitale and Smith, 2022). This effect is termed *social buffering* (also, in earlier literature, *stress buffering*), and is produced by the stress-coping strategy of *social support* (Rault, 2012). There is currently no universally agreed upon definition of social support (Uchino, 2006). Some definitions limit the benefits to times of stress; for example, social support has been defined as 'a social network's provision of psychological and material resources intended to benefit an individual's ability to cope with stress' (Hostinar and Gunnar, 2015). However, as we will see, the benefits of social affiliation and social support occur prominently – but not exclusively – during times of stress (Taylor *et al*., 2005) and, accordingly, social support in the present chapter uses the definition inclusive of all benefits derived from social interactions both within and outside of stressful contexts (Fig. 9.1b).

9.4.1 Social buffering of stress and fear as motivation for social connection

The stress buffering effect of social companionship appears to enhance the mechanisms of the attractive forces between social animals. A large literature now exists to show that, in general, the stressed animal is highly attracted to conspecifics, seeking social proximity or social contact (Kikusui *et al*., 2006; Rault, 2012) and that acquiring such contact can lead to a reduction in the stressed animal's stress hormone levels and distress vocalizations (Rault, 2012; Hostinar *et al*., 2014; Smith and Wang, 2014). For example, rats (Taylor, 1981; Denommé and Mason, 2022), cattle (Ishiwata *et al*., 2007), and pigs (Geverink *et al*., 1998) exposed to a noise stressor are more highly attracted to other animals than are non-stressed animals. These findings have led to the suggestion that social buffering may be a crucial component of the motivation underlying affiliative behaviors and social cohesion (e.g., Hennessy *et al*., 2009; Hostinar *et al*., 2014; Wu, 2021), since a calming effect would be expected to be reinforcing (Hennessy *et al*., 2009) (Fig. 9.1a). In fact, Hennessy and colleagues (2009) proposed that an important reason why certain conspecifics *become* preferred companions is precisely because they are the best at buffering one's stress responses.

Because of the role fear has been found to play in social isolation (Section 9.3.2), alleviation of fear has been similarly reported to be a motivator for social cohesion. For example, Coe *et al.* (1982) found that when monkeys were exposed in pairs to the fear-inducing stimulus of a snake they exhibited a strong preference for staying in close proximity with each other, and Kikusui *et al.* (2006) showed that fear increases rats' preference for conspecific contact and appears to be allayed when conspecific animals are together. Notably, there is substantial overlap between fear alleviation as motivation for social affiliations and the motivation attributable to social buffering, as the line between buffering stress and buffering fear is not at all distinct.

9.4.2 Categorizing the constructs of social support

The analysis of social support benefits is hampered by the existence of multiple methods of subdividing and categorizing the important constructs. In addition, all methods of categorization yield overlaps and indistinct lines between the different divisions (see Fig. 9.1b). For the purposes of the present chapter, the two major methods of subdividing the positive social support effects are stress-related versus non-stress-related and isolation-related stress versus non-isolation-related stress.

Stress-related versus non-stress-related effects

The social support literature has focused on stress buffering effects (resulting in the aforementioned occurrence of some definitions of social support confining the effects to a stress context). However, numerous studies have indicated that social support can protect and promote well-being both when individuals are and are not experiencing stress (Thoits, 2011; Feeney and Collins, 2015). That social support is beneficial in the absence of adversity led to new thinking, one influential approach being that of Cohen and Wills (1985), who proposed that social support refers to two theoretical mechanisms. The *main effects* hypothesis states that social support exerts positive effects on well-being irrespective of stressors (Fig. 9.1b). In this way, there is a direct relationship between well-being and social support: the more social support an individual has, the better the well-being, regardless of the individual's level of stress. Here, the relation between quality of life and social support is linear (Helgeson, 2003; Ditzen and Heinrichs, 2014). In contrast, the *social buffering* hypothesis views social support as operational and beneficial only during (or immediately following) episodes of stress and adversity, reducing the impact of stressors on the individual's well-being. Under these effects the individual's level of stress or adversity determines the relation of social support to well-being: in the absence of stress, well-being is independent of social support, whereas in instances of adversity, well-being is enhanced by the stress buffering effects of social support (Helgeson, 2003; Rault, 2012). There is evidence to support the existence, as well as the coexistence, of both mechanisms (Cohen and Wills, 1985; Ditzen and Heinrichs, 2014).

The existence of the social buffering effects is well documented empirically in both animals (see the section below on buffering of non-social-isolation stress and adversity) and humans (Kikusui *et al.*, 2006); however, in animals the main effects hypothesis has received virtually no attention by researchers until quite recently. Wittig *et al.* (2016) tested the main effects and social buffering hypotheses by measuring urinary glucocorticoid levels in wild chimpanzees with or without their bond partners in three situations: a natural stressor, everyday affiliation, and resting. Results showed HPA axis dampening during daily engagement with bond partners both within and outside of stressful contexts, thereby supporting the existence of a main effects mechanism. This is consistent with substantial research demonstrating that when social animals are permitted to interact with conspecifics, they had decreased plasma glucocorticoid levels during nonstressful times (reviewed by Kikusui *et al.*, 2006; DeVries *et al.*, 2007). These findings suggest that the well-being of nonhuman animals may benefit from social support during all aspects of life, not restricted to times of stress.

Isolation-related and non-isolation-related stress

In considering the stress-related benefits of social support, there are two types of stress that are relevant: that associated with and that not associated with social separation or isolation. Because social isolation is itself a stressor, some confusion exists when a social buffering effect occurs in situations of isolation. The presence of social companions generally has, by its very nature, an alleviating

effect on such isolation stress. The question, then, is whether social interaction in this context constitutes a 'true' buffering effect on neuroendocrine stress systems, or simply eliminates the stressor itself by restoring at least a degree of social companionship. As generally conceived, social buffering refers to the capacity of an animal to cope with a broader array of stressful challenges – isolation-related as well as non-isolation-related – when accompanied by conspecifics, and, as Rault (2012) has noted, the presence of partners has more to contribute to an animal's well-being than simply nullifying social separation distress.

Buffering of non-social-isolation stress and adversity

Evidence accumulating over the past 50 years demonstrates the buffering effect of social support for stress and adversity unrelated to social deprivation. The benefits to mental health and well-being are profound, as they correspond to the wide array of non-social-isolation types of stressors responsive to social buffering. Positive effects have been documented in two major groups of animals: the young (infants and juveniles) and adults. Stress buffering in these two groups may or may not involve the same neurobiological mechanisms.

INFANT AND JUVENILE ANIMALS The most extensively investigated form of social buffering is that exerted by the mammalian mother on her infant's stress responses (Hennessy *et al*., 2009). Rat pups (Hostinar *et al*., 2014) and goat kids (Liddell, 1949) exposed to a stressor exhibit less physiological and behavioral signs of stress when the mother is present compared to when she is not. When dairy calves are weaned from milk, those kept in the company of a familiar pen mate vocalize much less than those that are kept alone (De Paula Vieira *et al*., 2010) Stress buffering in the young has been demonstrated in nonhuman primates in several studies (reviewed by Kikusui *et al*., 2006). For example, when squirrel monkey infants were separated from their mother, they showed a lower HPA axis response if they remained in the company of their social group, indicating that the conspecific companions acted as a buffer to maternal separation stress. Similarly, when infants are separated from their social companions, they show increased cortisol levels when the mother is absent but not when she is present.

While social buffering of the HPA axis in early life has been studied most extensively in mammals (Hennessy *et al*., 2009), recent work has begun to include avian species. Edgar *et al*. (2015) compared stress responses of chicks in the presence and absence of their mother and found that mother hens are able to buffer their chicks' stress response to an aversive stimulus such as a puff of air.

ADULT ANIMALS Research methodology for studying social buffering in adult animals has varied widely in terms of species, type of stressor (e.g, electric shock, white noise, exposure to a novel environment, social defeat by a dominant conspecific, exposure to a live snake, and human encounter), and timing of the support relative to stressor exposure (e.g., before, during, or after) (Rault, 2012). The following represents a relatively small sampling of the research in this field.

Livestock animals (reviewed in Rault, 2012) – Sheep exposed to a stressful fear-eliciting stimulus (suddenly opened umbrella) showed fewer behavioral signs of reactivity (attempts to escape and fast movements) if in a group than if socially isolated (González *et al*., 2013). Lower stress levels (measured by behavior and cortisol levels) occurred in bulls during pre-slaughter handling if maintained in physical or visual contact with their familiar social group (Mounier *et al*., 2006). Fear-inducing stimuli elicit fewer behavioral signs of disturbance in heifers when near companion peers (Boissy and Le Neindre, 1990). When pigs were restrained, those with a companion present showed decreased behaviors such as alert standing and escape attempts compared to those without a companion, leading the investigators to conclude that pigs can benefit from social support (Reimert *et al*., 2014). In horses, the stress of stabling for the first time – as indicated by behaviors such as neighing, pawing, nibbling, snorting, and stereotypies – was significantly less in horses with companions than those without (Ditzen and Heinrichs, 2014). When horses were transported by trailer, those traveling with a companion showed significantly reduced physiological responses than those traveling alone (Kay and Hall, 2009). When taken to slaughter, horses show a desire to seek each other and engage in body contact in the abattoir and provide mutual support through affiliative behavior (Fletcher *et al*., 2023).

Rodents (reviewed in Gachomba *et al*., 2024) – In prairie voles, immobilization-induced increases in stress-related behaviors and corticosterone levels

occurred in females recovering from the stressor alone, but not if recovering with their male partner (Smith and Wang, 2014). Davitz and Mason (1955) reported that rats showed a lesser degree of immobilization when shocked in the presence of a companion than when shocked alone. Training rats with electric shock as punishment was less effective when the subject rat was accompanied with conspecifics than when trained alone (Rasmussen, 1939). Rats exposed to a fear stimulus or a novel environment showed fewer indicators of fear, such as withdrawal behavior and a lower corticosterone response, if with a partner rat than when alone (Davitz and Mason, 1955; Taylor, 1981; Kikusui *et al*., 2006). (Fig. 9.4). Similarly, following forced exposure to a novel environment, group-housed mice showed a significantly lower increase in corticosterone levels than did solitary-housed mice (Bartolomucci *et al*., 2003). Isolated rats, as compared to socially housed rats, show significantly greater corticosterone responses to restraint stress (Hermes *et al*., 2006). Immobilization and cold stress elicit greater reactivity of the HPA axis in isolated rats than in rats housed in groups (Dronjak *et al*., 2004). Rats tested alone in a chronic approach–avoidance conflict situation showed significantly greater gastric ulceration than rats tested with companions present (Conger *et al*., 1958). Ruis *et al*. (1999) found that if rats are isolated after social defeat by a dominant rat they will show long-lasting, anxiety-like behavioral and physiological changes, but if placed with familiar rats these adverse effects are greatly reduced.

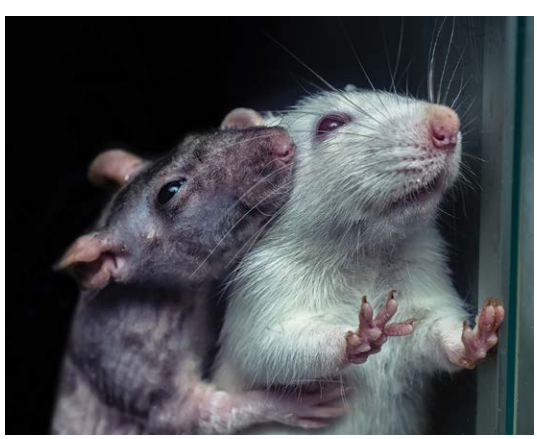


Fig. 9.4. Rats with companions present show less fear to a threatening stimulus than rats without companions (Davitz and Mason, 1955). (Image used under license from Shutterstock.com.)

Dogs – Dogs with storm phobia were exposed to a simulated thunderstorm and evaluated for behavioral signs of fear (pacing, whining, hiding) and cortisol level (Dreschel and Granger, 2005). Dogs with other canine companions in the household, compared to dogs without, showed less pronounced reactivity during and more rapid HPA axis recovery after the stressor. The effect of single- and pair-housing on the behavior and physiology of dogs during the first seven days of being placed in a shelter was measured (Hecker *et al*., 2024). Results indicated that, based on stress-related behaviors (lip licking, whining, and ears back) and urinary cortisol:creatinine ratio over days 1–7, pair-housed dogs exhibited significantly lower measures of stress than single-housed dogs.

Primates – In numerous nonhuman primate species, social relationships act as a potent buffer against stress (reviewed by Hostinar *et al*., 2014 and Sanchez *et al*., 2015). For example, when a conditioned stimulus using electric shock was induced in squirrel monkeys, later re-exposure to the training cue elicited an increase in fear responses and cortisol levels in monkeys without a social partner present but not in monkeys with companions present (Stanton *et al*., 1985). Squirrel monkey mothers who were separated from their infants showed an increase in cortisol if they lived alone, but not if they lived in a group (Mendoza *et al*., 1978). Marmosets placed in a novel environment with their heterosexual pair mate exhibited lower levels of urinary cortisol than when placed in the same environment alone (Smith *et al*., 1998). When wild male Barbary macaques were exposed to naturalistic stressors (low temperatures or group aggression), the monkeys with stronger social ties had lower fecal cortisol levels than monkeys with weaker bonds (Young *et al*., 2014).

9.5 Neuroendocrine Mechanisms Underlying Social Buffering

Many of the neural mechanisms that govern the display of behaviors that facilitate social bonding and maintain social relationships are conserved across species (Vitale and Smith, 2022); however, our understanding of these mechanisms remains vastly incomplete (Hostinar *et al*., 2014; Smith and Wang, 2014). Because neuropeptides such as oxytocin (OT) and vasopressin, and neurotransmitters

such as dopamine (DA) and endorphins, are integral in promoting affiliative and social-seeking behaviors, these compounds have been at the forefront of likely mediators linking social buffering and well-being (reviewed by Wu, 2021). Of these, OT has amassed the most supporting evidence.

9.5.1 Oxytocin

Oxytocin has been strongly conserved throughout evolution and has similar functions across vertebrates to promote affiliative social interactions and the formation of social bonds (Hennessy *et al*., 2009; Hostinar *et al*., 2014; Wu, 2021). In both humans and animals, OT is released in response to a variety of stressors (Taylor *et al*., 2005) and data support an inhibitory effect on sympathetic and HPA responses to stress (Taylor *et al*., 2005; Neumann, 2009; Wu, 2021). Exogenous OT administered during social isolation can eliminate the negative emotional effects of isolation (Smith and Wang, 2014). In rodents, OT has anxiolytic effects (Neumann, 2009; Smith and Wang, 2014) and central administration of OT inhibits the activity of the HPA axis and reduces anxiety-like behavior to acute psychological stressors in several mammalian species (Smith and Wang, 2014; Hostinar and Gunnar, 2015). When experimental stress in mice (Norman *et al*., 2010) and hamsters (Hostinar *et al*., 2014) elicits increased cortisol and depression-like behavior in isolated but not group-housed animals, treatment with OT attenuates these effects in the isolated animals. Conversely, injections of an OT receptor antagonist increases HPA activity (Hennessy *et al*., 2009) and negates the social buffering effect of social contact on HPA responses to stressors (Smith and Wang, 2014) and prevents the group housing benefits on depression- and anxiety-like behaviors in rodents (Smith and Wang, 2014).

In addition, affiliative physical contact with a conspecific promotes OT release (Hennessy *et al*., 2009; Kikusui *et al*., 2006; Wu, 2021). Animals prefer to spend time with conspecifics in whose presence they experienced high brain OT levels in the past (Taylor *et al*., 2005), a finding in accord with the studies mentioned earlier showing that animals and humans experiencing stress are highly attracted to conspecifics. Overall, current data strongly support a role for OT that is both necessary and, in at least some cases, sufficient, for mediating social buffering effects (Smith and Wang, 2014).

9.5.2 Opioids and other neurohormones

Endogenous opioids have also been implicated as a biological mediator for the beneficial effects of social buffering (Kikusui *et al*., 2006). Evidence suggests that endogenous opioids are, like OT, secreted in response to stress and to positive social contact and as well associated with down-regulation of sympathetic and HPA responses to stress (Taylor *et al*., 2005). Other potential neurohormonal mediators for stress buffering effects include DA, norepinephrine, serotonin, and prolactin (Taylor *et al*., 2005; Wu, 2021; Vitale and Smith, 2022). All evidence considered, it is generally accepted that social buffering effects are likely supported by multiple and potentially overlapping neurobiological pathways (Hostinar *et al*., 2014; Smith and Wang, 2014; Sullivan and Perry, 2015; Wu, 2021).

9.6 Factors Modulating the Effects of Social Buffering

As research on social buffering progressed, it soon became evident that there was a substantial variability and degree of inconsistency among individual responses to social companionship. It seemed clear that the presence of conspecifics interacts with a number of other factors to produce a buffering effect (Ditzen and Heinrichs, 2014; Hostinar *et al*., 2014).

It is first important to note that social contact in humans and animals is not always positive; social interactions and relationships can be a source of conflict, stress, and tension – with the potential to increase, rather than decrease, HPA reactivity in stressful situations (Seeman and McEwen, 1996; Helgeson, 2003; Denommé and Mason, 2022). Accordingly, in considering modulating influences on social buffering it is taken as a given that the benefits derived from social support are enabled by compatible partners and impeded by incompatible and antagonistic partners, the latter being inherent sources of stress (Proudfoot and Habing, 2015). This is the basis for the general agreement among farm animal researchers that frequent regrouping of herbivores should be minimized because it often results in an increase in aggressive and agonistic behavior as the animals reestablish their social relationships (Proudfoot and Habing, 2015). This may then render social support less effective, resulting in animals more rather than less fearful and reactive when encountering stressful procedures (Rault, 2012).

9.6.1 Familiarity of the social partner

The familiarity of the social partner has been demonstrated in numerous studies to be important in social buffering effects in animals (Wu, 2021; Denommé and Mason, 2022; Ricci-Bonot *et al.*, 2023). A familiar conspecific appears to be the most effective buffering influence (reviewed by Kikusui *et al.*, 2006; Rault, 2012); however, there is substantial variability among studies, which is likely due to context and other factors. The variations include: (i) a familiar conspecific is an effective buffer but an unfamiliar one is not (Hennessy *et al.*, 2009; reviewed by Rault, 2012); (ii) familiar and unfamiliar conspecifics both buffer, but familiar is more effective (Kiyokawa *et al.*, 2014; reviewed by Kikusui *et al.*, 2006); (iii) familiarity makes no difference (Boissy and Le Neindre, 1997); and (iv) a familiar conspecific is a *less* effective buffer than an unfamiliar companion (reviewed by Kikusui *et al.*, 2006; Hostinar *et al.*, 2014).

9.6.2 Number of social partners

The efficacy of social buffering is also influenced by the number of social partners. As with familiarity, research has revealed variability in which buffering patterns are most effective: in some species and situations a single partner provides the best buffering but in other circumstances multiple companions are necessary for buffering to occur (reviewed by Kikusui *et al.*, 2006). Increasing numbers in social groups in animals may result in overcrowding, leading to increased stress from agonistic behavior as well as greater pathogen exposure between animals (Proudfoot and Habing, 2015; Wu, 2021). This is consistent with some studies in humans showing that as the size of a social group increases a rise in negative affect and social conflict may diminish the benefits of social support, indicating that with regard to social support, more is not always better (Segerstrom, 2008).

9.6.3 Emotional state of the social partner

The emotional state of the social partner, in terms of which emotion and level of arousal, also appears to influence the social buffering effect (reviewed by Kikusui *et al.*, 2006; Rault, 2012; Wu, 2021). For example, Davitz and Mason (1955) showed that emotional responses in fear-conditioned rats were lower when the rat was accompanied by an unafraid rat than when the partner showed fearful behavior. More recently, Rørvang and Christensen (2018) found that when suddenly exposed to a novel stimulus, horses with a nonfearful companion exhibited decreased physiological and behavioral signs of fear as compared to horses with a fearful companion. Moreover, a fearful social partner may not only be ineffective as a buffer but may contribute to an *increase* in the subject's stress level (Denommé and Mason, 2022).

9.6.4 Age (stage of life)

Change in the nature of stress buffering effects has been shown to occur across an animal's lifespan (Hennessy *et al.*, 2009; Wu, 2021). Hennessy *et al.* (2009) found that infant guinea pigs are at first only buffered by their mothers. As they reach weaning age they can then be buffered by any adult female, and then at around the age of harem formation they can only be buffered by preferred females.

In reviewing the literature, Hennessy *et al.* (2009) reasoned that because buffering of stress appears to facilitate the formation and maintenance of social affiliations and that buffering effects change along with changing demands at different life-history stages, social buffering may serve, at least in part, to promote social affiliations in specific arrangements. On this basis they suggest that social buffering evolved to promote changes in social preferences in order to facilitate developmental transitions in social interactions most beneficial at different life stages (i.e., first toward the mother, then toward conspecifics, then toward mates, then toward offspring) (Hennessy *et al.*, 2009).

9.6.5 Social experiences during early life

Social experiences during early life in humans and animals are associated with variations in the nature and quality of social relationships throughout life. Such specific factors as being reared by the mother as opposed to a surrogate, the quality of parental care, and early positive social interactions with conspecifics (socialization) all appear to influence the individual's ability to benefit from social buffering at later points in life (reviewed by Hennessy *et al.*, 2009 and Sullivan and Perry, 2015).

9.6.6 What aspect of a social partner elicits the buffering effect?

The effects of social buffering have been found to occur without the need for physical contact.

Olfactory, auditory, and visual cues can, in certain circumstances, have buffering effects for both isolation-related and non-isolation-related stressors (Kiyokawa and Hennessy, 2018; Wu, 2021). For example, in male rats that were fear-conditioned and exposed to the conditioned stimulus in a test chamber that was either clean or imparted with the odor of a partner previously kept there, the clean chamber trials elicited a fear response but the odorized chamber trials did not (Takahashi *et al*., 2013). Rukstalis and French (2005) found that when marmosets were socially isolated from their familiar pair mates, those exposed to vocalization from their mates exhibited significantly lower levels of urinary cortisol. Simply providing a picture of a conspecific's face to an isolated adult sheep caused major reduction in the animals' behavior, autonomic, and endocrine stress responses (da Costa *et al*., 2004) and the picture of an unfamiliar horse face with a relaxed facial expression seemed to have the potential to act as a social buffer, depending on the nature of the stressful situation (Ricci-Bonot *et al*., 2023).

9.7 Promotion of Positive Affect

Up to this point, all of the ways by which social support promotes mental health and well-being have involved an alleviation of unpleasant experiences, i.e., negating the emotional distress of social deprivation and buffering non-isolation-related stress. The other major benefit comes through the promotion of positive aspects of well-being (Feeney and Collins, 2015). As mentioned earlier, current evidence suggests that the social brain has evolved such that engaging in adaptive social interactions activates the reward systems of the brain and generates positive affect.

In addition to their role in alleviating negative social emotional experiences, OT, DA, and endorphins appear to play a major role in the central reward circuitry through regulation of pleasurable affect, including the sense of security and comfort, in the context of social relationships (Cozolino, 2006). In humans, evidence points to the possibility of a link between an oxytocin–opiate system and soothing, calming, and feelings of social connectedness and safeness (Gilbert *et al*., 2008). In a study involving lactating female rats, Febo *et al*. (2005) used functional magnetic resonance imaging to demonstrate that mother–pup interactions during suckling resulted in an activation of the DA reward system in the mother. In addition, the researchers reported that the mother rat will prefer to spend time with pups over receiving cocaine, suggesting that the reward value of social interaction with nursing offspring can outweigh that of a euphoric stimulant drug (Febo *et al*., 2005). In all, the provision of social support appears to help to sustain a positive affective balance (Feeney and Collins, 2015), leading Galindo *et al*. (2018) to suggest that social companionship may be the most effective way of enriching the lives of social species in captivity.

9.8 The Special Case of Dogs

Strictly speaking, social buffering occurs between conspecifics. The domestic dog stands out as the species where this conspecific selectivity underwent dramatic changes to include – robustly – *inter*specific social interactions and relationships. There is now substantial evidence that the domestication of the dog (in concert with evolutionary changes in humans) involved the formation and amplification of the components of social connectedness directed toward a *different* species – humans – and this has enabled humans to assume the role of alleviator of negative affect of isolation, social buffer of non-isolation-related stress, and elicitor of positive affect for dogs[1] (Hennessy *et al*., 2009; reviewed by McMillan, 2016).

In a recent review of literature reports published from 2000 to 2014, Pop *et al*. (2014) found that when dogs interacted with humans in various settings (specifically, animal shelters, laboratory, or clinical settings such as Animal Assisted Therapy), despite a few contradictory findings the studies showed positive human–dog interaction was most often associated with a significant decrease in stress (as measured by cortisol levels, blood pressure, and behavior) and significant increases in the levels of OT, DA, and β-endorphin in the dogs (see also Hennessy *et al*., 2020). Specific studies demonstrating the enhanced alleviation of isolation-related stress include a report by Tuber *et al*. (1996) showing that most dogs seek contact with humans and, when given the choice between interacting with another dog or a human, they often prefer social interaction and proximity with people. And a study by Pinelli *et al*. (2023) demonstrated that isolated Australian Cattle Dogs benefited from the presence of unfamiliar humans, even if never socialized toward humans earlier in life (Fig. 9.5). Studies showing the buffering of non-isolation-related stress include

Tuber *et al.*'s (1996) work in which dogs showed a lower stress response to a novel situation in the presence of a human compared to the presence of another dog, and that dogs in the novel environment will seek proximity and solicit interaction from a human. Support from a dog's human companion can positively affect the behavior of a dog in a stressful situation (Dwyer *et al.*, 2006), and multiple studies conducted in veterinary clinics show that owner–dog interactions reduce stress of dogs during a veterinary examination (Csoltova *et al.*, 2017; Girault *et al.*, 2022) (Fig. 9.6). A study suggesting an enhanced ability for humans to increase positive affect in dogs was reported by McGowan *et al.* (2014), in which dogs expressed more excitement towards gaining access to a human as compared to access to another dog.



Fig. 9.5. Dogs with plentiful canine companionship will often still desire human companionship. (Image used under license from Shutterstock.com.)

9.9 Concluding Remarks

The evidence accumulated over the past 80 years is clear: for social animals – human and nonhuman alike – health and well-being are, generally speaking, promoted by positive social interactions and relationships and adversely affected when individuals are deprived of adequate social inclusion. The three major components of the connection between social factors and well-being are: (i) the harmful effect of negative affect experienced in response to social deprivation; (ii) the beneficial effect of positive social interactions in buffering general stress; and (iii) the beneficial effect of positive affect experienced in response to affiliative social interaction. For social animals, all three components appear to contribute to the attractive forces between individuals, and all three are involved in the mental health and well-being of the animals.

For all of the knowledge acquired, however, there remain many questions. For example, because stress buffering effects vary by species, sex, age, personality, socialization and other past experiences, familiarity of companions, ideal number of companions, type of stressor, and undoubtedly other

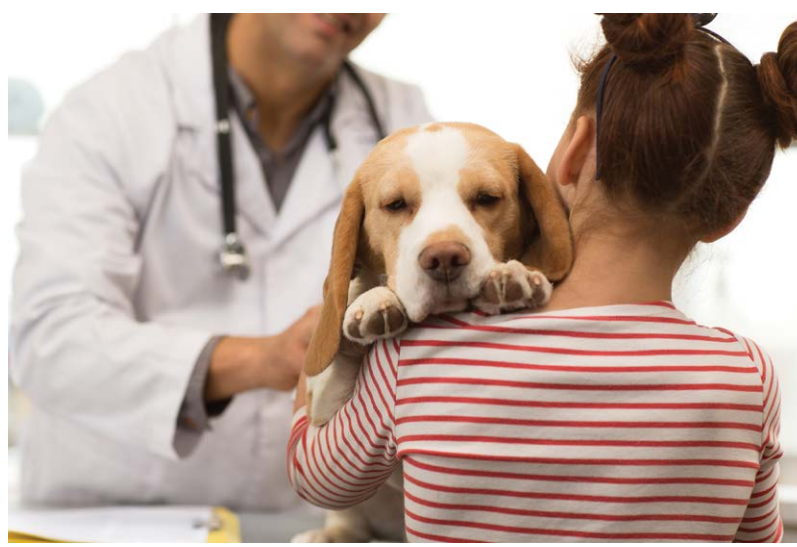


Fig. 9.6. Dogs in stressful circumstances comforted by the physical proximity and touch of humans have benefited emotionally (McMillan, 2016). (Image used under license from Shutterstock.com.)

factors, specific recommendations for promoting social buffering effects must be tailored to individual circumstances. Furthermore, while unable to be included in this chapter, other factors are involved in the considerations for promoting social buffering. For example, Chun *et al*. (2022) have pointed out that the animal providing social buffering may experience adverse mental health effects: 'Although social buffering is beneficial for the recipient, it can also have anxiogenic effects on the provider of the social buffering – a phenomenon referred to as stress contagion.' In fact, De Waal and Preston (2017) suggested that the transmission of stress through stress contagion during social interactions may be an essential precursor to the initiation of social support behaviors.

Note

[1] This is not to suggest that no other species is able to receive social support and social buffering from humans (for example, positive human interaction with a familiar person during stressful events calms pigs (Luna *et al*., 2024) and dairy cows (Waiblinger *et al*., 2004)), but that dogs have attracted the most research and as a result of changes during domestication appear to experience greater benefits from interactions with humans than do other species (reviewed by McMillan, 2016).

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10 Fostering Mental and Behavioral Wellness During Upbringing and Throughout Life

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10.1 Definitions and Terminology

Historically, animal programs have focused on the physical health of animals while psychological or behavioral health has taken a secondary role. While there is no consensus in the definitions of terms such as mental (psychological) wellness, well-being, quality of life, mental health, or stress as they apply to nonhuman animals (hereafter animals) (see Chapter 1, this volume), most scientists agree that animal well-being not only depends on good physical health but also incorporates a positive affective or mental state (Mendl *et al.*, 2010; Burani *et al.*, 2020). As Duncan and Fraser (1997) state, any consideration of general welfare must include assessment of mental wellness in addition to those of health and longevity. Recently, Martelli and Krishnasamy (2023) defined welfare as consisting of three categories – evolutionary history, individual history, and management practices – that sum to provide the overall well-being of animals under human care. Accordingly, welfare and well-being are so intertwined that the appropriate physical care of an animal along with its environment and individual experiences cannot be valuably separated when considering the overall well-being of animals.

10.1.1 Mental health

Inherent in our working definition of mental health is that it is a variable condition existing on a continuum from very poor to very good. Mental health is characterized by the constantly changing combination of pleasant and unpleasant emotions and variations in the functioning of various mental (cognitive) processes including learning, thinking, remembering, and perceiving. Mental health largely comprises the background mood state and the fluctuating discrete emotions that change rapidly from situation to situation (Burani *et al.*, 2020). For that reason, the time frame for assessments of mental health should be specified but this is rarely the case in most published research. For our purposes, we consider mental health, mental wellness, mental well-being, and mental quality of life as synonymous.

10.1.2 Behavioral health and mental health

Behavioral health and mental health are often used interchangeably (Rettew, 2023). The interrelationships among subjective experiences, physiologic processes, and behavior are complex, where each one seems to be influenced by the others. However, animal subjective experiences are not directly accessible to people, and many physiological measures of mental health are difficult to access, leaving behavior as the chief indicator of internal states and mental health (see Chapter 23, this volume). Even though behavior is not always a perfect reflection of internal physiological and subjective states, we will use the terms mental health and behavioral health interchangeably for the purposes of this chapter.

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10.1.3 Stress and stressors

Stress is another term frequently used in discussions of well-being to describe various physiological and/or behavioral responses to environmental stimulation. It too has no commonly agreed-upon definition. We will use McEwen's (2000) 'stress response', defined as a physiological and/or behavioral response to a perceived threat to homeostasis. Stress responses that are damaging to the animal are called distress and those that are beneficial are called eustress (see also Chapter 11, this volume). The environmental stimulus that elicits the stress response is known as the stressor and the outcome of the stress response for the animal is known as coping. Coping can vary from good (successful) to poor (unsuccessful), depending on the change in the animal's well-being.

10.2 Welfare and the Concept of Needs

It has long been recognized that good welfare depends on good health. Good health in turn is dependent, in part, on certain physical needs, such as food, water, and protection from the physical elements, being met. As alluded to above, research has made clear that mental as well as physical needs must be met to ensure good mental well-being and overall welfare, and Poole (1992) was among the first to directly address this idea by providing a list of five needs for mammals: stability and security in the environment, environmental complexity, novelty and unpredictability in the environment, opportunities to achieve goals, and social companionship. McMillan (2002) and Hetts *et al.* (2004) incorporated and expanded on Poole's original list. Although they frame the needs in slightly different ways, there is considerable overlap in the lists of McMillan and Hetts *et al.*, including labeling needs behavioral as compared to mental. For sake of simplicity, in this discussion we will follow McMillan's (2002) categorization and describe points of departure from Hetts *et al.* We will use Poole's and Hetts' label of behavioral needs in preference to mental needs.

10.2.1 Avoiding negative emotional states

The first behavioral need is to escape, avoid, or minimize fear, discomfort, boredom, and depression. These unpleasant emotional states can arise from illness, such as a cat suffering from arthritis of the hips; an adverse physical environment such as a dog in a hot yard without shade or water; or from social conflict such as a house cat that is repeatedly stalked by a dog or treated roughly by a young child. These examples illustrate the physical needs for food, water, and a safe environment, but they become behavioral needs when including the associated emotions.

10.2.2 Social companionship

The second behavioral need is for social companionship (Massen *et al.*, 2010; Chapter 9, this volume). This might be for members of the animal's own species, another animal species, or people. A playful young cat may find a persistent young child a good playmate while an arthritic cat may find the same child a major stressor. The quality of the social experience will differ with the identity of the companion, the context in which the companion is presented, the behaviors presented by the companion, and prior experiences of the animal. For example, a dog that has been the victim of an attack by another dog may be frightened of dogs resembling the attacker. As we will see later, puppies and kittens that have had no experience with people at a young age can find people very frightening later in life.

10.2.3 Mental stimulation

The third behavioral need is for mental stimulation (Burn, 2017). Most mammals and birds have a self-rewarding curiosity for exploring new places and things that sometimes extends to the re-exploration of familiar places. Monotonous, uniform environments with nothing new to experience can create boredom and depression. Giving animals opportunities for foraging for food, manipulating food puzzles, or investigating novel things are examples of ways to increase mental stimulation.

10.2.4 Predictability

The fourth behavioral need is predictability in both the physical and social environment (Bassett and Buchanan-Smith, 2007). Although mental stimulation is important, having predictability for such things as mealtimes or friendly social partners can reduce anxiety and create positive anticipation of the coming encounters. This anticipatory excitement can be rewarding and create positive emotions. Conversely, frequent unpredictability in the environment or in the behavior of others can create anxiety

and distress, making otherwise tolerable situations intolerable (see Chapter 8, this volume). However, a degree of unpredictability in the environment, especially if it involves positively reinforcing events, can enhance mental health by relieving or preventing boredom. Examples of types of 'pleasant surprises' will be discussed later (Section 10.5.4).

10.2.5 Controllability

The fifth behavioral need concerns control over the environment (reviewed in Mineka and Hendersen, 1985 and Chapter 8, this volume). Animals that have control over certain variables in their lives (e.g., providing a dog door for on-demand access to the outside) can create their own predictability in changing environments. The ability to control the environment and make choices is very important for many species.

10.2.6 Pleasurable experiences

The sixth behavioral need is the need to generate pleasurable experiences (Boissy *et al*., 2007). As noted above, good welfare must include actively providing opportunities that create positive emotional states; the mere absence of fear does not guarantee the presence of 'joy' or similar affective states. Such experiences may include species typical behaviors like opportunities for cats to scratch, for dogs to use their olfactory abilities in scent work, or opportunities for social and object play for most species. These actions are self-reinforcing and create positive emotions. Other pleasurable experiences may be generated through opportunities to engage in learned, externally reinforced behaviors such as a cat meowing for food or a dog barking at the back door to go outside. Animals that are prevented from showing sufficient species typical behaviors often become frustrated and the needs get expressed in behaviors people find unacceptable. This can lead to restrictions or punishment, resulting in a decrement in mental well-being.

10.3 Development and Mental Welfare

Two classes of factors determine the developmental trajectory of an animal; genetic predispositions and environmental influences. These factors interact from conception and throughout life to create the physical structures, physiological and psychological processes, and behavioral actions that comprise the living animal. Both the mental and physical health of an animal are determined by these interactions.

10.3.1 Genetic predispositions

Genes influence behaviors, emotions, and mental processes that impact welfare in people as well as other animals (reviewed by Plomin *et al*., 2008). The impact of genetics on behavior is becoming clearer due to improvements in genetic analysis and a firmer understanding of the evolutionary history of domestic dogs (Serpell and Duffy, 2014; Dutrow *et al*., 2022). As the first domesticated species, canids have been subject to centuries of selective breeding for both form and function with a spike occurring in the past 200 years via breed development. Research suggests that aggression, trainability, and attachment to humans have strong genetic links (MacLean *et al*., 2019). These are also the primary behaviors that underlie positive relationships with our companions and ensure healthy social interactions.

In animals, it is known that genes can influence a variety of behaviors that either directly contribute to or indicate mental wellness. One of the best examples in companion animals is seen in the work of Murphree and colleagues (Murphree *et al*., 1967; Dykman *et al*., 1979) who selectively bred two lines of pointer dogs, one for normal behavior and the other for nervous behavior. In a very few generations, the dogs in the nervous line were consistently much more fearful of people than those in the normal line, indicating a genetic influence. From a young age the nervous dogs were fearful of people – being terrified of close human proximity and freezing statue-like for minutes at a time – and the fear became more prominent as they grew. Because of their exaggerated fear, these dogs likely had reduced well-being compared to their non-fearful counterparts.

Mills *et al*. (1997) point out that genetic selection for or against traits that influence welfare such as fearfulness and adaptability to changing environments may be a powerful way to improve animal well-being. Such change would come slowly if left to traditional selective breeding; however, in the future, with newer gene splicing and editing techniques (along with a well-developed understanding of gene actions and interactions), very specific changes to an animal's anatomy and physiology could be quickly made that could improve well-being.

10.3.2 The development of altricial mammals

Altricial animals are born in a state of relative physical and behavioral under-development. They are completely dependent upon their mother for survival in the early days after birth: they cannot feed themselves, have limited ability to thermoregulate, cannot see or hear, and are capable of very little movement. For most altricial mammals, the process of development from conception to adulthood can be divided into several phases:

- Prenatal: conception to birth;
- Neonatal: birth to the opening of the eyes and ears and coordinated movement;
- Socialization: the end of the neonatal phase to around the time of weaning or several days afterwards; and
- Adolescent or Juvenile: the end of the socialization phase to sexual maturity and young adulthood.

Because different species develop at different rates, the length of each phase varies across species.

10.4 Environmental Influences on Behavior During Early Development

The events animals experience during behavioral development not only influence their welfare at the time but often have life-long impacts. Much more is known about environmental influences that produce negative effects on welfare than is known about those that maximize or optimize positive welfare. Both Serpell *et al*. (2017) and Dietz *et al*. (2018) reviewed the development of the behavior of dogs and the effects of early experiences on the development of behavior problems. Bradshaw *et al*. (2012) have provided a review of the development of behavior in cats. Historically, it has been thought that events occurring during the socialization phase were critically important for normal social development (Scott and Fuller, 1965). More recent research suggests that environmental and social stimulation during other phases are also important in influencing later social behavior and adaptation to environmental challenges.

10.4.1 Prenatal phase

In dogs and cats, the prenatal phase lasts about 63 days. In mice and rats, it lasts about 19–21 days and 21–23 days, respectively. The effects of prenatal influences on behavior have received very little research attention in dogs and cats but studies of laboratory rats, mice, and primates have shown significant but often conflicting results. In her review of the behavioral results of aversive stimuli on pregnant female rats and mice, Weinstock (2008) found that seven of 14 studies found increases in pup fear later in life, but five found no effects and two found decreases in fearfulness. Six of 11 studies found aversive stimulation of pregnant female rats and mice produced deficits in learning and memory, but three others found no effects and two actually saw improvements in offspring learning and memory.

Notwithstanding the conflicting findings, an overview of the literature shows an extensive array of adverse behavioral and psychological outcomes in the offspring of stressed animal and human mothers, including impaired ability to cope with stress, maladaptive social behavior, increased fearfulness and emotionality, decreased exploratory behavior, impaired adaptation to conditions of conflict or aversion, latent inhibition (a model for schizophrenia and depression in human beings), and cognitive alterations including learning deficits and diminished attention span (Braastad, 1998; Huizink *et al*., 2004; Beydoun and Saftlas, 2008).

As mentioned, studies of the influence of prenatal maternal stress on fetal development in dogs are lacking; however, in one study of a related canid, the blue fox (*Alopex lagopus*), pregnant females were mildly stressed during the last trimester of gestation (Braastad *et al*., 1998). The stress consisted of removing the female from her cage, holding her for 1 minute and then returning her to the cage. Results showed that at 10 days of age, when compared to the young of unstressed mothers, the offspring of stressed mothers had elevated plasma levels of progesterone and cortisol as well as increased adrenal production of progesterone and cortisol, indicating enhanced hypothalamic–pituitary–adrenal (HPA) axis activity. When tested at 5 weeks of age in three tests for response to novelty, compared to control cubs the prenatally stressed blue-fox cubs showed increased reactivity in all three tests: increased activity in an open-field, more frequent re-entry from a dark box into the open-field, and more persistent activity when being held by a human.

10.4.2 Neonatal phase

The neonatal phase varies by species, ending at three weeks for dogs, two weeks for cats, and weaning (six weeks) for rats. There is a rich body of research

on the effects of exposure of neonatal animals to various kinds of stimulation including handling and separations from mother and littermates (Serpell *et al*., 2017). These and other experiences have produced a variety of effects (Wilson *et al*., 1965; Gazzano *et al*., 2008b), many of which are contradictory. In general, current evidence suggests that the effects of mild stressors on the development of the HPA axis improves the animal's ability to cope with stress later in life (Serpell *et al*., 2017). For example, when newborn puppies were exposed to the stimulation of gentle handling and tested later, they were found to be less fearful, more exploratory, have enhanced learning ability, and overall greater emotional stability and resilience than unstimulated control dogs (Fox, 1978; Gazzano *et al*., 2008b; de Azevedo *et al*., 2010). However, in some cases these experiences can sensitize animals to fearful reactions as adults (see review in Serpell *et al*., 2017).

A variety of variables may influence the results, but the intensity and kind of stimulation seem to be two important ones. Mild stimulation seems to create greater resilience to adverse conditions, while more intense or long-lasting stimuli seem to do the opposite. Resilience to fear-provoking stimuli would appear to contribute positively to welfare, in that resilient animals are better able to cope with challenging and aversive environments (see Chapter 13, this volume). In contrast, chronically fearful animals are more likely to have reduced welfare.

The quality of maternal care can affect the later behavior of young animals. In general, good maternal care has positive effects on offspring (Foyer *et al*., 2016; Guardini *et al*., 2016). Maternal and prenatal experiences have been shown to interact (Wakshlak and Weinstock, 1990). Postnatal handling of rats attenuated the effects of aversive maternal prenatal stimulation when offspring were tested at eight weeks of age for fearful behavior in both open-field and maze tests.

10.4.3 Socialization phase

Research has shown that during the socialization phase it is easiest for young animals to develop both inter- and intraspecific social relationships, learn their species identity, and practice species-typical behaviors. Because it is so easy for social relationships to form during this phase, young animals readily become attached to individuals they spend time with (Cairns and Werboff, 1967); thus, the first attachments young animals form (i.e., primary socialization) are to their mother and littermates. The preferences for types of social partners that begin during this time are long-lasting and, accordingly, events during this developmental period appear to have the greatest potential influence on adult behavior, welfare, and mental health, explaining why this developmental phase has received the most research attention.

Dogs

In a classic study of dog socialization, Freedman *et al*. (1961) determined that the sensitive period for socialization was between 2.5 and 9 to 13 weeks. Puppies who had no experience with people before 14 weeks were fearful of people, uncooperative, and described as 'wild'. The onset of fear responses is thought to be the mechanism that ends the sensitive period for socialization in dogs and other species. Morrow *et al*. (2015) compared the development of fear responses in German shepherd, Yorkshire terrier, and Cavalier King Charles spaniel puppies from 2 to 12 weeks old. The onset of increasing fear in the spaniels was 2 weeks later than that of German shepherds, indicating a possible genetic component.

As we saw for the neonatal phase, maternal care plays a major role during the socialization phase. In a survey of dog owners in Finland that examined the maternal care and early experiences of dogs in relation to behavior problems, Tiira and Lohi (2015) reported that dogs receiving poor maternal care or fewer early socialization experiences were more likely to have fears of people and things. Also resembling processes observed in the neonatal phase, mildly aversive stimulation during the socialization period can be beneficial to dogs. Elliot and Scott (1961) separated puppies briefly (10-minute periods) from their natal environments from 3 to 9 weeks old. The puppies initially showed high levels of distress, but this steadily decreased by the end of the treatment period. When compared to 9-week-old puppies that had not experienced separations, the mildly stressed puppies exhibited less distress. This may have relevance for helping prepare puppies for placement into homes.

Cats

The socialization phase for cats seems to be between 2 and 7 weeks old (Karsh, 1983; McCune, 1995; Turner, 2000). This has practical importance

because many cats are weaned between 6 and 8 weeks, at the end of the sensitive period. To take advantage of this time of rapid social learning, breeders and caretakers for neonatal cats should begin socialization prior to weaning.

For cats, more than dogs, there appears to be a crucial interplay between time with nursing mother and socialization with people. Kittens that are handled at least 15 minutes a day from 2 to 6 weeks old are friendlier than kittens that are handled less frequently (Seitz, 1959). Additionally, kittens that are handled in a novel area with their mother present are more willing to enter a novel area and approach strangers than those who are socialized without the mother present (Turner, 2000).

Another important factor in cat socialization is the age at weaning. Kittens that are removed from their mothers at 2 weeks, but maintained on bottles, will display higher rates of aggression in adulthood than those that are allowed to stay with the nursing mother and weaned at a more developmentally appropriate time, regardless of amount of human socialization (Ahola *et al*., 2017). In addition, cats weaned before 14 weeks of age had higher rates of aggression towards strangers compared to those weaned after this age (Ahola *et al*., 2017).

McCune (1995) found that genetics could interact with social experiences to affect the outcome of early handling. Kittens born of a 'friendly-to-people' father and that were handled daily from 2 to 12 weeks were more attracted to and friendlier to people than kittens with identical handling but sired by an 'unfriendly' father. These results suggest that an epigenetic component may help to explain why some animals remain fearful of people even when they have had good experiences at identified ideal ages for socialization.

The socialization process in cats appears to be a complex interplay between genetics, epigenetics, time with the mother, and exposure to humans on a regular basis.

Broader meaning of 'socialization'

The classic literature on 'socialization' refers to social attachments. Scott and Fuller (1965) speculated that location attachment may also develop during this time. For this and other reasons the term 'socialization' has come to have a broader meaning referring to animals' abilities to readily adapt to unfamiliar circumstances and a broad array of events, stimuli, and social interactions. This ambiguity in the meaning of the term has impaired clear communication about the early development of behavior.

From this broader definition have come recommendations that young animals should be exposed to a wide variety of experiences to increase their resilience and adaptability. In one study, a group of purpose-bred service-dog puppies were provided additional visual, auditory, tactile, and human interaction experiences beyond the broad array already included as part of their enriched rearing environment (Vaterlaws-Whiteside and Hartmann, 2017). When this group was compared to a control group at 8 weeks of age, they were less distressed when left alone, displayed less overall anxiety, and were less distractable. In a survey study of more than 6000 dog owners, social fearfulness in adult dogs (fear of unfamiliar dogs and people) was strongly associated with limited socialization and training between the ages of 7 and 12 weeks (Puurunen *et al*., 2020). Owners who reported their puppies had experienced infrequent or limited exposures to strangers, car rides, and novel environments and who grew up in urban settings during puppyhood reported the highest rates of social fearfulness in adulthood. This fear also impacted the amount of training and activities that the pets engaged in as adults, which can limit the amount of mental enrichment owners are able to safely provide.

During the spring and summer of 2020, a global quarantine was issued due to the COVID-19 pandemic. This allowed for a natural experiment to compare the effects of limited early socialization of housed puppies on their subsequent adult behavior. Sacchettino *et al*. (2023) found that puppies raised during COVID-19 restrictions showed higher rates of aggression and fearfulness as adult dogs, compared to a similar cohort born after the quarantine was lifted. The differences in adult behavior appear to be strongly tied to the limited exposures provided during the socialization period of development. Kinsman *et al*. (2024) found that puppies experienced a similar breadth of exposures (meeting new people, encountering new environments, etc.) but less frequently and less often than puppies outside of the quarantine restrictions. They also found that puppies socialized during the pandemic displayed higher rates of aggression and fear as adults compared to puppies raised before or after these restrictions. In both studies, the major difference was the amount and quality, rather than type, of socialization provided during this developmental stage.

Current recommendations for socialization experiences suggest exposing animals to circumstances they will likely encounter as adults. The longstanding advice to avoid exposing puppies to other dogs to protect them from contagious diseases until they have finished their vaccination series (approximately 16 weeks of age) is no longer supported. The American Veterinary Society of Animal Behavior (2008) states that the risk to life for dogs is higher for under-socialization than potential viral exposure during this developmental stage.

The age at which pups should be removed from their natal home and placed in their new homes is a subject of controversy and conflicting data. Scott and Fuller (1965) recommended homing between 7 and 8 weeks old due to the bonding that can occur between puppy and new owner. Pierantoni *et al.* (2011) reported that dogs homed between 4 and 5.5 weeks old were more likely to be fearful and have other behavior problems, including excessive attention-seeking, possessiveness, destructiveness, and excessive barking than those homed at 8.5 weeks old. Slabbert and Rasa (1993) found pups homed at 6 weeks had higher mortality and morbidity and more signs of separation distress than those homed at 12 weeks. Conversely, a Finnish study (Jokinen *et al.*, 2017) found dogs homed between 13 and 16 weeks old showed more fearful and aggressive behavior than those homed between 6 and 8 weeks of age.

Based on the research literature, it is hard to identify a single best time for weaning and placing puppies in homes. Obvious questions arise about the variations in the breeding environment, maternal care, and genetic differences already discussed. More research is needed but it appears placing puppies too early (before 7 weeks), or too late (after 9 weeks) could increase risks of behavior problems for dogs acquired as pets.

10.4.4 Adolescent phase

In dogs, this phase is from about 12 weeks old to sexual maturity, which can be from 6 months to over 2 years old depending upon the breed of dog and rearing conditions. The adolescent phase in cats is also variable, with sexual maturity occurring from about 4 months to 1 year old depending on factors including presence of estrus females and intact males, length of day, and time of year the kittens were born (Albright *et al.*, 2022).

Serpell and Duffy (2016) studied the impact of adversity in the adolescent/juvenile phase (between 12 weeks and 1–2 years of age depending on the individual and breed). Results of their study showed that particular frightening or traumatic events during the puppy-raising period (2–14 months of age) were associated with differences in scores for a number of behaviors. Specifically, puppies that were reported as having been attacked or threatened by another (unfamiliar) dog, when compared to puppies not having this experience, scored significantly higher for fear of dogs and aggression toward unfamiliar humans at 12 months of age. When the trauma involved being frightened by a familiar or unfamiliar person, the dogs exhibited significantly higher levels of fear toward unfamiliar persons as well as being reported as less trainable. The authors concluded that puppies and young dogs are sensitive to aversive experiences long after the ostensible end of the socialization period (i.e., 12 weeks) and that such encounters may have long-term negative consequences for behavior.

McMillan (2017) reviewed seven studies concerning adult behavior of dogs born at large commercial breeders. The results indicated a higher-than-expected frequency of emotional and behavioral problems in dogs from those facilities compared with dogs from other sources. The problems included aggression toward the dog owner's family, unfamiliar people, and other dogs as well as fears of people, other dogs, and non-social things and events. There are several reasons why dogs from these commercial facilities might have more problems, including genetic predispositions, prenatal aversive events, inadequate maternal care, inadequate socialization experiences, early weaning and maternal separation, events related to transport and sale of the dogs, as well as inadequate owner-related knowledge and care. These factors include those both inside and outside the adolescent phase.

A survey of Australian pet owners (Wormald *et al.*, 2016) revealed the average age of exposure of pet dogs to unfamiliar people and other dogs was 13 weeks old. But the longer owners waited to expose their dogs to other dogs, the *lower* the probability their dog would show dog-to-dog aggression. They also reported no relationship between the number of other dogs that subject dogs had met and the amount of time spent with other dogs and inter-dog aggression. This appears to be counter to the conventional wisdom that the earlier the exposure to other dogs and the more dogs encountered,

the less the likelihood of dog-to-dog aggression problems. One possible explanation is that the more encounters a dog has, the more likely at least one of them will result in a conflict with enduring behavior effects.

As we saw for the neonatal and socialization phases, mild stress during adolescence can be beneficial to an animal's long-term mental well-being. The Serpell and Duffy (2016) study cited above looked at major stressors during adolescence; however, a body of research investigating the effects of less stressful experiences during this phase in laboratory rodents has demonstrated that mildly stressful experiences during this period may help animals cope with stressors later in life. Adolescent rats were exposed to several weeks of various aversive stimuli, from tilting their cages, to exposures to smells or sounds of potential predators (Chaby *et al.*, 2015). As adults, these rats and their untreated controls were exposed to a mildly aversive foraging test (baited open field box in a darkened room) and a more aversive one (baited open field box in a brightly lit room with the sight and sound of a hawk). The rats did not differ in their performance in the low-stress foraging test, but the rats exposed to adolescent stressors performed better than the controls in the high stress test. The researchers concluded that the benefits of some kinds of stressful experiences may come through helping young animals prepare for future stressful environments. An important caveat here is that these results cannot be directly applied to other species, such as domestic dogs and cats.

Taking the neonatal, socialization, and adolescent periods as a whole, there is now good evidence to suggest that the complete elimination of stress may not be desirable, as minor stressors during the early phases of life appear to be beneficial to mammalian development and improve later resilience to stress (Serpell *et al.*, 2017).

10.5 Recommendations for Improving Mental Health of Adult Companion Animals

10.5.1 Realistic expectations

To start, caretakers need to have realistic and reasonable expectations about their pets' behaviors to avoid setting unattainable goals that can lead to disappointment (for the caretaker) and frustration (for the caretaker or pet). When it comes to people–pet relationships, unrealistic expectations for a pet's behavior often stem from an insufficient understanding of the pet's physical and behavioral needs, species-typical behavior, and inability to accurately read behavioral signals especially of negative emotional states. Pet owners have had access to information about the physical needs of companion animals from veterinarians, pet professionals, books, videos, and online resources, and this education has clearly improved the physical health of pets. However, until recently, the remarkable scientific advancements regarding animals' behavioral and emotional needs have been largely confined to scholarly journals and textbooks – not readily accessible to the general pet-owning public.

10.5.2 Understanding normal behavior

Knowledge of the normal behavior of the animals we care for is essential when trying to provide a good quality of life for the animals and whenever we are trying to modify their behavior. However, despite the wealth of information available on pet behavior, incomplete and incorrect information about normal pet behavior abounds. For instance, many people do not know enough about elimination behaviors to know the best way to housetrain a dog or set up an effective litterbox station for cats. Another example is the misconception that a dog or cat causing destruction or house-soiling when left alone is motivated by spite.

10.5.3 Recognizing emotional states and meeting behavioral needs

Of the six behavioral needs discussed earlier (Section 10.2), the need to avoid negative emotional states seems likely to be the most important. In general, unmet needs for social contact, mental stimulation, predictability, and controllability will elicit or increase negative emotions while having those needs met will elicit positive emotions. Because behavioral needs are so frequently due to the need to alleviate negative emotions – e.g., aggressiveness to relieve fear, barking to alleviate loneliness, inappropriate urination to cope with anxiety – an inability to correctly identify an animal's emotional states makes it difficult to meet its behavioral needs. Conversely, caretakers who can more accurately read the emotions of their pets can better meet their pets' needs and promote better welfare. Unfortunately, some research has found

that pet parents have difficulty identifying signs of fear, depression, and other negative emotions in their dogs (Mariti *et al*., 2012), and pet professionals with little experience also have difficulty recognizing fearful behavior in dogs (Wan *et al*., 2012). Please see Chapter 23 of this volume for a more detailed discussion of identifying emotional states in animals.

Compounding the problem of accurately detecting animals' emotional states is the fundamental fact that, as in humans, what elicits pleasant and unpleasant emotions in animals varies – often quite substantially – between individuals. Thus, based on genetic predispositions and prior experiences (especially those, both positive and negative, during the key developmental phases discussed earlier), the needs for social contact and mental stimulation will vary between individual animals – some enjoying them more than others. New social contacts and environments will be a source of rewards and positive emotions for better socialized dogs, but a source of aversiveness and negative emotions for others. The need to control and/or predict aspects of the social and physical environment will be important regardless of socialization status; however, poorly socialized dogs will likely find some unpredictable and uncontrollable environments more aversive and emotionally unpleasant than better socialized dogs.

Because of this highly individualized nature of what animals find rewarding and unrewarding, just as for humans generalized recommendations for meeting behavioral needs cannot be expected to be a good fit for all animals. Any guidelines about how to meet the needs of dogs or cats must take into account that the needs of each animal will be different, and management and training should be tailored to the individual. In addition, it is important to keep in mind that behavioral needs will change with age. The need for control of the environment for a 4-week-old puppy will not be the same as for that dog at 4 years old or at 10 years old. Owners should be reminded that their pets' needs will change over time and will need to be re-evaluated.

10.5.4 Creating positive emotions

Given the variability in behavioral needs of animals, it is important that caretakers continually assess what their pets find rewarding and aversive. This is best accomplished by understanding and carefully observing the body language of the animal that indicates positive and negative emotional states. This may be an area where accurate education could have a significant impact on improving the welfare of companion animals (Mariti *et al.,* 2012; Philpotts *et al.,* 2019).

Another way to determine what pets find reinforcing is by offering choices and taking note of indicated preferences. Would the family cat prefer the perch by the window where he can look out, or in the corner where he can observe the family? Place the perch in each location for a few days and observe the duration or frequency of use by the cat to understand his preference. A Check Sheet (Fig. 10.1) can help caretakers and pet professionals identify the emotions of the animals in their care and determine if they are meeting the behavioral needs of the animals.

Creating an environment that is largely predictable, but with 'pleasant surprises' at times will be beneficial for many animals. Feeding times, play and exercise times, and bedtime should be consistent, but spontaneous walks, a new puzzle toy, or a short ride in the car may break up routines and create more positive emotions. Monitoring the animal's emotional responses to these unpredictable surprises will help the caretaker identify the ones that are pleasant and those that are not.

Giving pets choices in other ways may help give them a better sense of control, especially with experiences that are aversive. Caretakers should avoid forcing animals to experience things that are clearly undesirable to the animal, except when it is necessary for the well-being of the animal or others (e.g., going to the veterinarian or groomers). But many times, the emotional valence of currently aversive events can be changed so that they become at least more tolerable and maybe even enjoyable. Experienced behavior consultants and trainers can help accomplish these changes with behavior modification techniques such as counterconditioning and desensitization.

Giving animals control and choices in their lives is important to helping them achieve good mental health but this approach has limits. Animals (and people) do not always make the best choices for their long-term mental and physical health or take into consideration the consequences of their choices on others (McMillan, 2002). Some animals will eat themselves into obesity if allowed, shortening their lives and limiting their opportunities to generate more positive emotions. Some choices by animals may create problems for caretakers or others in the

A Check Sheet for Making Your Pet Happy (Giving Her a Good Quality of Life)

How to use this Check Sheet

Providing a good quality of life (QOL) for your pets is more than just providing food, water and shelter, good health care, and protecting them from undue fear and stress. QOL also means providing for their behavioral needs for exercise, mental and social stimulation, opportunities to control parts of their environment and having safe, pleasant places to rest and sleep. It also means trying to maximize their opportunities to obtain rewards and experience pleasant emotions while trying to minimize the opportunities for unpleasant emotions such as pain, anxiety, uncertainty, and fear. To do this, the first steps are to recognize and attend to the emotions your pets are experiencing. Try to review this check sheet for your pets every few months, because their behaviors and likes and dislikes may change as they age, as they acquire new life experiences, and even when their physical surroundings change from season to season or if you move. If you're having trouble completing this check sheet, discuss it with the pet professional who gave it to you.

- ❒ Can you recognize the behaviors and postures associated with these emotions in your pet? Write down what they are for your pet. (Think about what your pet looks like and what she does)
  - o Happiness _____
  - o Contentedness _____
  - o Sadness _____
  - o Depression _____
  - o Fear or Anxiety _____

  If you're not sure, talk to the professional that gave you this list about how to read the emotions in your pet.

- ❒ What activities or situations make your pet happy or give her joy? Make a list. It might be playing fetch or chasing a toy, for example. How often do you provide these for your pet?
  - o _____
  - o _____
  - o _____
  - o _____
  - o _____

- ❒ What objects, activities or situations make your pet contented or relaxed and tranquil? Examples might be napping in the sun or sleeping with you. How often do you provide these for your pet?
  - o _____
  - o _____
  - o _____
  - o _____
  - o _____

- ❒ How are you meeting your pet's need for regular exercise?
  - o Describe what you do.
  - o _____

- ❒ How are you meeting your pet's need for mental stimulation?
  - o Describe what you do.
  - o _____

- ❒ How are you meeting your pet's need for pleasant social contact with other animals and people?
  - o Describe what you do.
  - o _____

- ❒ How are you meeting your pet's need to express species-typical behavior such as investigation, scratching, digging or chewing?
  - o Describe what you do.
  - o _____

Fig. 10.1. A check sheet for making your pet happy.

- ❒ How are you meeting your pet's need to control parts of her environment? Such as getting out of bad weather or having ways to ask you for treats, walks or pets?
  - o Describe what you do.
  - o _____
- ❒ How are you meeting your pet's need for safe, comfortable rest and sleep spots?
  - o Where are they?
  - o _____
- ❒ How are you meeting your pet's needs to avoid, escape or minimize things or experiences that cause pain, fear, threats or discomfort? (Such as pesky children, fireworks or confinement to a small crate)
  - o Describe what you do.
  - o _____
- ❒ Do you provide a reasonably predictable environment for your pet? (Such as having consistent rules for her to follow, consistent times for feeding, play and exercise)
  - o Describe what you do.
  - o _____

Fig. 10.1. Continued.

community. Dogs who chase bicycles and cars cannot be allowed to exercise this choice because of the danger it presents to others. So, giving animals control to make their own choices should always be tempered by the potential consequences to the well-being of all involved. Accordingly, giving animals control to make their own choices should always involve a weighing of the short-term well-being benefits of those choices against the animal's long-term benefits.

10.6 How Professionals Can Help

There are many opportunities for pet professionals to provide expert advice to pet caretakers about expectations, normal behavior, behavioral needs, and recognizing emotional states in pets. A recent survey found that most pet caretakers are seeking information from unverified sources predominantly on the internet, but only discussing these findings with a professional less than 50% of the time (Kogan *et al*., 2018). This increases the spread of inaccurate or outdated information. Veterinarians and other pet professionals should make a concerted effort to curate lists of internet-based education resources that are reliable and accurate to help caretakers access only beneficial information.

10.6.1 The benefits of education, enrichment, and training

One source of education and training for caretakers and their pets is puppy classes and kitten kindergartens. Although the content of these classes can vary widely, a well-run course will provide developing puppies or kittens with controlled exposures to stimuli they are likely to experience throughout their lives such as vacuum cleaners and unfamiliar people. Many of these classes also teach basic manners for dogs (e.g., loose leash walking) and provide caretakers with a fundamental education regarding pet behavior and management. Some research has examined the effectiveness of puppy classes. Cutler *et al*. (2017) found that owners reported fewer fears in puppies that attended classes compared to those that did not. Less conclusive results in another study (Seksel *et al*., 1999), however, found short-term improvement in cued learning (such as sit or stay) but no long-term effects on response to handling, novel stimuli, or new social situations (Seksel *et al*., 1999).

Another way to provide information is during veterinary visits or in separate classes for caretakers. One study by Gazzano *et al*. (2008a) found that new dog owners who attended an expert lecture on dog behavior and care reported reduced incidences of aggression, barking, house soiling, and begging for food when surveyed 1 year later.

Environmental enrichment holds promise for preventing or attenuating the effects of early deficits (Kentner, 2015) or even boosting the quality of life for some animals housed in 'normal' home environments. Herron and Buffington (2010) have recommended that cats living exclusively indoors be provided with enrichments that address many of the behavioral needs discussed here. While there is little direct empirical evidence to support their

specific recommendations, addressing the behavioral needs of animals living in restricted environments is considered important.

Resilience training has been gaining popularity in human psychotherapy and has been the subject of research in humans and animals for several years (Tabibnia and Radecki, 2018); however, it has not to date become a common procedure in the care of companion animals. Liu *et al.* (2018) noted that 'The term "resilience" refers to the ability to adapt successfully to stress, trauma and adversity, enabling individuals to avoid stress-induced mental disorders such as depression, posttraumatic stress disorder (PTSD) and anxiety'. Resilience training involves methods that essentially teach the brain to respond more favorably to potentially threatening stimuli. The potential for such interventions in animals may be seen in such work as the study described earlier in Section 10.4.4 by Chaby *et al.* (2015), which demonstrated how adolescent exposure to distressing conditions improved foraging performance under different distressing situations later in life. However, much research remains to be done to show the applicability and effectiveness of such treatments to companion animals. (For a discussion of resilience in animals, see Chapter 13, this volume.)

At this point in time, animal caretakers should be cautious in implementing enrichment programs or resilience training. The differences among the studies cited here are numerous, including differences in species and breeds; the nature, intensity, and duration of the early experiences as well as their timing during development; how and when the effects on the animals are evaluated; and the specific measures taken. It is not yet clear which elements of enrichment, resilience training, and puppy/kitten classes are beneficial, but a reliable correlation is starting to emerge showing the lasting impact of early life experiences on adult behavior in dogs (McMillan *et al.*, 2015; Buttner *et al.*, 2022; Baslington-Davies *et al.*, 2023). Specifically, adverse life events including poor or limited socialization with people and conspecifics, non-domestic maternal environment, and the use of positive punishment have been linked to higher rates of fear and aggression in adult dogs (Baslington-Davies *et al.*, 2023). These two behaviors are also the main reasons for relinquishment to shelters and the top two risk factors for abuse of dogs in homes (McMillan *et al.*, 2015). This result highlights the importance of early life experiences when socializing and raising companion dogs.

10.6.2 Prevention of behavior problems

Just as prevention of disease can improve physical health, prevention of behavior problems can improve mental health. Likewise, improvement in mental health can prevent behavior problems. We have discussed the roles of genetics and early experiences in influencing mental health. We have also talked about the information animal caretakers need to prevent and correct poor mental health including realistic expectations, the ability to recognize emotional states of their animals, and addressing the behavioral needs of their animals. But there are specific pet behaviors and life changes that create problems for caretakers and may impair the mental health of the animals. It is possible to prevent many of these problems with the right information when these behaviors occur or when life changes are expected in a family. Preparing pets for the arrival of a new baby or creating a plan to help them adjust to a move can help prevent fear, aggression, house soiling, or other negative behavioral reactions.

Research suggests that expert advice provided to new pet parents can reduce the incidence of some kinds of behavior problems that can harm human–animal relationships and have a negative influence on the mental health of animals (Gazzano *et al.*, 2008a). Providing new adopters 5 minutes of education about housetraining techniques significantly increased housetraining success and reduced the use of punishment (Herron *et al.*, 2007). This proactive approach is preferable to reactively solving problems that have already had a detrimental effect on the pet's mental health and weakened the family–pet bond.

A list of informational topics related to dog and cat behavior that may help prevent behavior problems can be found in Fig. 10.2. Hetts *et al.* (2004, 2005) have urged the creation of educational handouts for caretakers that provide specific protocols or strategies to help prevent common behavior concerns. Such educational materials can be found in veterinary behavior textbooks such as Herron (2024) or Landsberg *et al.* (2024), and on professional websites such as that of the American Society for the Prevention of Cruelty to Animals (2024) and the University of California, Davis, College of Veterinary Medicine (UC Davis Veterinary Medicine, n.d.).

10.6.3 Resolving behavior problems

Routine assessments of behavior and mental health of animals by veterinarians at all non-emergency

Informational Topics on Dog and Cat Behavior

Dog Behavior

- ❒ Introducing a Family Dog to a New Baby
- ❒ Introducing a Family Dog to a New Dog
- ❒ Introducing a Family Dog to a New Cat
- ❒ Dog Threats or Aggression to People
- ❒ Dog Threats or Aggression to Other Dogs
- ❒ Dog Threats or Aggression to Other Animals
- ❒ Helping Children and Dogs Get Along
- ❒ Excessive Barking
- ❒ Destructive Behavior
- ❒ Fears and Phobias in Dogs
- ❒ The Dog That Cannot Be Left Alone
- ❒ House Training Dogs
- ❒ Elimination Behavior Problems
- ❒ Socializing Dogs
- ❒ Using Rewards (Positive Reinforcement) To Change Behavior
- ❒ Cautions on Using Punishment to Change Behavior
- ❒ Reading Your Dog's Emotions
- ❒ Dogs that are Intolerant of Handling
- ❒ Dogs that become Overly Excited
- ❒ Guidelines For Choosing a Dog Trainer

Cat Behavior

- ❒ Introducing a New Cat to Family Cats
- ❒ Introducing a New Cat to Family Dogs
- ❒ Cat Threats or Aggression To People
- ❒ Cat Threats or Aggression to Other Cats
- ❒ Cat Aggression to Other Animals
- ❒ Helping Children and Cats Get Along
- ❒ Cat Excessive Vocalizations
- ❒ Cat Destructive Behavior
- ❒ Cat Elimination Behavior Problems
- ❒ Socializing Cats
- ❒ Using Rewards (Positive Reinforcement) To Change Behavior
- ❒ Cautions on Using Punishment to Change Behavior
- ❒ Reading Your Cat's Emotions
- ❒ Cats that are Intolerant of Handling

Fig. 10.2. Informational topics on dog and cat behavior.

appointments can help to identify problems early, before they become serious. Hetts *et al.* (2004) discuss protocols for such assessments, and examples of brief behavior screens can be found online at the website of Animal Behavior Associates (dogs: 2024a, cats: 2024b). Once problems have been identified, providing behavior consulting services at the veterinary hospital or a referral to a qualified animal behavior consultant should be made. (See also Chapter 26, this volume, for more detailed information on the treatment of emotional disorders in animals.)

10.7 Conclusions

In summary, our knowledge of the development of behavior and well-being, the interactions of the different variables influencing them, and the wide inter-individual variation is too incomplete at this time to permit the formulation of highly specific protocols for fostering the mental health of animals. However, we can make some general recommendations that can apply, with individually tailored specifics, to all animals.

Genetic predispositions and experiences early in life can have profound effects on later behavior and

mental health. In general, caretakers should maximize pleasant experiences and minimize unpleasant ones. Many kinds of aversive experiences in early life as well as insufficient exposure to some kinds of experiences have deleterious effects on behavior and, presumably, mental health. Conversely, on the positive side, some kinds of extra or enriching experiences, as well as mildly stressful events, seem to promote healthy behavior and resilience, which, we assume, will improve mental health.

Behavior problems are ultimately the result of animals exhibiting behaviors that are unacceptable to people. The earlier problems, or warning signs of potential problems, are identified, the sooner intervention and even prevention can occur. Behavior screenings, much like depression screenings used in human medicine, should become standard, and can be administered by veterinarians, groomers, trainers, and any other appropriately trained professionals. Preventing and treating behavior, or mental health, problems is just as important to the animals' well-being as preventing and treating physical health problems.

To accomplish all of the above tasks, pet parents, and pet professionals, need help and information from experts well-versed in the scientific principles of animal behavior. This must become the norm, rather than continued reliance of pet caretakers on the long-standing body of popular misinformation still widely disseminated.

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Part 3 The Unpleasant Experiences: Distress, Suffering, and Mental Illness

11 Distress and Suffering: On the Nature of the Extremes of Unpleasant Experience

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In the course of sentient life, with the exception of death itself there seems nothing more important than the experiences of distress and suffering. Human and nonhuman animal (hereafter animal) lives place the utmost priority on avoiding these mental states, and yet for such immense importance they remain poorly understood. Suffering, in particular, has been the subject of philosophical and religious writings for millennia, and despite it being widely acknowledged as one of the main goals of human (Büchi *et al*., 2002; Carnevale, 2009; Tate and Pearlman, 2019) and veterinary (Weary, 2019; American Veterinary Medical Association, 2024) medicine, there is little agreement about its definition and no bioethical consensus as to what it is (Phillips *et al*., 2023). Carnevale (2023) noted that suffering 'remains a phenomenon that is difficult to understand and "assess" in clinical practice', and Cassell (1999) suggested that one reason for this is that suffering is subjective in nature and that for health professionals, 'Objective knowledge is considered scientific and valuable, whereas subjective information is thought to be "soft" and second-rate'. Consequently, present day descriptions of suffering include elusive (Frank, 2001), enigmatic and nebulous (Kanov, 2021), complex and multidimensional (Krikorian *et al*., 2012), very difficult to quantify (Sensky, 2010), and scarcely researched (Büchi *et al*., 2002).

In the scientific literature as well as everyday nonscientific discourse the terms distress and suffering have vacillated between being considered different and being the same mental phenomena. The overall aim of this chapter is to explore what is known about the nature of these phenomena (or this phenomenon) to serve as a foundation for much needed research in this vitally important area of the life experience.

11.1 Definitions and Conceptualizations of Distress and Suffering

There is currently no universally accepted definition of distress or suffering in any species, animal or human (National Research Council, 2008; Bustan, 2019). Barnard (2007) writes that suffering 'is a putative negative subjective state that is rarely defined, either in terms of what it comprises or of where on a presumably sliding scale of negativity it lies'. Few scholars have explicitly addressed the issue of animal suffering (Weary, 2016), and within the veterinary community there is substantial disagreement on the meaning of suffering in animals. Baumgaertner *et al*. (2016) studied reports from 42 veterinary experts and found 'evidence of disputes between experts concerning the definition of suffering, the significance of clinical findings and the relevance of different assessment methods'. Distress is a notably polysemous term that has defied innumerable attempts at a consensus interpretation.

Why is it important to clarify our understanding of distress and suffering? The lack of explicit definitions affects the evaluation of these phenomena and their impact on individual well-being in medical, animal care, and legislative contexts (National Research Council, 2008). In particular, disagreement on the meaning of the terms all but guarantees confusion about how to identify, measure, and study the phenomena. For example, if two separate studies measured the number of times per week people reported experiencing distress (or researchers were measuring the frequency of distress in

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animals), without a consistent definition of distress there would be no way to tell if the studies were evaluating the same thing. More broadly, knowing how, when, and why distress and suffering arise and abate is crucial to developing the ability to prevent their emergence and to facilitate their resolution.

In the legal arena, precision in the defining of suffering in animals becomes particularly pivotal, where obtaining a conviction for animal cruelty may hinge on proving that an animal has suffered (Fordyce, 2017). However, while the word 'suffering' often appears in the wording of the applicable law, rarely does the language include a statutory definition of the term (Fordyce, 2017). A typical example is the Minnesota statute that defines 'abuse' and 'cruelty' to mean 'the causing … or allowing … of unnecessary pain or suffering to a pet or companion animal' (Minnesota Legislature Office of Revised Statutes, 2024). In such cases, the evidence provided through the expert testimony of a veterinarian requires a clear explanation of what suffering is and how it is recognized.

11.1.1 Definitional comparisons between distress and suffering

To start off an exploration of the nature of distress and suffering we must first confront the question of whether they are the same or different things. Philosopher David DeGrazia (2014) wrote that:

> Suffering bears a close relationship to distress. … The precise relationship between distress and suffering is a subtle matter. Perhaps suffering is a form of severe distress, as Cassell claims. Or maybe suffering is distinguishable from distress but closely associated with it, as in the idea that one can suffer in response to distress. One might be nervous, notice one's heartbeat, and fly into a panic attack. We might describe this as suffering (the panic attack) as a response to distress (nervousness).

In the scientific literature, it can be seen that distress has frequently been equated to and used interchangeably with suffering (e.g., National Research Council, 2008; Ledger and Mellor, 2018). In a review of six medical dictionaries' definitions of distress, Duffee (2020) found relative unanimity, concluding that it was commonplace to define distress as suffering. She concluded that, 'in medicine "distress" tends to mean "suffering", or some similar term whose differences from suffering have not been established'. However, her review did note that there was some variance in how exact the dictionaries equated the two terms. As one example, distress was likened to cognate concepts of suffering such as 'discomfort'. Moreover, in the general as well as scientific literature distress is commonly defined in terms of suffering, and suffering in terms of distress. An example of the former is the *Farlex Partner Medical Dictionary*'s (2012) definition of distress as 'Mental or physical suffering or anguish' and examples of the latter include where suffering 'is viewed as a distress' (Bustan, 2019) and 'is a specific distress' (Krikorian and Limonero, 2012). Phillips *et al*. (2023) wrote that the intensity of suffering 'ranges from distress to agony', indicating that distress is the mildest form of suffering. Most incongruous are the directly opposing views of distress being a 'form of suffering' (DeGrazia, 1996) and suffering being a 'form of distress' (Cowden *et al*., 2022).[1]

11.1.2 Affective experience of extreme aversiveness

In characterizing distress and suffering one of the most prominent aspects is that the essence of both is the subjective experience of feelings, or affect[2] (Tomkins, 1963; Dawkins, 1980; Rushen, 1990; DeGrazia, 1996; Krikorian *et al*., 2012; Baumgaertner *et al*., 2016; Ledger and Mellor, 2018; Weary, 2019; Cowden *et al*., 2022). Affective states have a hedonic dimension, which may be positive (pleasant) or negative (unpleasant) and have physical or emotional origins. It is the negative affect (NA) that comprises the experiential aspect of distress and suffering. Examples of physical-based NA include pain, illness, nausea, thirst, hunger, breathlessness (air hunger), urinary bladder distention, pruritus, and temperature extremes; examples of emotion-based NA include fear, anxiety, frustration, boredom, helplessness, hopelessness, separation distress, social isolation and loneliness, depression, and grief (Cassell, 2004; Ledger and Mellor, 2018).

A general consensus now holds that, being felt subjective experiences, distress and suffering require consciousness (Russell and Burch, 1959; Krikorian and Limonero, 2012; DeGrazia, 2014; Coleman, 2020). (For an opposing view on the requirement of consciousness for suffering, see Bueno-Gómez, 2017 and Van Hooft, 1998; for an agnostic view of the requirement for consciousness in affect in animals, see Mendl and Paul, 2020.) In reference to

distress, for example, Russell and Burch (1959) wrote that, 'It is assumed that to be in a state of distress an animal must be in a certain state of consciousness, which may be eliminated by, for instance, deep general anesthesia.' More recently, the National Research Council (2008) similarly pointed out that distress could be prevented in laboratory animals by using a general anesthetic and euthanasia before consciousness is regained, and Karas and Silverman (2014) stated that, 'While under general anesthesia an animal cannot consciously perceive the presence of a negative state, and thus distress is prevented by loss of consciousness.'

The *intensity* of the affective experience is also a major element in scientific and nonscientific definitions of suffering and distress. For suffering, scientific views are consistent with the common everyday usage of the term, which refers to not just any degree of unpleasant experience, but rather to a *very* unpleasant experience (Olsson *et al*., 2019). Svaneus (2014) suggested this in the general view that, 'it is important to try to uphold some form of *severity* criterion in order not to turn every negative mood immediately into a case of suffering.' More specific descriptive examples specifying intensity include those in which suffering refers to 'a wide range of intense and unpleasant subjective states of people or other animals, such as fear and frustration' (Dawkins, 1980), 'a negative experience that is considerably intense or persistent' (Cowden *et al*., 2022), 'a highly unpleasant emotional state associated with more-than-minimal pain or distress' (DeGrazia, 1996), 'a more-than-mild disagreeable overall feeling' (Mayerfeld, 1999), 'negative subjective affects that animals are likely to experience where the impact of their character, intensity, and/or duration [are] sufficiently aversive or extreme' (Ledger and Mellor, 2018), 'strong, negative affective states such as severe hunger, pain, or fear' (Baumgaertner *et al*., 2016), '[the experience of] intense and prolonged unpleasant states' (Fraser and Duncan, 1998), and 'a negative subjective state of some considerable magnitude or duration … [that exceeds] some threshold of severity and/or duration' (Weary, 2019). Morton (2000a) asserted that, 'Animals that are sentient can feel positive and negative emotions, and suffering may occur when these feelings are overwhelmingly negative.' Articulating the level of aversiveness in different terms, Hick (1966) wrote, 'I would suggest that by suffering we mean that state of mind in which we wish violently or obsessively that our situation were otherwise.' In these quotes the word suffering is clearly used to distinguish severe or prolonged unpleasantness from experiences that are mild or fleeting (Weary, 2016).

Threshold concept

In the conception of suffering and distress as intensely unpleasant affective experiences, there is an inherent question of determining what magnitude and duration of unpleasantness qualifies as the particular state, i.e., distress or suffering. This involves a threshold, above which distress or suffering exist and below which they do not. This would exclude minor aversive experiences, such as a twinge of anxiety, feeling a little chilly, a slight pain, a hint of sadness, or minor thirst. In this vein, Dawkins (1980) notes that a major difficulty with any definition of suffering is determining a clear line where suffering begins, writing, 'There is a subjective element, for example, in deciding how much fear, conflict etc. constitutes "suffering".' This threshold concept would not mean that there cannot be mild distress or suffering, just that even the mild forms exceed the threshold. Importantly, the concept of a threshold raises questions central to managing and alleviating distress and suffering: What is the nature of the threshold? What creates it and what affects it? We will return to these important questions later.

Unspecified intensity

Contrary to the notion of suffering and distress being affective experiences of substantial intensity, both have also been described in the literature with no reference to intensity, allowing for (or in some cases specifying) the term to indicate any level of unpleasant affect. *For example,* Rushen (1990) wrote that, 'Distress…can be considered as the common, negative emotional component that underlies a diverse range of more specific mental states such as fear, pain, anxiety and frustration', and Russell and Burch (1959) stated that 'any degree' of visceral ill-health may be assumed to entail a measurable amount of distress. DeGrazia (2014) writes that distress 'may be understood as a typically unpleasant emotional response to the perception of environmental challenges or to equilibrium-disrupting internal stimuli'. Distress has even been used to indicate an aversive experience of relatively *low* intensity affect (e.g., Tomkins, 1963).

Examples for suffering lacking specification of intensity include Wilkinson and Zayegh's (2022) view that 'we use the term *suffering* to refer to negative hedonic states', and Fraser's (1988) proposition, referring to animals, that 'Suffering is essentially the experience of negative feeling in the spectrum from pain, through malaise, to frustration.' Notwithstanding these references, the general consensus appears to clearly favor the view that suffering is an unpleasant experience of great intensity, a point that Weary (2019) addressed when he wrote that applying the meaning of 'any felt negative affective state' to suffering 'would seem to strain the boundaries of common usage of the word'.

11.1.3 Noted operational definitions for distress in animals

In humans, measurement of distress is most frequently done by self-reports of subjective experience. However, since these methods are unavailable in animals, investigations of distress require operational definitions, i.e., definitions that prescribe measurable criteria. Two of the most commonly utilized operational definitions in the literature include the development of pathological changes (e.g., Selye, 1974; Kopin *et al*., 1988; Clark *et al*., 1997) and the exhibition of abnormal behavior (e.g., Kopin *et al*., 1988; Clark *et al*., 1997).

Distress is the state that exists when stress responses lead to pathologic changes

Numerous literature discussions of distress have suggested that an indicator of the presence of distress is the development of pathologic changes. For example, Carstens and Moberg (2000) stated that 'Certainly the presence of pathologies such as disease, self-mutilation, or death are obvious indicators of distress', and the Committee on Pain and Distress in Laboratory Animals (1992) wrote that when pathologic changes, such as gastric ulcers, occur, it can be said that the animal is not only stressed, but distressed.

However, upon scrutiny it becomes evident that pathology may not be a reliable indicator of distress. Most importantly, the 'development of stress-related pathology' is not at all a precise and recognizable event. For example, not all adverse stress-induced health changes become manifest immediately; pathologic changes may appear at a much later time in the individual's life. In addition, pathological changes may consist of an increased *susceptibility to or risk for*, as opposed to overt expression of, pathology. Evidence from studies of humans (reviewed in Miller *et al*., 2011 and Fagundes *et al*., 2013) and animals (reviewed in Miller *et al*., 2011) indicates that early life adversity (ELA) shows strong correlations to the development of psychopathology later in life. For instance, several rodent and primate models of ELA, including those that model maternal separation or loss, abuse, neglect, and social deprivation, have demonstrated that these types of early stressful experiences are associated with long-term alterations in neuroendocrine responsiveness to stress, emotional and behavioral regulation, coping style, cognitive function, quality of social affiliations and relationships, and expression levels of nervous system genes shown to be associated with anxiety and mood disorders (Sanchez *et al*., 2001; Cohen *et al*., 2006). In humans, severe stress early in life, such as child abuse, increased the risk of anxiety and depressive mood disorders (Chapman *et al*., 2004; Shea *et al*., 2005) and of developing PTSD in response to major stressors (Brewin *et al*., 2000) later in life. In all, there is consistent evidence linking early stress and later physical and mental health disorders in humans and animals, and that in animals this is a causal link (Miller *et al*., 2011). The key point here is that if adverse health effects (pathology) are used to operationally define distress, delayed effects and increased risk of pathology would both require that the confirmation of *current* distress could only be made retrospectively at some point in the future. In such cases an individual currently enduring adversity could not be determined *at this time* to be experiencing distress, even for humans assessing their own mental state, raising the highly implausible scenario of a person currently enduring some form of adversity being asked, 'Are you experiencing distress?' and the person responding, 'I don't know. I guess I'll find out when I'm older.'

Distress is the state that exists when adversity leads to abnormal and maladaptive behaviors

One of the most prominently proposed indicators of the presence of distress in animals is the occurrence of abnormal or atypical behavior. For example, the Committee on Pain and Distress in Laboratory Animals (1992) has written that, 'When an animal is experiencing distress, maladaptive behaviors result, varying in range and severity with

increasing distress' and that the appearance of such behaviors marks the point where distress arises. Likewise, the National Research Council's Committee on Recognition and Alleviation of Pain in Laboratory Animals (2009) defined distress as 'an aversive state in which an animal is unable to adapt completely to stressors and the resulting stress, and (as a result) shows maladaptive behaviors'. Examples of abnormal behavior in captive animals include stereotyped, repetitive behaviors, which, over time, may become increasingly directed towards the animal's own body and result in self-mutilation (Wemelsfelder, 1999).

However, this view also does not stand up well to analysis. First, as noted by the National Research Council (2008), it is unclear at this time whether any or all abnormal behaviors qualify as indicators of distress, and distress may not manifest itself with recognizable maladaptive behaviors. Second, not all abnormal behavior during severe adversity is pathological or maladaptive; some abnormal behaviors can (and often do) represent homeostatic processes of adaption to stressors (Committee on Pain and Distress in Laboratory Animals, 1992; Tiefenbacher *et al*., 2005; National Research Council, 2008). Research shows that in some humans and nonhuman primates, even more serious forms of abnormal and self-injurious behavior may function to reduce arousal (Tiefenbacher *et al*., 2005) and it has been suggested by those who favor the arousal reduction hypothesis as an explanation for stereotypic behavior that such behavior may serve to calm the animal and in so doing *avoid* distress (Mason, 1991). For instance, in rhesus monkeys, bouts of self-injurious biting were associated with reduced indices of physiological stress (Novak *et al*., 2006) and several studies have demonstrated that some individuals exhibiting a high degree of stereotypic behavior appear to cope better than non-stereotypic conspecifics (reviewed in Committee on Pain and Distress in Laboratory Animals, 1992 and Mason and Latham, 2004).

11.1.4 Other conceptualizations of distress

Distress is any severity of certain mental disorders

This conceptualization of distress is a more specialized version of the view using unspecified intensity and is the one used most often in the context of human mental health, psychology, and well-being. Here the term (often used in the wording of psychological distress) describes an array of types of psychopathology, of any severity. Cromby *et al*. (2013) use the term distress 'to refer to just the same kinds of phenomena that textbooks of this kind usually call mental illness or psychopathology. We use distress to mean *all* of the different kinds of difficult or unusual experiences associated with the hundreds of psychiatric diagnoses currently employed.' Psychological distress is defined by some authors as depression and anxiety (e.g., Kessler, 1979; Mirowsky and Ross, 2003) and by others as also including other states such as burnout, irritability, worrying, problems concentrating, and, more broadly, psychological maladjustment and negative mental health states (e.g., Holahan and Moos, 1981; Veit and Ware, 1983; de Haes *et al*., 1990; Dyrbye *et al*., 2006).

Distress is a specific, discrete, or basic emotion

Distress has been conceived of as a specific emotion. For example, Izard (1977) wrote that 'distress is the most common negative emotion' and that 'distress and sadness are generally considered synonymous'. This view is often expressed in the form of a list in which distress is included as an emotion comparable to other specific emotions, such as Roseman *et al*. (1994) describing the selection process in their experimental design: 'The emotions studied were fear, sadness, distress, frustration, disgust, dislike, anger, regret, guilt, and shame.'

This characterization has not been proposed for suffering; to the contrary, as will be discussed later, suffering has been proposed to be composed of an array of emotions (Bustan, 2019). As noted by Kanov (2021), 'the experience [of suffering] is not reducible to an emotion or a singular feeling'.

11.1.5 Distress and suffering as severe forms of lesser states of adversity

Related to the threshold question is the notion that one phenomenon *becomes* another – or *elicits* another[3] – when it reaches some unspecified more extreme level. The two main examples here are *distress is severe stress* and *suffering is severe distress*.

The view that distress is severe stress is relatively common among the general public as well as the scientific community. For example, Moberg (1987) proclaimed in the simplest terms that the most

severe form of stress is distress. This view is also expressed in language that describes stress becoming distress, such as in the National Research Council's (2008) report *Recognition and Alleviation of Distress in Laboratory Animals*, where mention is made of 'the transition of stress to distress', and when Wolfensohn *et al.* (2018) refer to the 'point where [stress] will develop into distress'. Suffering being described as severe distress was the view of Cassell (2004) and Morton (2000b), the latter writing that, 'it should be assumed that persistent … distress in animals leads to suffering'. Incorporating all three levels, Henry (2017) proposed a stepwise progression of stress to distress to suffering.

11.1.6 Human suffering and distress involve two types: psychophysical and existential

One of the most prominent themes shared by characterizations in the human literature is that there exist two types of suffering, experienced in different ways, and involving a distinction between the clinical suffering of a physiological or psychiatric nature and *existential suffering* (Cassell and Rich, 2010; Bueno-Gómez, 2017; Carnevale, 2023). The former is that which is most commonly considered when the term suffering is used: the highly unpleasant affective experience with which everyone is familiar from their own lives. In contrast, existential suffering involves a cognitive as well as affective component and is associated with threats to the integrity of the self. This distinction has also been described as clinical and nonclinical suffering (Cassell and Rich, 2010).

The descriptions of what constitutes existential suffering have varied among different writers. Broadly conceived, suffering contains nonphysical dimensions – social, psychological, cultural, spiritual – associated with one's personhood (Krikorian *et al.*, 2012; Tossani, 2013). More specifically, Cassell (1982) placed personal identity as central to his conception of suffering, defining suffering as 'a specific state of severe distress related to the imminent, perceived or actual, threat to the integrity or existential continuity of the person'. He went on to state that suffering occurs when a person perceives an impending destruction of the self and it continues until the threat of disintegration is no longer present or until the integrity of the person is able to be restored in some other manner. Others have attributed quite expansive elements to existential suffering, including a lack or loss of meaning, purpose, or agency (Tate, 2022); a disintegration of values, belief systems, and connections to the world (Kearsley, 2010); feelings of isolation, hopelessness, helplessness, and angst related to a sense that one can no longer be the person one has known oneself to be (Phillips *et al.*, 2023); corrosion of all parts of their person by damaging friendships [and] frustrating desires (Tate and Pearlman, 2019); and long-term implications associated with threat, loss, potential damage and impending harm for the self (Bustan *et al.*, 2015).

A similar, and in fact in many ways the same, literature discussion exists for *existential distress*. Numerous authors have principally equated existential suffering and existential distress, using the terms interchangeably (e.g., Kissane and Yates, 2003; Bates, 2016; Vehling and Kissane, 2018; Van Tilburg *et al.*, 2019). Multiple themes are common to both descriptions of existential distress and existential suffering, demonstrating the virtual match between the concepts, and also why they appear to play the largest role in terminal illnesses and at the end of life. For example, Kissane and Yates (2003) define existential distress as 'that distress which arises from confrontation with the essence of existence – the issues of death, the meaning of life, aloneness, responsibility, freedom, choices, and a sense of personal worth'. Other themes identified for existential distress include fears and/or loss of a sense of security, connectedness to others, justness, controllability, certainty and hope for a long and fruitful life, being a burden to others; pointlessness or hopelessness; and regret or embitterment about what has been missed in life (Bates, 2016; Vehling and Kissane, 2018). Existential distress has also been likened to demoralization (Vehling and Kissane, 2018).

As only cognitively mature humans would seem to have the cognitive capacity for the self-reflection, sense of loss of personhood, and long-term vision comprising these existential concerns, especially at the time surrounding the end of life, this two-type conceptualization suggests a divergence between distress/suffering experienced by cognitively mature humans and that experienced by animals and very young humans.

11.2 The Nature of Distress and Suffering

Descriptions are offered for various characteristics of distress and suffering, such as the causes, circumstances

surrounding their occurrence, and their manifestations. However, in so doing current definitions often fail to distinguish 'what *is* distress/suffering' from 'what *indicates* distress/suffering'. A useful analogy here is gravity. The force of gravity is well-described in terms of the physics and mathematics of its actions between two objects (i.e., it is directly proportional to the product of the objects' masses and inversely proportional to the square of the distance between them), how it explains the orbits of celestial bodies, and its contribution to the nature of black holes. In addition, gravity can be measured with extreme accuracy by determining the strength of attraction between two bodies. But none of this answers the question, what *is* gravity? McClelland (2020) addressed the question of what *is* suffering by posing this scenario: It is known that an individual may experience a constant intensity of pain over time; however, due to various moderating factors (see Section 11.3) the extent of one's suffering may decrease independently of the experienced pain. McClelland asks, 'But if the pain itself hasn't got any better, what exactly has improved?' These questions represent the current status of understanding for distress and suffering.

11.2.1 The function of distress and suffering: affect and motivation as core elements

Deviations from homeostasis represent a threat to and reduced chances for fitness; hence, animals have evolved effective mechanisms for detecting and correcting such deviations (Panksepp, 1998). The central nervous system (CNS) assesses the importance of stimuli to homeostasis and, for those stimuli representing a meaningful threat, organizes and initiates the responses necessary to maintain or restore biological equilibrium (Panksepp, 1998). It is now well recognized that defensive responses on the part of the organism cannot be random or generalized in type and intensity; rather, responses must be both specific and proportionate to the stimulus or situation that elicits them (Selye, 1974; National Research Council, 2008). For most threats, the simplest and frequently the most biologically cost-effective response for an animal is to alter its behavior in a way that alleviates the threat, for example, increase distance between self and threat, scratch an itch, curl up when cold, seek shade from the hot sun, and cough to clear an airway irritant. This may involve only the CNS and voluntary muscle activity, and there may be little or no sympathetic or glucocorticoid response (Moberg, 1985; Clark *et al.*, 1997). When a threat is not alleviated by a specific but minor behavioral response, as when the disturbances are more intense and/or persistent, other behavioral responses as well as nonspecific physiologic and biochemical responses and arousal mechanisms are required to aid in neutralizing the threat: these are the stress responses (Clark *et al.*, 1997).

Expanding on Selye's (1936) original distinction between selective (and normally adequate) responses to minor challenges and non-selective (emergency) responses to major challenges which can be termed stressors, Day (2005) suggested that stress is the body's multi-system response to any challenge that overwhelms, or is judged likely to overwhelm, selective homeostatic response mechanisms. A crucial point here is that when stimuli are aversive or otherwise threatening enough to activate a stress response, the primary defense mechanisms are assisted by, *but not replaced by*, the stress response.

The function of affect has been a topic of discussion for several decades among psychologists, emotion theorists, evolutionary biologists, ethologists, and philosophers. It is now widely accepted that affective states are adaptive psycho-physiological constructs that act as guides to facilitate behavior beneficial to reproductive fitness and to discourage behavior contrary to these goals (Dawkins, 1990; Committee on Pain and Distress in Laboratory Animals, 1992; Barnard and Hurst, 1996; Panksepp, 1998; Mendl and Paul, 2020; Reimert *et al.*, 2023). Affective states vary along three principal dimensions: valence, arousal, and motivational intensity (Harmon-Jones *et al.*, 2013). Unpleasant affect – our primary concern in distress and suffering – is evolutionarily constructed to *alert* the animal to threats, *focus attention* on the immediate threat and not on matters less relevant (at that moment) to survival, and *motivate* behavioral responses to eliminate the threat (Panksepp, 1998; Schultheiss and Wirth, 2018). As expressed concisely by Schultheiss and Wirth (2018), 'Motivation is, at its very core, about affect… [and] attaining a pleasurable incentive (reward) or … avoiding an aversive disincentive (punishment)' is its hallmark. Additionally, in general, the strength of motivation is correlated with the intensity of the affect, so that as the intensity of affect increases, so too does the intensity of motivation (Webster, 2011; Mellor, 2016).

11.2.2 What causes distress and suffering to arise?

What is clear in all conceptualizations of distress and suffering is that they describe aversive states that arise as the intensity and unpleasantness of one or more NAs increase. Why and how does this happen?

As stated, when primary responses are inadequate to address a homeostatic challenge, a stress response is activated. This mechanism, honed over millions of years of natural selection, is highly effective in restoring homeostasis; however, in some cases the stress response generates inadequate changes in the behavioral and physiologic homeostatic systems (National Research Council, 2008). When faced with the possibility that current protective mechanisms are insufficient, the individual has four choices:

1. The individual could continue to do the same thing it has been doing. However, as Wechsler (1995) pointed out, 'If an animal can neither escape from nor remove an aversive stimulus, it is not adaptive to repeat these coping strategies over and over again.' In this way, continuing current coping methods would have a meaningful likelihood that in terms of an adaptive response, *insufficient* would progress to *failing* and then to *failed* (with some exceptions, as explained below).
2. The individual could continue current coping efforts, but carry them out more forcefully: 'try harder' (Crombez *et al*., 2008).
3. The individual could do something different.
4. The individual could cease coping efforts, i.e., 'shut down', originally described by Engel and Schmale (1972) as the conservative-withdrawal response and characterized behaviorally primarily by immobility.

For choices 1 and 4, successful adaptation may be achieved by waiting the stressor out. If the stressor abates, both strategies can pay off, and in the case of choice 4, the individual preserves resources in the process. Additionally, a successful outcome could result for both strategies if, while being carried out, habituation were to occur. For both choices, however, there is also substantial risk of a catastrophic outcome. The risk involved then leaves choices 2 and 3 as the most likely to be successful when coping, at the level of the stress responses, is perceived to be insufficient and at risk of failing. In selecting choice 2 (try harder) or 3 (do something different) and defense systems have been unable to adequately meet the demands created by the threat, a situation of different biological importance is reached (Broom, 2008). Here, a crucial requirement becomes an enhancement of the 3 key functions of affect: alert, focus attention, and motivate behavior. The intensified focus of attention has been addressed by Olsson *et al*. (2019) and Franchi *et al*. (2024), who described a defining feature of suffering to be 'dominate attention'.

The motivational component in a potentially failing situation instills a determination in the individual's pursuit of the goal (the proximate goal being the alleviation of NA), which may historically have proven successful in overcoming obstacles and preventing the premature disengagement from a primary goal (Rothermund, 2006). In this way, a higher degree of motivation – a motivation boost or amplification – initiates the more demanding efforts in the face of potential coping failure. Distress and suffering have both received attention in terms of a specific motivational function to meet the objective of successful adaptation to a threat.

Russell and Burch (1959) wrote that 'one of the best criteria for distress is that of serving as motivation' and shortly thereafter Tomkins (1963) proposed that distress motivates the individual to take action necessary to reduce, remove the source of, or change his relationship to the cause of the distress. In the opinion of Clark *et al*. (1997), avoiding distress is one of the main objectives motivating learning and, similarly, Henry (2017) stated that distress 'motivates us to eliminate the source of stress'. In a view incorporating stress, distress, and suffering, Krikorian and Limonero (2012) wrote that:

> [In the face of a threat]… regulatory and coping processes in all dimensions are activated. When an event is perceived as a challenge and the resources employed in the regulatory process are sufficient, eustress occurs. In contrast, distress occurs when events are perceived as threatening and resources are insufficient to allow the person to adapt and cope. … In time, if the threat diminishes or the resources become stronger, this process can lead to adaptation…

The enhanced motivation function with respect to suffering was described well before this, as early as 145 years ago when Spencer (1880, as related by Dawkins, 1980):

> saw disagreeable feelings of pain or other kinds of suffering as a sort of internal stimulus, causing the animal to move away and find some other environment. Animals that experienced suffering when they

> found themselves in conditions which were harmful to their well-being and took steps to find somewhere else, he said, would survive better than those that derived pleasure from the harmful environment and stayed in it.

More recently, Dawkins' (1990, 2006) view of suffering hinged on the motivational element; she asserts that animals often suffer in situations in which they are prevented from doing something that they are highly motivated to do. Gilleard (2018) states simply that 'our own suffering moves us to seek its alleviation'; similarly, Carnevale (2009) suggested that suffering is the most important factor that drives patients to seek medical attention. Kauppinen (2019) describes the motivational aspect of suffering in different terms: he states that to the sufferer, suffering represents 'something to-be-ended' and 'generates [a] felt desire for change'. Suffering, to Kauppinen, 'is registered by motivational states that have phenomenal content, so it involves a felt wish for things to be otherwise, and is unpleasant to experience' (Kauppinen, 2019). Barnard and Hurst (1996) described suffering as a generalized subjective 'state of emergency' that is geared to avoiding deleterious circumstances. Duffee (2020) pointed out how suffering motivates the individual to more narrowly target their concerns: 'Sufferers replace their goals with a new focus on ending their suffering.'

Perhaps the clearest illustration of the connection between suffering and motivation is in the context of torture (Lee, 2006; Massin, 2020). Torture is the external activation of the body's natural affective mechanisms, but done in a way that amplifies the negative affective experience to a much greater intensity than is typically encountered in a living being's natural life. In so doing, a primary objective of torture is to create an extreme level of motivation to compel an individual to do something they resist doing. And because NA can be physical-based or emotion-based, either of these can be elevated to the level of torture; examples, respectively, include physical pain and social isolation (Grassian, 1983).

At this point it is instructive to take a slight step back and consider a common characterization of both distress and suffering in the literature, namely, their depiction as maladaptive or failed states. This has most often been presented as a failure of coping or adaptation to stressors (e.g., Committee on Pain and Distress in Laboratory Animals, 1992; Clark *et al.*, 1997; National Research Council, 2008; Karas and Silverman, 2014; Olsson *et al.*, 2019). For example, the Committee on Pain and Distress in Laboratory Animals (1992) issued a statement saying 'Stressors do not pose a threat to the animal as long as it can maintain an adaptive equilibrium. When that is no longer possible, the animal enters a state of distress, in which its behavior and physiology become maladaptive.' Similarly, Clark *et al.* (1997) stated that a maladaptive state of distress occurs when an animal fails to adapt, cope, habituate to a challenging stimulus, and the National Research Council (2008) wrote that 'Progression into the maladaptive state [of distress] may be due to a severe or prolonged stressor or multiple cumulative stressful insults with deleterious effects on the animal's welfare' and suggested that the distinguishing feature between stress and distress is that the latter reflects 'an animal's ability or inability to cope or adapt to changes in its immediate environment and experience'. Karas and Silverman (2014) wrote that, 'When the effort required to adapt to some stressors, or the aversive nature of the stressor, increases and reaches a point where the animal fails to be able to adapt adequately, this is considered by some authors to represent distress.' Minor variations in wording place the emphasis on the inability to maintain homeostasis (e.g., Clark *et al.*, 1997; National Research Council, 2008) or adaptive equilibrium (e.g., Committee on Pain and Distress in Laboratory Animals, 1992), or that coping mechanisms are overwhelmed (e.g., Moberg, 2000).

However, abundant evidence argues against the notion of distress as a failed, maladaptive state. Most importantly, distress and successful coping frequently coexist: distress is often present during fully successful adaptation or coping attempts (Committee on Pain and Distress in Laboratory Animals, 1992; Tiefenbacher *et al.*, 2005; National Research Council, 2008). For example, during the course of an illness caused by an infection (such as the influenza virus) to which the body is successfully responding, there can be considerable distress (as anyone who has ailed with a bad case of the flu can attest). If distress is (only) the result of *failing* adaptation, it should not occur since adaptation is succeeding, albeit slowly. The same is true during the time that the body is successfully healing a broken bone or burned skin; distress from pain may be present while the adaptation is proceeding (in fact, one of the main features of burn pain is that its duration often exceeds healing time (Latarjet and Choinère, 1995)).

11.2.3 A low-motivation form of suffering and distress

Suffering conceived as a failed, maladaptive state is a more complicated picture. First, the capacity for suffering is widely accepted as a product of natural selection (Cabanac, 1979; Dawkins, 1980; Broom, 1986; Dawkins, 1990; Barnard and Hurst, 1996) that helps to restore physiological deficits resulting from animal's natural environment (Cabanac, 1979; Broom, 1986), enhances the animal's capacity to learn from past experience (Dawkins, 1980), and enables an animal to cope with the conflict and often eventually to resolve it (Olsson *et al*., 2011).

The adaptive motivational value of suffering notwithstanding, some authors have described suffering as a state of 'exhaustion'. For example, Krikorian and Limonero (2012) wrote, 'suffering results from perceived threat and exhaustion of coping resources', and Henry (2017) stated that suffering is followed by exhaustion of all psychological, psychosocial, and personal resources. Moreover, a clear exception to the motivational benefit of suffering has been identified: the existence of a form (or result) of suffering in which the sufferer exhibits a generally depressed state of low motivation. High-motivation suffering would include examples such as more forceful efforts to breathe during an asthma attack, faster and more evasive running to flee a predator, extreme protective measures to prevent back pain, parents highly motivated to find a missing child, and the like. In contrast, low-motivation suffering would include a general sense of helplessness – a 'giving up' due to the perception that coping efforts no longer appear to be succeeding. Weary (2019) pointed to the low mood associated with instances of suffering in humans and animals and how this is accompanied by a general decline in previously motivated behaviors. As he also notes, the extensive literature on 'learned helplessness' – in which repeated exposure to inescapable aversive stimuli leads to a relatively consistent combination of cognitive, emotional, and motivational deficits (Maier and Watkins, 2005) – likely represents this form of suffering. Indeed, there may be not only a connection between learned helplessness and the aforementioned exhaustion, they may in fact be referring to the same thing. In the context of a 'threat and resources model' of suffering Krikorian and Limonero (2012) noted the relevance of helplessness, writing, 'Suffering occurs when biologically or psychologically noxious stimuli, internal or external, are perceived as a threat, while coping resources are judged deficient, leading to helplessness.' And the intertwining of helplessness and exhaustion with suffering was described by Chapman and Gavrin (1993): 'Suffering refers to a perceived threat to the integrity of the self, helplessness in the face of that threat, and exhaustion of psychosocial and personal resources for coping.' Little is known about the relationship between the high-motivation and low-motivation forms of suffering, for example, any potential progression from one to the other.

The low-motivation associated with extreme adversity suggests that there are limitations on the evolutionary value of suffering, as Broom (2008) noted when he wrote that extreme suffering is 'probably not adaptive'. It has been noted that extreme adversity can overwhelm the individual's reserves of resilience, overtax coping skills and the ability to manage stress, and create feelings of loss of control, hopelessness, and despair (Seery, 2011; see also Chapter 13, this volume).

It is important to note here that the low-motivation form of suffering is not, by any scientific determination, limited to suffering. In the large body of research involving exposure to uncontrollable adversity leading to learned helplessness, the labeling of the mental state induced largely has been the prerogative of the researcher. Accordingly, whether such a state is considered to be stress, severe stress, distress, suffering, or something else is not a scientific appellation. Ultimately, there is an equally strong argument for considering the individual developing learned helplessness – with decreased motivation – to be experiencing distress as for experiencing suffering.

11.2.4 The quantitative–qualitative question: how do distress and suffering differ from less intense negative affect?

The motivation and attention-focusing functions of distress and suffering suggest that, contrary to the view of failed, maladaptive states, both experiences serve as highly adaptive, emergency processes for an individual who perceives themselves in grave danger. But because intensified affect is itself highly motivating and attention-focusing, this leaves unanswered the fundamental question about the nature of distress and suffering: Are these merely intense NA, or are they something *in addition to* the intensified NA? Does the greater NA (in magnitude

and/or duration) *become* distress/suffering or *elicit* distress/suffering? Do distress and suffering differ qualitatively or only quantitatively from less intense NA? This conundrum was noted by DeGrazia (1996):

> Suffering is a highly unpleasant emotional state associated with more-than-minimal pain or distress. The words 'associated with' bypass the difficult conceptual and scientific issue of whether more-than-minimal pain and distress *cause* or *are forms of* suffering.
>
> (italics in the original)

In a clinical context, we can imagine the scenario of an 18-month-old human toddler crying because of some unseen pain. As the crying intensifies – presumably from increasing pain – it is reasonable at some point to conclude that the child is suffering. Is this anything different than merely greater pain?

As has been described, we know that as the intensity of an NA (which I will call the primary NA) increases, there arises at some point an extremely aversive experience we call distress and/or suffering. And while this is happening, the primary NA remains present. As Ledger and Mellor (2018) wrote:

> …note that when specific negative affects approach their extreme, they are not transformed into an experience of 'suffering'; rather, they retain their original character so that, for example, intense breathlessness continues to be experienced as breathlessness. The same is true for thirst, hunger, pain, nausea, anxiety, fear, panic, or depression, as these and all other such negative experiences also retain their individual character when they are present at high intensities.

The nature of distress and suffering can be thought of in two ways. The first is that distress/suffering are nothing more than intense NA; that is, they differ quantitatively, but not qualitatively, from less intense NA. In this view, as NA – e.g., fear, nausea, pain, anxiety, loneliness – intensifies, we simply label the experience distress or suffering when it becomes extremely aversive (Fig. 11.1a). If, conversely, there is a qualitative difference from less intense NA, as the intensity of NA rises a new experience is 'added onto' the intensifying NA (Fig. 11.1b). In this conceptualization, distress/suffering is an affective experience of its own composition, and accompanies the increasingly intense primary NA to create what is perceived subjectively as a singular experience: *NA-related distress/suffering*. In this case, the distress/suffering affect never exists on its/their own – there is no experience that is 'just distress' or 'just suffering' (for an opposing view, see Gilleard, 2018) – but rather it always exists secondary to, and concurrent with, the primary NA (McClelland, 2020).

Both of these two different natures of distress and suffering involve a threshold concept. This threshold appears to be very indistinct – like any line one might attempt to draw separating day from night – and mutable (see Sections 11.3 and 11.4 below). If there is no qualitative difference between distress/suffering and intense primary NA, then the threshold is merely that point where the NA gains the additional label of distress/suffering. If distress and suffering are qualitatively different from intense primary NA, then the threshold is that point where the additional distress/suffering affect emerges to become part of the overall experience.

It has been well established that two distinct dimensions constitute the experience of pain: pain sensation (nociceptive dimension) and pain unpleasantness (affective dimension) (Bustan *et al*., 2015). Bustan *et al*. (2018) noted that pain-related suffering had been 'conceptualized either as an enhanced form of pain unpleasantness or as an additional element'. To answer the question of whether suffering consisted of such an additional element, Bustan *et al*. (2015) designed an experiment in which participants were exposed to noxious mechanical stimuli of varying intensities and durations and then self-reported their ratings of pain intensity, unpleasantness, and suffering. The researchers' findings demonstrated that what they termed 'pain-related suffering' constitutes an integral component of pain that is distinct from and can be assessed independently of pain intensity and unpleasantness, i.e., 'an independent self-contained element and not simply an expansion of unpleasantness'. They concluded that pain-related suffering 'seems to differ from unpleasantness in a qualitative more than in a quantitative measure'. A follow-up study (Brunner *et al*., 2017), again using participants' self-ratings, indicated that unpleasantness and pain-related suffering are not simply independent constructs, but are processed and interpreted in separate ways. In both studies, the Bustan group found that participants were able to clearly dissociate suffering from unpleasantness.

While these studies were limited to the suffering associated with physical pain, there is nothing unique about the affect of pain that would make it likely to

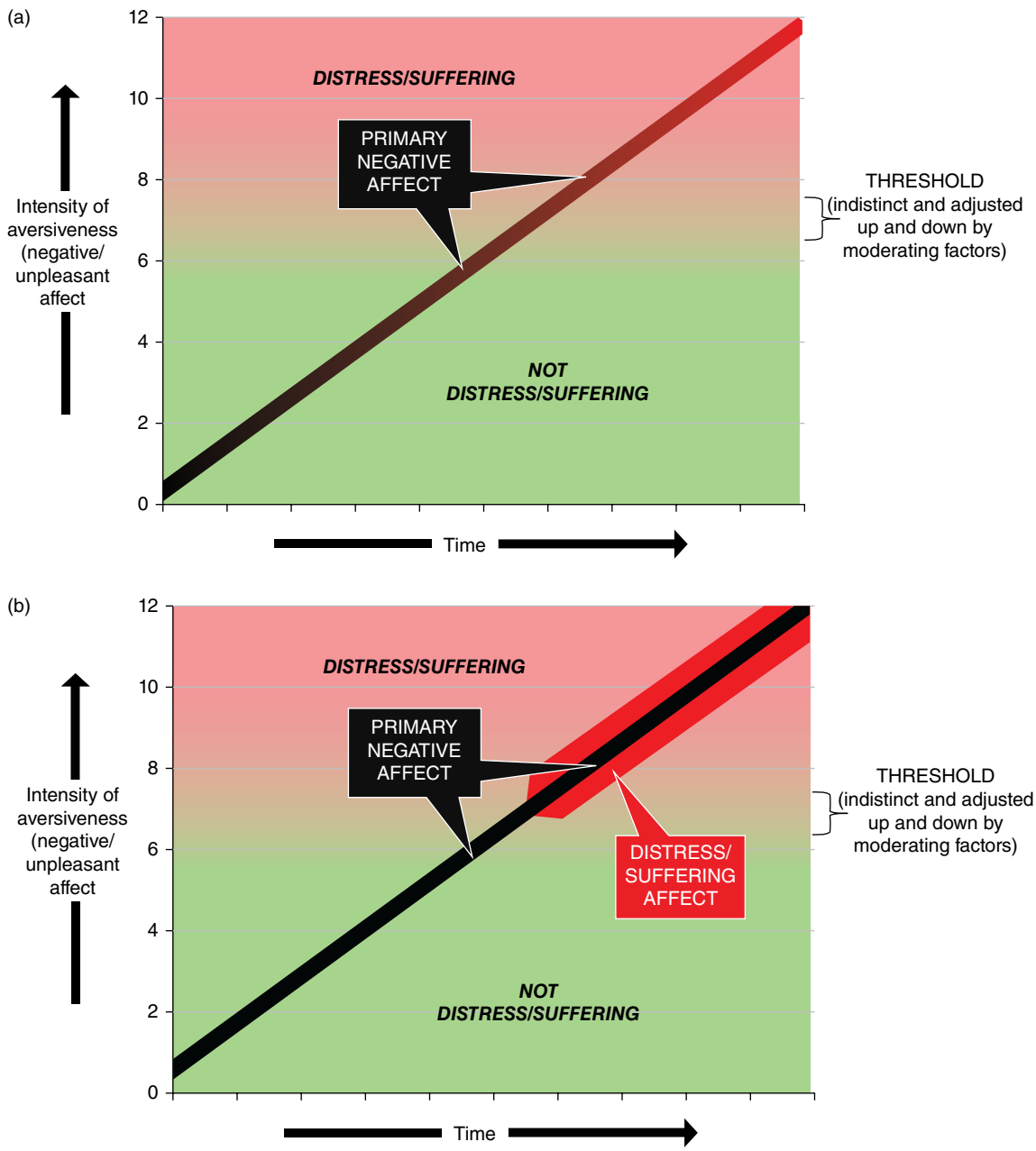


Fig. 11.1. (a) As the intensity of the primary negative affect (NA) increases, we simply label the experience distress/suffering when it becomes highly aversive. (b) As the intensity of primary NA increases, a new experience is 'added onto' the intensifying NA to create what is perceived subjectively as a singular experience: *NA-related distress/suffering*.

be the only NA with an independent dimension of suffering. Moreover, because distress and suffering appear to arise under the same conditions of an intensifying NA, it is reasonable to assume that both contain this 'add-on' dimension as a part of their overall experience. If all NA-related distress and suffering contain this 'add-on' dimension, the next question is, what does this add-on component consist of?

Research to answer this question is lacking and Bustan (2019) expressed doubts that this could be determined with certainty: 'In the process of assessing the suffering of an ill person, it seems impossible to determine the one thing, or philosophically speaking a thing-in-itself, that could serve as the main substance of suffering.' Nevertheless, pain-related suffering has been conceptualized as an additional element combining several negative emotions (Bustan *et al.*, 2018; De Ridder *et al.*, 2021) and has been examined more explicitly by Wade and Hart (2002), who assessed suffering in people with chronic pain. Their procedure specifically avoided the term 'suffering', instead having the participants provide scores on a visual analog scale for the intensity of feeling they experienced from five selected negative emotions assumed to underlie pain-related suffering: depression, anxiety, frustration, fear, and anger. Their findings supported the notion that an array of negative affects constitutes the dimension of pain-related suffering; however, the fact that the investigators restricted their evaluation to these five emotions allows for the possibility that additional negative emotions may contribute to the suffering experience. One such emotion, suggested Cassell (1999), is anguish.

A particular challenge presents itself at this point regarding human distress and suffering. If it is true that distress/suffering contains an added-on dimension and that dimension is comprised of an array of negative emotions, then how does this model account for the existential elements of distress/suffering involving perceptions and reflections on the threatened integrity of the self? This model would seem to offer a comprehensive view of suffering in animals and very young children, but an incomplete accounting of distress/suffering in cognitively mature humans.

11.2.5 Amplification function for distress and suffering

An additional consideration for the function of distress and suffering has been described (Fig. 11.2). Some authors have proposed that the unpleasant experience of the primary NA is amplified by distress/suffering. Tomkins (1970) described an amplifying process in which affects 'boost the gain' of the drive signals under such deleterious circumstances. For example, an affect of intense fear is rapidly recruited whenever an organism's air supply is suddenly jeopardized while under water, such that the drive signal of hypoxia (and/or hypercapnia) is greatly magnified by the sense of panic. Kauppinen (2019) articulated a similar notion with regard to pain-related suffering, writing that 'suffering redoubles the unpleasantness of the pain', thus amplifying the displeasure of the painful experience. Also

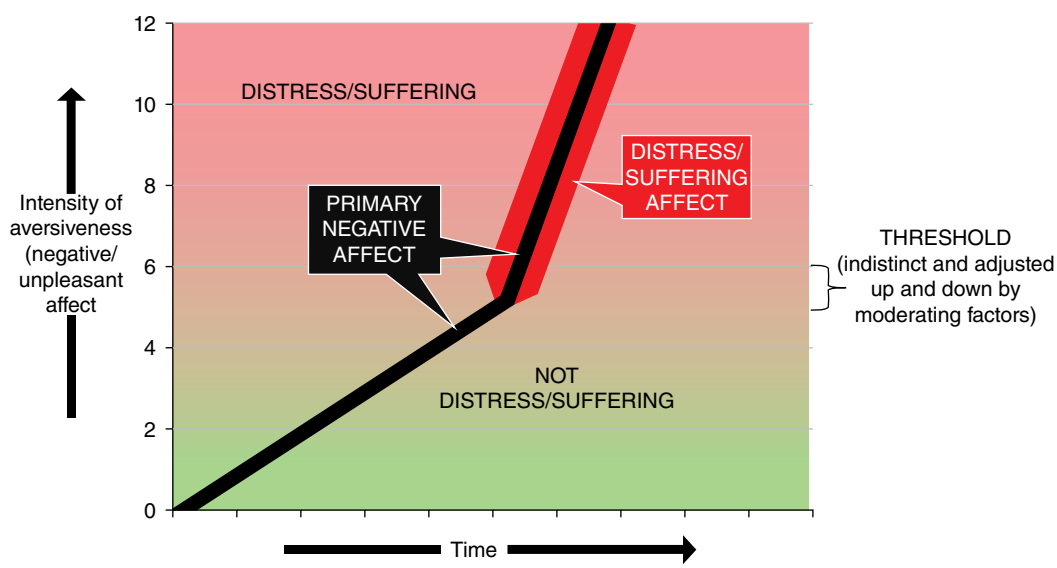


Fig. 11.2. At the threshold, the intensity of the primary negative affect rises faster due to the amplification effect of distress/suffering.

agreeing with this view was Bayés *et al.* (1996), who asserted that suffering may amplify emotional distress. This raises a third possibility to explain the nature of distress/suffering: the aversiveness of the NA undergoes an amplification process upon reaching a certain level.

This amplification function may deserve more attention than it has received, as it can plausibly be seen to be the reason distress and suffering evolved. As mentioned, motivation increases as the intensity of NA increases, so why would an extra process evolve 'on top' of that? One reason could be to amplify the unpleasantness and motivation. Another could be to mitigate these factors, the subject we turn to next.

11.3 Factors Altering the Threshold and Moderating Distress/Suffering

The point where increasingly intense NA experiences are considered to be distress or suffering is not simply indistinct, but studies have shown that the increase in intensity does not demonstrate a simple linear relationship with the intensity of the suffering experience nor consistency regarding the point of onset of distress/suffering (the threshold). Krikorian *et al.* (2012) have noted that the relationship between physical symptoms and suffering is unclear, some studies showing a strong correlation while in others the correlation is weak. Klein (2015) noted that, 'pain and suffering can vary independently in their intensity'. Brady (2018) has recently argued that what makes an experience a suffering is not the intensity of the unpleasantness as even extreme unpleasant experiences may not be associated with suffering, a view supported by a study examining the relationship between pain intensity and pain-related suffering. In the study, Bustan *et al.* (2015) identified a close correlation between intensity and suffering ('more pain yields more suffering'); however, lower pain levels did not prevent the elicitation of suffering. They concluded that 'suffering may not exclusively represent a pain intensity-bound feature' and that these results may indicate 'why people may claim to suffer despite minor pain or else report of enhanced pain without enduring suffering'. More recently, Bustan (2019) concluded that the results from his laboratory meant that 'an increase in the pain intensity definitely leads to higher unpleasantness and suffering, but not necessarily at a constant ratio. In patients, we can notice this non-linear relation when increasing pain intensity inducing in some instances terrible suffering, and not in others.'

These findings confirm the long-held belief that the experience of suffering, in particular, is affected by many factors other than simply the intensity of the primary affect. The questions of 'What affects the onset threshold?' and 'What mitigates the suffering experience?' are indispensable for our efforts to alleviate distress and suffering. While our current knowledge in this area is limited, certain factors have been identified as increasing or decreasing the threshold for the onset of distress/suffering (Figs 11.1 and 11.2). One of the, if not *the*, most important factors influencing the onset and intensity of distress and suffering is the sense of personal control. This factor is in fact considered so integral that several authors have regarded it as one of the basic elements that constitute suffering (e.g., Ferrell and Coyle, 2008). Accordingly, control will be discussed in its own subsection to follow.

11.3.1 Emotions

As described above, evidence supports an aggregation of negative emotions comprising the 'substance' of suffering (and likely distress). But negative emotions such as fear, anger, sadness, helplessness, and desperation may also serve to exacerbate suffering (Bayés *et al.*, 1996). Conversely, suffering may be lessened by positive emotions (Folkman, 2008).

11.3.2 Personality traits

Certain personality traits, such as those involving neuroticism, can exert selective enhancement of affective components of suffering (Harkins *et al.*, 1989).

11.3.3 Learned experience

Suffering can be worsened or mitigated by prior learning, creating expectancies and fears (Fordyce, 1988; Weary, 2019). For example, in their studies of humans, Bustan *et al.* (2018) found that the probability of expressing suffering was predominantly associated with fear of pain.

11.3.4 Social support

In humans, Roberts *et al.* (2015) reported that social support increases pain tolerance in humans, and Younger *et al.* (2010) found that involvement in intimate relationships elevates pain thresholds.

In animals, Keverne *et al.* (1989) determined that social grooming in monkeys causes a release of endogenous opioids (i.e., endorphins), reducing pain sensitivity, while Osako *et al.* (2018) demonstrated that in prairie voles, sensitivity to pain was positively correlated with the anxiety-like signs caused by social isolation after partner loss. (See also Chapter 9, this volume.)

11.3.5 Meaning

One factor found to raise the threshold of and moderate suffering may be exclusive to humans: the meaning an individual finds in the primary NA (e.g., pain) and the associated suffering (Beecher, 1956; Cassell, 1982; Rodgers and Cowles, 1997; Cassell, 1999; Carnevale, 2009). In his seminal study comparing wounded combat soldiers with similarly wounded civilians, Beecher (1956) found that the meaning of the injury – for example, soldiers seeing their wounds as meaning removal from the battlefield and a trip home – had a major beneficial influence on the pain experienced and a lesser need for narcotics. Beecher noted that in comparing the soldiers and civilians there was no relationship between the extent of a wound and the pain experienced and that 'The intensity of suffering is largely determined by what the pain means to the patient.' Similar conclusions were drawn by Sullivan and Ballantyne (2016), who wrote that suffering is 'more associated with the meaning of chronic pain than with its intensity', and Cassell (1982), who asserted that the degree of suffering associated with illness is determined more by the meaning of the illness to the patient than the intensity of the illness experience itself, offering the example of neurologic deficits of early multiple sclerosis being a potential source of intense suffering for a cellist but being only moderately distressing for a scholar (Cassell, 1999). More recently, the Bayesian brain hypothesis (which views the brain as a predictive machine in which an individual does not respond 'naïvely' to new sensory information but rather integrates this new information within the context of expectations generated from past experiences (Lecorps and Weary, 2024)) may offer insights into the processes whereby meaning is generated in the brain. This all has important implications for treating suffering; as Rodgers and Cowles (1997) observed: 'changing [the] meaning may ameliorate the suffering that is experienced'.

11.4 Sense of Control

The theme that has received pronounced attention in terms of the onset and mitigation of suffering and distress is the sense of personal control. (See also Chapter 8, this volume, for an extended discussion on personal control.) Control is here defined as the perception that one has a response available that can lessen the aversiveness of the event – it bestows to the individual the sense that he/she can, at will, terminate the event, make it less probable or less intense, or change its duration or timing, each of which can increase the individual's ability to tolerate the unpleasant stimulus (Thompson, 1981; Foa *et al.*, 1992).

A large literature has demonstrated that for those who perceive that they have the ability to affect the outcomes they experience, the intensity and harmful effects of physiologic and emotional stress are reduced in humans (Sapolsky, 1994) and animals (Joffe *et al.*, 1973), and coping ability in stressful situations is improved in humans (Thompson and Spacapan, 1991) and animals (Broom, 1986). While the research overwhelmingly supports a beneficial effect of the personal sense of control, some investigations on the perception of pain have yielded some inconsistent results. As Löffler *et al.* (2018) have reviewed, studies in healthy volunteers demonstrated that controllable situations reduced pain intensity and unpleasantness but did not always change pain perception. Further, Wiech *et al.* (2014) found that when people exerted control over painful stimulation half of the subjects reported a reduction in pain perception and the other half reported an increase. Although these findings involve pain perception rather than distress and suffering, the conflicting data point toward caution in interpreting effects of control on subjective phenomena as a whole.

The precise mechanisms explaining how having a sense of control impacts the experiences of distress and suffering are not fully understood. However, evidence in humans indicates that the benefits result, at least partially, from the perceived controllability acting as an assurance that one will not face an event that is beyond the limits of endurance (Löffler *et al.*, 2018). Multiple studies have investigated the influence of a sense of control on experiences of adversity, in the name of both distress and suffering.

11.4.1 Control and distress

In humans, Steptoe and Poole (2016) stated that 'It is generally found that distress is associated with a

perception that events are uncontrollable' and Lundberg and Frankenhaeuser (1978) have argued that how much a task can be controlled is a major determinant of the degree of distress experienced. The relationship between perceived control and distress in specific human populations (e.g., patients with particular diseases and people in certain occupations) has been widely studied. Unfortunately, almost without exception these studies either omit any definition of distress or use the term consistent with 'psychological distress' as defined in Section 11.1.4, making direct comparisons of these studies problematic. This work has shown that in people with chronic pain (Crisson and Keefe, 1988), women with breast cancer (Barez *et al*., 2009), firefighters (Brown *et al*., 2002), and teachers (Leung *et al*., 2000), the greater the sense of personal control (internal locus of control), the lower the level of psychological distress. Other studies have found positive effects of perceived control on distress in response to electric shock and loud noises (reviewed in Thompson, 1981). A series of studies of torture survivors by Başoğlu *et al*. (1994, 1997, 2007) demonstrated that the subjective appraisal of the torture event as being uncontrollable and unpredictable was associated with higher perceived distress during torture; distress was lessened when the victim gained some ability to exercise control over torture stressors.

In animals in a research setting, Russell and Burch (1959) suggested that 'serious distress may not be present in experiments where an animal has already learned to eliminate a painful stimulus in advance – e.g. by turning a wheel or pressing a lever'. In its report *Recognition and Alleviation of Distress in Laboratory Animals*, the National Research Council (2008) wrote:

> Predictability and controllability (i.e., the ability of the animal to control its environment) are important determinants in 'the transition of stress to distress'. Numerous studies indicate that, in animals that can predict the onset of a stressful stimulus or control its duration, the behavioral and physiological impacts of stressor exposure are attenuated. Notable among these studies are findings that rats exposed to inescapable shock develop clear signs of distress, whereas yoked rats that can terminate shock exposure do not, despite subjection to the same intensity and duration of shock experience (Maier and Watkins, 2005).

11.4.2 Control and suffering

Numerous researchers have addressed the relationship between control and suffering. In the view of Löffler *et al*. (2018), 'The lack of controllability of experienced pain seems to greatly contribute to the extent of suffering.' Kauppinen (2019) expanded that view to suffering beyond that due to pain, stating that, 'Suffering seems to always involve a sense of lack of control over the unwanted situation.' This interpretation was shared by Krikorian and Limonero (2012), who interviewed 40 individuals at least 70 years old about their experiences and philosophies on suffering and found that one of the three main themes was the view of suffering as a loss of control. They concluded that, 'The two main aspects of suffering are, therefore: the sense that one cannot control the threat itself, and the sense that one cannot control one's perception of that threat,' and described the point of onset of suffering as 'when the person becomes aware of an inability to act on his or her intentions'. Cassell (1999) made a similar point when he wrote, 'Suffering can start with anguish over the possibility that if the symptom continues, the patient will be overwhelmed or lose control – "I won't be able to take it".' Moreover, as noted above, fear has been identified as a modulator of suffering, and Weary (2016) has pointed out the overlap with control and fear:

> When pain is associated with fear the likelihood of suffering increases; fear that the pain will increase to the extent that it can no longer be controlled with analgesics, fear that it will last forever, fear that the patient will become overwhelmed by the pain, or fear that the pain is a sign of a serious disease. Fear associated with loss of control is a recurrent theme in studies of human suffering.

Cassell (2004) recounted his anecdotal findings on a relationship between suffering and the perception of control, writing that people in pain frequently report suffering from the pain when they do not believe that the pain can be controlled. He observed that, 'Patients who have been rolling in agony, believing their pain beyond relief, will often tolerate the same severe pain without complaint after they have been shown that it can be controlled' (Cassell, 2004). Simply having knowledge about the source of the pain – conceived by some as a form of control (Averill, 1973) – also exerts an effect. Cassell (2004) wrote that 'patients can writhe in pain from kidney stones and by their own admission not be suffering, because they "know what it is"; they may also report considerable suffering from apparently minor discomfort when they do not know its source.'

In animals, a vast body of research – in particular, that within the realm of 'learned helplessness' – has demonstrated that animals that are able to control or terminate their exposure to negative events have significantly improved welfare relative to animals that experience the same exact events (including duration and intensity) but for which the events are uncontrollable (Olsson *et al.*, 2019). These studies, however, address aspects of welfare but not explicitly suffering. In humans, such studies on the influence of a sense of control can include self-reports specifically on suffering from the experimental subjects. Löffler *et al.* (2018) examined how controllability affected the perception of pain and pain-related suffering, and the modulation of these experiences by the sense of control. They administered painful electric stimulation to 26 healthy subjects in both controllable and uncontrollable[4] conditions and recorded the subjects' ratings of pain unpleasantness and suffering. The findings showed that controllability reduced the experience of pain-related suffering and supported the view that the transition from pain to suffering results when patients feel that they lack control. These researchers acknowledged that because previous studies on the effect of controllability on pain had yielded some inconclusive findings (as mentioned above), 'the circumstances under which controllability reduces suffering therefore remain incompletely understood'. Büchi *et al.* (2002) did not limit their study of suffering to that associated with pain, instead taking a broader view at the perceived burden of suffering due to illness (e.g., rheumatoid arthritis, type 2 diabetes mellitus, chronic obstructive pulmonary disease, and systemic lupus erythematosus). Evaluating 714 persons through the use of the Pictorial Representation of Illness and Self-Measure (PRISM), the researchers found lack of control over one's illness was associated with greater suffering.

A final point to consider regarding the relationship of a sense of control and distress/suffering is that it is currently unclear as to whether the sense of no control is a *constituent part of* distress/suffering, or *an elicitor/modifier of* distress/suffering. In the former case, the sense of no control would constitute a feeling, and that feeling would be a part of the unpleasant experience of distress/suffering. In the latter case, the sense of no control would constitute a cognitive assessment, and that assessment would then exert an impact on the onset (threshold) and/or intensity of the unpleasant experience of distress/suffering. Further research may help disentangle these possibilities, or demonstrate that both are involved.

11.5 Proposed Definition of Distress and Suffering

In accordance with the foregoing view of the constitution and functions of distress and suffering, the following definition is proposed. *Distress and suffering may both be conceived of as conscious, highly unpleasant, intensified affective motivational states that occur in response to a perception that current coping mechanisms (involving, in part, physiologic stress responses) are at risk of failing to alleviate the aversiveness of the current situation in a sufficient and timely manner. Suffering (and likely distress) includes a low-motivation form, which exists as an intensified affective state absent the motivational component. An existential type of distress and suffering has been proposed which may accompany the affective type and comprises existential concerns about the integrity of the self and of one's life overall; this type is likely exclusive to cognitively mature humans.*

11.6 Measuring Distress and Suffering

Unquestionably the greatest challenge for the clinical application of the concepts of distress and suffering is the subjective nature of the experiences. As Carnevale (2009) notes, 'suffering is a subjective feeling that cannot be measured objectively, whether in adults or in infants', and Weary (2016) reiterated the long-standing view in philosophy that 'the exact nature of subjective experiences in any other individual is ultimately unknowable'. In agreement with this, several authors have written that because suffering is a personal and subjective matter, the only way to determine its presence and extent is to ask the sufferer (Cassell, 2004; Carnevale, 2009; Krikorian *et al.*, 2012; Tossani, 2013). So, how do we confirm the presence of distress and suffering and how do we quantify their psychological impact?

A discussion of methods for measurement of NA in general, in all its levels, is beyond the scope of this chapter and has been covered in depth elsewhere (e.g., Mendl and Paul, 2020; see Chapter 23, this volume). The focus here is on assessment of the states associated with extremes of NA, i.e., distress and suffering as defined above.

11.6.1 Measurement of distress and suffering in humans

Despite the similarities between distress and suffering in the human literature (see Section 11.1), the measurement of the two phenomena has been approached differently. The methods for assessing distress have mainly focused on the psychological distress of mental disorders (see Section 11.1.4), and rely on self-reported symptoms; for example, the Symptom Checklist-90-Revised (Jorgenson, 2020) and the Rotterdam Symptom Checklist (de Haes *et al*., 1990).

Measurement of suffering in humans was not an area of research interest until relatively recently, but today several assessment tools have been developed (reviewed in Schulz *et al*., 2010 and Brunner *et al*., 2017). In their review, Schulz *et al*. (2010) enumerate (with specific examples cited for each) the methods for assessing suffering and their various components:

1. Simple direct questions eliciting self-assessment ratings such as 'Are you suffering?' and 'To what extent are you suffering?'
2. Indices of psychological, spiritual, and social feelings along with measurement of physical symptoms.
3. Measures of pain behavior.
4. Scales that emphasize physical symptoms.
5. Healthcare providers' ratings of patient attributes such as calmness, screaming, pain, and stability of general medical condition, and their overall impression of the patient's level of suffering.

Some of the foregoing methods are limited to communicative persons (e.g., #1 and parts of #2), but the others may be used with individuals too young to verbalize their thoughts and feelings.

Measurement of suffering in infants and young toddlers has received special attention. First, the debate over whether infants have the capacity to suffer due to their lack of language or self-awareness for reflecting upon the experience has all but ended; that the very young can suffer is supported intuitively as well as by a robust consensus of parents and pediatric healthcare professionals, both anecdotally and empirically (Tate, 2020). Measurement of pain-related suffering in prelingual or cognitively impaired children relies heavily on subjective ratings performed by parents (Tate, 2020), as well as tools that measure physiologic (e.g., heart rate and blood pressure), behavioral (e.g., grimacing and crying), metabolic, and hormonal responses to pain (Lago *et al*., 2009). However, as of yet, no universally agreed upon procedure for measuring pain, distress, or suffering in infants has been developed (Wilkinson and Zayegh, 2022).

In humans above toddler age, a large proportion of suffering assessment instruments address primarily the suffering associated with pain, though more recently some tools have been developed to evaluate the suffering arising from other causes. For instance, the study mentioned earlier by Büchi *et al*. (2002) validated PRISM, a nonspecific measure of suffering associated with illness in general.

Other innovative methods for measuring suffering have been described. For example, Bayés *et al*. (1997) developed a tool for screening the suffering of terminally ill patients. They posed a specific question to 371 terminal oncological and AIDS patients on 665 different occasions: 'How long did yesterday seem to you?' and then asked them to assess their current condition. Their results showed that the simple answer about subjective length of time correlated well with subjective suffering in approximately half the patients.

11.6.2 Proposed methods for measurement of distress and suffering in animals

Measurement of distress in animals has largely been directed toward the development and application of operational definitions such as those discussed earlier (Section 11.1.3). However, in addition to the noted limitations of these definitions it is important to point out that their value is almost exclusively for determining the presence or absence of distress (as operationally defined) and have not been shown to correlate with the mental experience of distress. As such, whether one employs the definition using the criterion of pathological changes or abnormal/maladaptive behavior, in neither case has there been demonstrated a direct correlation between the 'quantity' of the criteria and the 'quantity' of distress experienced psychologically. The reason for this is the same reason for developing these operational definitions in the first place: no effective, much less objective, methods for measuring the subjective mental experience of distress in animals have yet been developed.

Research targeting the measurement of suffering in animals lags even further behind the efforts to measure distress. Facing virtually identical obstacles as researchers studying measurement of suffering in human infants, the currently available methods measure various components of suffering

rather than suffering itself. These include measurement of pain (e.g., Sneddon *et al*., 2014), stress (e.g., Ataallahi *et al*., 2022), cognitive bias (e.g., Paul *et al*., 2005), and quality of life (e.g., Belshaw *et al*., 2015). Novel methods with potential for measuring suffering have been proposed. Weary (2019) suggested that pain-related suffering may be measurable based on the known ability of pain to interfere with perception and cognition. He notes that because more intense experiences of pain can cause a decline in perceptual processing and other cognitive functioning, it may be possible to determine associations between painful experiences and decreases in the animal's ability to process and respond to environmental cues, to perform cognitively demanding tasks, and to learn new associations. He suggests that, 'One value of this approach is that it may provide a type of qualitative threshold, in that it could distinguish pain that interferes with normal cognitive functioning versus pain that does not.' Dawkins (1990, 2006) proposed that the link between motivation and suffering may permit using the former as a proxy for the latter. Using her concept that suffering results when animals are highly motivated, but unable, to perform a behavior, Dawkins suggested that methods able to measure the strength of motivation may be able to ascertain whether a deprivation or aversive stimulus is severe enough to cause suffering. Using as the comparison standard a basic necessity for life (food), the idea is that if the effort that an animal would make to achieve some objective equals or exceeds that which it would perform to obtain food (while hungry), then we may presume that the effort stems from a motivation to alleviate a state so unpleasant as to constitute suffering (Dawkins, 1990, 2006; Kirkden and Pajor, 2006). Methods for measuring motivation strength (not specifically for purposes of assessing distress or suffering) have been discussed in the literature (e.g., Kirkden *et al*., 2003).

However, while motivation holds promise as an indicator, and hence potentially evidence, of suffering and/or distress, there are important limitations with its use. First, as we have seen, some suffering (and likely distress) occurs with low-motivation states (e.g., depression, learned helplessness, major illness). Second, on a practical basis, we cannot test each individual animal's motivation regarding all unpleasant experiences, and for deceased animals, such as those involved in court cases for severe neglect or abuse, motivation testing is of course not possible at all. Yet, to counter this limitation, there are numerous naturally occurring circumstances that may be helpful in estimating motivation. Examples include how aggressive an animal is in protecting a painful body part or fighting off fear-eliciting threats, how hard a dog with separation anxiety tries to escape from its enclosure, and how far a starving horse will push its head under a wire fence to reach vegetation in the adjoining field.

11.7 Closing Comments

The pursuit of a more complete understanding of the nature of distress and suffering has vast implications for our goal to detect and alleviate the extremes of unpleasant experiences in sentient creatures. A discussion of the treatment of distress and suffering is beyond the scope of this chapter, but consider that while the most obvious and direct method for easing distress/suffering is to minimize the intensity of the underlying negative affect(s), there are methods which may be used when that approach is not completely successful, or not successful quickly enough. One of these is to raise the threshold for the onset of distress/suffering, which requires a thorough understanding of how such thresholds are formed and how they may be modified (Section 11.3). A second method suggested by Weary (2016) considers treating the NA-related suffering:

> …the treatment of suffering may require more than just treating the underlying negative affective state such as pain; it will also require treating the low mood, or better still addressing the conditions that resulted in the low mood. In some cases the low mood will be a direct result of the affective state …, in which case treating the pain alone may be adequate.

All of these approaches will become more refined as research further elucidates the nature of distress and suffering.

Are distress and suffering the same or different phenomena? To be clear, the fact that I have defined them as near equivalent does not mean they are in fact the same, although the predominant trend in the human medical literature adopts this stance (see Section 11.1.1). Currently, there is insufficient evidence to distinguish them as separate and distinct phenomena. There exist extensive similarities between the two; those described in the proposed definition along with a strong overlap in proposed causes. For example, the major causes of suffering have been specified as physical injury, pain, disease,

lack of water, lack of food, temperatures that are too low or too high, not enough space to move around in, fear, anxiety, depression, lack of stimulation, helplessness, hopelessness, social isolation, and loss of loved ones (Cassell, 2004; Tossani, 2013; Bueno-Gómez, 2017; Kauppinen, 2019) – all identified by others as causes of distress (e.g., National Research Council, 2008).

But at our current level of understanding there also appear to be differences. At the minimum, there are subtle conceptual variations in how we think about distress vis-à-vis suffering. While one can both *feel* and *experience* distress, it seems that suffering is *experienced* but not *felt* (Tate, 2020). If a person in a state of distress were asked, 'What are you *feeling* right now?', 'distress' would be an entirely reasonable answer. However, if a sufferer were asked the same question, 'suffering' seems not quite right. If, in contrast, both persons were asked 'What are you *experiencing* right now?', both 'distress' and 'suffering' would seem appropriate.

In the end, the question as to whether distress and suffering are the same or different is not currently a purely scientific determination as the definitions for each term remain obstinately polysemous and fluid. Until a consensus is reached on precisely what distress and suffering refer to, comparing the two will remain a joint endeavor of philosophy and science.

Notes

[1] The question of whether distress and suffering are the same or different things makes writing about the two terms problematic, as combining the terms implies they are the same and separating them implies they are different. Being an unsettled issue, this chapter takes a 'Schrödinger's cat' approach, where the terms are regarded to be both the same and not the same, and will use both 'distress and suffering', 'distress and/or suffering', and 'distress/suffering' where deemed most appropriate.

[2] Affect is often regarded as the feeling experienced in connection to an emotion or mood (Mendl and Paul, 2020), but the definition used in the present chapter is the broader interpretation of Fredrickson (2001), who wrote that affect 'refers to consciously accessible feelings. Although affect is present within emotions (as the component of subjective experience), it is also present within many other affective phenomena, including physical sensations, attitudes, moods, and even affective traits.' In this chapter the use of negative affect (NA) will be taken to mean any unpleasant feeling, and is equated to aversiveness.

[3] There are two possible processes involved in the progression of one mental phenomenon to another: (i) Distress and suffering are severe *forms of* lesser states of adversity (the less intense state *becomes* the next more intense state); and (ii) the less intense state *elicits* the more intense state (DeGrazia, 1996). This point is discussed further in Section 11.2.4.

[4] The influence of a sense of control on suffering cannot be fully investigated in experiments with humans since any ethically conducted experiment will permit a subject to terminate their participation at virtually any point. Accordingly, a person will never be under the impression that they have lost all control with no chance of regaining it.

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12 Psychological Trauma and Posttraumatic Psychopathology in Animals

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12.1 Introduction

The knowledge that severe adversity can cause long-term psychological and physiological problems in humans has been recognized for centuries. 'Trauma', the ancient Greek word meaning 'to wound' or 'to pierce', first referred to the bodily injury suffered by soldiers from the piercing of their armor (Spiers and Harrington, 2001). In the more recent use of the term, particularly in the human psychological and psychiatric literature, trauma is now understood as a wound inflicted upon the mind as well as the body (Ray, 2008). Despite the longstanding recognition of stress-induced changes, the characteristic syndrome of psychological trauma only attained formal recognition in 1980, when the American Psychiatric Association (APA) included in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-III) a new category, called *posttraumatic stress disorder* (PTSD) (Nayback, 2009). From a retrospective viewpoint, the disorder that is now known as PTSD first appeared in the official nomenclature when the first edition of the DSM in 1952 described the syndrome under the name 'gross stress reaction' (Andreasen, 2010).

In general, physical and psychological processes of an organism return to a baseline state of homeostasis after disruption. Recent studies in humans and nonhuman animals (hereafter animals) have shown that following experiences of severe psychological stress a homeostatic psychological state may not be reestablished, especially with traumas that are prolonged or repetitive in nature (Wilson, 2004). Rather than return to homeostasis the mind–body undergoes persistent dysfunction, often continuing to operate as if the trauma were perpetual and ongoing in daily life (Wilson, 2004). The different forms that this enduring dysfunction can take constitute posttraumatic psychopathology.

12.1.1 Indistinct concepts and terminology

A major problem pervades the field of psychological trauma: the inherently indistinct lines between the most fundamental concepts, including pathological versus nonpathological, adaptive versus maladaptive, normal versus impaired function, and clinically significant versus not clinically significant changes (Marshall *et al*., 1998; Wakefield and Horwitz, 2010; Joseph, 2011). Questions persist as to whether firm lines exist to distinguish these basic concepts or if they each comprise a dimensional continuum.

12.1.2 What is psychological trauma?

In both scientific and everyday usage, psychological trauma has had two meanings. It is used to refer to the stressful stimulus or event, such as 'the dog was *exposed to* trauma', or to the *response to* the stressful stimulus or event, such as 'the dog *experienced* psychological trauma'. This double meaning conflates the injury with the incident. When an event is deemed 'traumatic', the assumption is that the event, by definition, results in injury (Gist and Devilly, 2010). However, the well-established fact that multiple individuals exposed to the same aversive stimulus or event will experience a diverse

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array of psychological outcomes including no long-term effects (Ruscio *et al*., 2002) demonstrates that trauma is not the event, but rather the response of individuals to that event. In this context it is important to stipulate that the aversive, stressful events are *potentially* traumatic and that trauma is what occurs within an individual during and after exposure to the event (O'Donnell *et al*., 2010). In this chapter the term 'potentially traumatic event' (PTE) will be used to maintain clarity that the event itself is not traumatic and the reactions of those exposed may for some individuals never reach a pathologic level of intensity or duration (Gist and Devilly, 2010), and 'trauma' will be used to denote the response and not the stressor.

12.1.3 Psychological trauma: considerations when comparing humans and animals

A large body of research has demonstrated that despite the influence of higher cognitive functions in humans, basic emotional processes are shared by humans and other mammals (Panksepp, 1998). Strong evidence also indicates commonalities across species in psychopathological processes. Brain structures and neuroendocrine mechanisms implicated in mood and anxiety disorders are shared across a wide range of vertebrates and vulnerability, risk, and protective factors for stress- and trauma-related psychopathology also appear to operate similarly among higher animals (Panksepp, 1998). Nevertheless, despite the shared brain structures and emotional processes, a number of factors must be taken into consideration when comparing psychopathology in humans and animals.

Language and cognitive barriers

Among the most formidable challenges in our attempts to understand psychological processes in nonhuman species are the limitations in the animals' capacities for introspection of their subjective experiences and the language barrier that impairs their ability to convey the content of their thought processes (and/or our ability to interpret their communications). These barriers greatly hinder our ability to acquire two types of information highly relevant to the assessment of psychological trauma in any species: historical information and information about one's subjective experiences. From a comparative perspective, the same challenge occurs in very young children, where research has shown that because of limited capabilities for verbal expression, assessment criteria need to be more behaviorally anchored (Scheeringa, 2016).

Historical information

The histories of companion animals are almost always incomplete, since unless the current caregiver raised the animal from birth, the experiences that that animal was exposed to or deprived of may be omitted from the animal's records or unknown altogether. This is true not just for the obvious cases of stray and shelter animals, but also for animals purchased as pets from reputable sources, since some stressful event may have occurred prior to the purchase, including the first eight weeks of life. Moreover, due to the abundant research on the effects of maternal stress on the prenatal neuroendocrine development of mammalian fetuses (Braastad, 1998), an accurate history of adversity needs to also include maternal experiences throughout pregnancy.

The deficiencies in historical information create two major diagnostic problems. First, as will be discussed in more detail later, inadequate socialization[1] in early life may produce behaviors – predominantly fear-based – that often closely resemble those resulting from psychological trauma. Second, the diagnoses of certain trauma- and stressor-related disorders are contingent on historical information before and after a stressful event to distinguish pre-existing conditions from effects. Specifications in the diagnostic criteria, in particular 'not present before trauma' or 'beginning after the traumatic event(s) occurred' (American Psychiatric Association, 2013), cannot be met when the individual's history prior to such an event is unknown. Child psychology research has shown that there is no feasible way to obtain information about traumatic events from the victims themselves if the children are too young to verbalize experiences (Scheeringa, 2016).

Information about subjective experiences

The current 'gold standard' for the diagnosis of posttraumatic disorders in humans is the diagnostic criteria set forth in the fifth edition of the DSM (American Psychiatric Association, 2013), which rely heavily on patients' subjective reports of their experiences and internal states (Pitman *et al*., 2012;

Merians *et al*., 2023). Clearly, the subjective experiences of some symptoms such as recurrent, involuntary, and intrusive distressing memories of the traumatic event(s); dissociative flashbacks; nightmares; and an inability to remember important aspects of the traumatic event(s) cannot be confirmed (or modeled) in animals and may only be inferred from nonverbal behavioral and other measures (e.g., physiological measurements, brain imaging) (Foa *et al*., 1992; Whitaker *et al*., 2014; Richter-Levin *et al*., 2018). This, as for incomplete histories, is not exclusive to animals, for although inaccessibility to subjective states applies to *all* animals it also applies to some humans, such as infants, some mentally disabled individuals, and persons with dementia (Ferdowsian *et al*., 2011).

12.2 Adaptive Fear Responses

The emotion of fear – consisting of physiological, perceptual, and psychological elements – elicits adaptive behavioral responses when real or perceived threats endanger the life or well-being of the individual (Rosen and Schulkin, 1998). Behavioral responses are traditionally grouped into three categories: flight, fight, or freeze (Wiedenmayer, 2004). Lang (1977) has described the concept of a fear structure, which is conceived of as a neural program for escape or avoidance behavior containing information about the feared stimulus, the behavioral responses, and the appraised meanings of both stimulus and responses. Activation of a fear structure occurs when the animal perceives environmental cues that correspond to information represented in the structure, which coordinates and monopolizes brain resources for the purpose of enhancing the animal's ability to defend against a challenge (LeDoux, 2012). When a fear structure accurately represents threats in the world it serves as a blueprint for effective action, which, in conjunction with its motivational function, results in the production of self-protective behavior (Rosen and Schulkin, 1998; Cahill and Foa, 2007; LeDoux, 2012).

Fears are either innate (hard-wired) or learned. Most relevant to the phenomenon of psychological trauma is the latter, for, as we will see, trauma commonly (though not always) occurs as a result of a fearful experience and then manifests as a fear or anxiety disorder. Evidence indicates that the evolutionary development of fear learning mechanisms was guided by the fact that the likelihood of injury or death is strongly linked to the speed, strength, and duration of learned fears. In situations where the animal perceives a high risk of injury, subsequent exposure to this stimulus or situation could have fatal consequences and therefore fast-learning mechanisms that can immediately alter behavioral responses, as occurs in one-trial learning, are of high fitness priority (Wiedenmayer, 2004). In a review of research on the formation of learned fears in animals, Wiedenmayer (2004) presented findings from studies with rats demonstrating that a single aversive experience may alter synaptic transmission in components of the fear pathway such as the amygdala, hippocampus, and periaqueductal gray and profoundly affect an animal's behavioral, psychological, and physiological responsivity. Such neural alterations may persist for extended periods of time and appear to underlie long-term behavioral changes after the threat (Winters *et al*., 2021).

The vast majority of current animal models of PTSD integrate fear conditioning in some way to study the neural basis of fear learning and, more recently, the memory-related aspects of PTSD-like symptoms (Siegmund and Wotjak, 2006; Bienvenu *et al*., 2021). In this particular form of classical conditioning, a biologically neutral stimulus (conditioned stimulus, CS) acquires threat status when it occurs in association with a biologically significant threat (unconditioned stimulus, US) (LeDoux, 2012).

Crucial for the understanding of psychological trauma is that the learning involved with an aversive experience involves two processes: generalization and sensitization. In fear conditioning neural connections form to associate with the US not only the CS, but also the contextual cues of the environment (Wiedenmayer, 2004). The process of generalization accounts for how traumatic reactions can broaden to involve not only stimuli clearly related to the traumatic event (trauma-related cues, TRCs), but also to stimuli seemingly unrelated (Monson *et al*., 2007). Sensitization, on the other hand, is a nonassociative form of learning that refers to an increased responsivity after an aversive event to the TRCs and in some cases to other, even harmless, stimuli (Wiedenmayer, 2004). Through sensitization, the animal becomes more reactive each time a nonthreatening stimulus is encountered, which can result in problematic responses such as hyperexcitability and exaggerated fear responses (Mills, 2009). Both generalization and sensitization appear to contribute to the emotional disturbances in posttraumatic distress (Parsons and Ressler, 2013).

For situations and stimuli that continue to pose a potential risk for an individual, retention of fear memories and responses is adaptive. However, when the risk subsides it is biologically costly to retain highly reactive fear responses for nonthreats, and, in such situations, memory-modulating mechanisms – e.g., fear extinction, habituation, de-sensitization, or forgetting – serve to restrict the duration of memory storage and ensure that only relevant features are retained (Wiedenmayer, 2004). Memory-modulating mechanisms may allow animals to gradually trade off threat-related behaviors with other activities more relevant to current needs. The phenomenology and neurocircuitry of fear conditioning and extinction are highly conserved among humans and many other animal species (Bonne *et al*., 2004; LeDoux, 2012; VanElzakker *et al*., 2014).

12.3 Posttraumatic Psychopathology in Humans and Animals

The changed behavior elicited by normal fear responses is of clear survival value in protecting animals from danger. However, fear mechanisms, like any other biological process, are vulnerable to dysfunction. When this occurs, adaptive, nonpathological responses cross over to become maladaptive and pathological. What is not at all clear is at what 'level' this occurs, that is, where any line might exist that distinguishes pathologic behavior from adaptive, high levels of fear (Marshall *et al*., 1998; Wakefield and Horwitz, 2010). In addition, many gaps remain in our understanding of how traumatic events produce the changes constituting longer-lasting and pathologic sequelae, including reduced thresholds for activation and hyperexcitability in fear circuits and disruption of memory-modulating mechanisms regulating the balance between learning and forgetting, resulting in an emotional event being stored for an excessive period of time (Rosen and Schulkin, 1998; Wiedenmayer, 2004). The work in this area will be presented in the discussion of the pathophysiology of PTSD (see section on Neurobiology and pathophysiology of PTSD).

Acknowledging the indeterminacy of any line separating normal from pathological fear, Foa and Kozak (1986) have proposed criteria for such a distinction. They suggested that a fear structure is pathological or maladaptive when the following characteristics are present: (i) associations among stimulus elements are inaccurate or unrealistic; (ii) harmless stimulus and response elements are erroneously associated with threat meaning; (iii) physiological and escape/avoidance responses are evoked by harmless stimuli; and (iv) excessive and easily triggered response elements interfere with normal, adaptive behavior.

Transitioning from a discussion on pathological fear to posttraumatic psychopathology in general requires a brief explanation. Historically, a large proportion of pathophysiology research on psychological trauma, and in particular PTSD, has focused on fear mechanisms, and hence there is much overlap between fear research and PTSD research. However, as Friedman *et al*. (2007) have noted, since other emotions, such as sadness, grief, anger, guilt, shame, and disgust, are also associated with PTSD, it would be inappropriate to conceptualize this disorder entirely within the context of fear-based appraisals and reactions. Reflecting the emphasis of the trauma literature on fear, the discussions of psychological trauma in this chapter will be predominantly about this particular emotion. Throughout, however, it bears keeping in mind that while pathological fear constitutes much of posttraumatic psychopathology, the two phenomena are not equivalents.

The challenge of identifying lines between adaptive and pathologic fear can be broadened to psychopathology in general. As is the case for fear specifically, while a definitive line dividing nonpathological and pathological may not be possible for mental disorders as a whole, there is little debate that at some point nonpathological crosses over to pathological. The DSM-5 (American Psychiatric Association, 2013) approaches this by defining mental disorder as:

> a syndrome characterized by *clinically significant* disturbance in an individual's cognition, emotion regulation, or behavior that reflects a *dysfunction* in the psychological, biological, or developmental processes underlying mental functioning. Mental disorders are usually associated with *significant* distress or disability in social, occupational, or other important activities. (Italics added to identify terms with potential ambiguity) (p. 20)

The formal recognition of PTSD (defined in the next section) in 1980 was accompanied by the recognition that PTSD fell short of capturing the full range of posttraumatic responses and psychological injuries, which vary in both *type* and *severity*.

Epidemiological studies have shown that PTSD symptoms are not the only, indeed not even the most likely, *type* of posttraumatic reactions; other types include specific phobia, generalized anxiety disorder (GAD), and mood disorders (O'Donnell *et al*., 2004; Rosen *et al*., 2010; Levin-Aspenson and Greene, 2024). It is now accepted that the reactions to overwhelming psychological stressors are best understood as a spectrum of conditions rather than as a single disorder (Herman, 1997; Briere and Spinazzola, 2005; Bryant, 2010), and in this chapter 'spectrum' will refer to this array of different types of posttraumatic pathologic responses.

12.3.1 Posttraumatic stress and posttraumatic stress disorder

In addition to the diagnosis of PTSD referring to just one *type* of response to trauma, it also represents only one *level of severity*, namely, very severe. This de-emphasizes if not ignores the less severe forms of this particular type of posttraumatic response (Norris and Slone, 2007). On this issue of severity, a major point of debate is whether PTSD is a dimensional condition differing only quantitatively from milder and normal reactions to stressful events or whether it is a discrete syndrome qualitatively different from less severe and normative stress reactions (Ruscio *et al*., 2002). It is known that not everyone exposed to a PTE will develop the full complement of symptoms of PTSD, but most people will develop some emotional distress following the adversity (Joseph, 2011). To address this question, Ruscio *et al*. (2002) conducted multiple taxometric procedures in a large sample of male combat veterans to determine the latent structure of PTSD. They found that PTSD was best characterized as a dimensional disorder rather than a categorical structure that views PTSD as a qualitatively distinct clinical syndrome subject to a dichotomous diagnostic breakdown of 'PTSD' and 'no PTSD' (Ruscio *et al*., 2002).

This dimensional view suggests that posttraumatic distress symptoms are distributed along a mild-to-severe continuum and individuals who meet current PTSD diagnostic criteria generally represent those affected most severely (Briere and Spinazzola, 2005; Friedman *et al*., 2007). This implies there to be no distinct line that would qualitatively separate these individuals from those exhibiting less severe signs (see Fig. 12.1). It has been proposed that this continuum be referred to by the term posttraumatic stress (PTS, and will be used in this chapter), and that once PTS reaches a certain level of intensity (as measured by number of specified symptoms) the individual experiencing it is said to have PTSD (Joseph, 2011). This chapter will endorse the dimensional interpretation of PTS and PTSD, and will use the term PTSD when referring to research that has used a categorical view. In addition, 'continuum' will refer to the gradations of severity of PTS responses as depicted in Fig. 12.1.

New terminology to describe the forms of PTS exhibited by victims who experience substantial psychological impairment and distress but fall below the diagnostic threshold of PTSD is not consistent among researchers; the terms include *subthreshold*, *subsyndromal*, and *partial* PTSD (Bergman *et al*., 2017; Klein *et al*., 2024). In a recent review, Bergman *et al*. (2017) found that the majority of articles used the term *subthreshold PTSD*, which will be used in this chapter. As the term implies, subthreshold PTSD denotes a condition consisting of the presence of some symptoms of PTSD, but the number and intensity of the symptoms fail to reach the diagnostic threshold for the

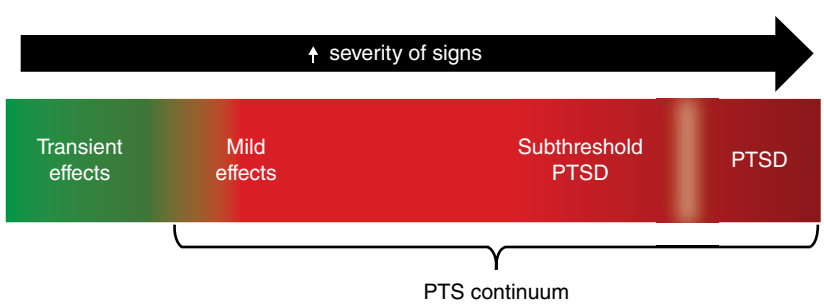


Fig. 12.1. Dimensional view of posttraumatic stress. PTS, posttraumatic stress; PTSD, posttraumatic stress disorder. (Adapted from Herman, 1997; Briere and Spinazzola, 2005; Joseph, 2011.)

disorder as described in the DSM (Ruscio *et al*., 2002; Cukor *et al*., 2010). In contrast to subthreshold forms of PTS, the condition in which all the diagnostic criteria have been met is referred to most commonly as simply PTSD, but has also been termed *full* PTSD and *full-threshold* PTSD (Friedman *et al*., 2007; American Psychiatric Association, 2013; Klein *et al*., 2024), as well as *full-blown* PTSD (Bergman *et al*., 2017). Other methods of describing the PTS continuum have been used, such as the notion that subthreshold PTSD be considered an 'intermediate phenotype' of the disorder, and individuals would be 'affected, intermediate, and non-affected' (Richter-Levin *et al*., 2018).

The validity and clinical relevance of subthreshold PTSD have been questioned since it was first used with the Vietnam veteran population (Cukor *et al*., 2010), but lending credence to the concept is the clinically significant difference between those with PTSD, subthreshold PTSD, and no symptoms (Cukor *et al*., 2010). By multiple measures – functional impairment, severity of symptoms, wanting or needing treatment, healthcare utilization, distress, psychological well-being, psychological impairment, and quality of life – subthreshold PTSD falls between full PTSD and having no disorder (Norris and Slone, 2007; Cukor *et al*., 2010; Brancu *et al*., 2016; Bergman *et al*., 2017; Klein *et al*., 2024).

Subthreshold PTSD consists of different conditions and courses. Subthreshold PTSD groups may include individuals with PTSD who have partially remitted to subthreshold status, vulnerable patients whose symptoms will develop into late onset full PTSD, and individuals who will remain at chronic, subthreshold levels (Cukor *et al*., 2010; Brancu *et al*., 2016; Bergman *et al*., 2017).

Studies investigating the prevalence of subthreshold PTSD have been hampered by the variability of diagnostic criteria among researchers, but it is clear that subthreshold PTSD is prevalent among PTE-exposed individuals (Cukor *et al*., 2010; Brancu *et al*., 2016). Norris and Slone (2007) summarized the epidemiology of PTSD by noting that at any one point of time there are at least one to two times as many individuals in the current population with severe subthreshold PTSD as those with full PTSD. The recognition of the concept of subthreshold PTSD has engendered ongoing debate among human mental health professionals, as the concern about the possibility that creating a subthreshold diagnosis may pathologize normal responses to extreme adversity must be continually weighed against the possibility of ignoring the needs of a crucial subpopulation of individuals who experience significant psychopathology and functional impairment (Cukor *et al*., 2010; Bergman *et al*., 2015; Klein *et al*., 2024).

Posttraumatic stress disorder is one of the most severe outcomes of exposure to a severely aversive event. At present, PTSD is not a well-defined disorder. The definition and diagnosis of PTSD in humans is based on behavioral symptoms and self-reports, without any objective parameters (Richter-Levin *et al*., 2018). PTSD is not defined by or comprised of the immediate responses to trauma exposure; it is rather a disorder of the more chronic, lingering symptoms.

The clinical diagnosis of PTSD is made only if an individual exhibits a certain number of symptoms from each of four well-defined symptom clusters for a certain period of time. As specified in the DSM-5 (American Psychiatric Association, 2013), in addition to the history of exposure to actual or threatened death, serious injury, or sexual violence, the four symptom clusters that distinguish PTSD from other posttraumatic psychological disturbances are unwanted *intrusions* of memories of the traumatic event, often in the form of dissociation, flashbacks, and nightmares; *avoidance* of anything reminiscent of the traumatic event; *negative alterations in cognition and mood*; and alterations in arousal and reactivity, including *hyperarousal* symptoms such as hypervigilance and increased startle response. Additional diagnostic elements include: the components within these symptom clusters must begin or worsen after the traumatic event(s) occurred, the duration of symptoms is greater than one month, and the disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning. On the basis of several decades of research demonstrating that children and adolescents can develop PTSD (e.g., Scheeringa *et al*., 2003), DSM-5 has introduced a set of diagnostic criteria for children 6 years of age and younger, which require fewer and slightly recategorized symptoms than are set forth for humans over 6 years of age. Generally speaking, the diagnosis of PTSD is used in children and adolescents when intrusive memories, avoidance, and arousal symptoms are serious, continue, and interfere with daily functioning (Fairbank *et al*., 2007). Table 12.1 summarizes the criteria for children 6 years of age

Table 12.1. Summary view of the DSM-5 diagnostic criteria for posttraumatic stress disorder in children 6 years of age and younger (American Psychiatric Association, 2013).

Criterion	Specified criteria for children 6 years of age and younger
A	The child has been exposed to an event involving real or threatened death, serious injury, or sexual violence in at least one of the following ways: **1.** Directly experienced the event. **2.** Personally witnessed another person, especially a primary caregiver, experience the event (not including events appearing on television, in movies, or other images). **3.** Learned that a primary caregiver experienced the event.
B	The child has at least one of the following intrusive symptoms that are associated with the event and first appeared after the event occurred: **1.** Spontaneous, recurring, involuntary, and intrusive memories of the event which cause distress (but may not appear distressing to observers and may be expressed in forms of play). **2.** Event-related dreams that are recurring and distressing (however, clearly associating the fearful dream with the traumatic event may not be possible). **3.** Episodes in which the child feels and/or acts as if the event were happening again, which may be through flashbacks or other dissociative reactions (this may occur in the context of play reenactment). **4.** Intense and enduring emotional distress when encountering internal or external reminders of the event. **5.** Pronounced physiological reactions when encountering internal or external reminders of the event.
C	The child has at least one of the following six event-related symptoms involving either persistent avoidance or disturbing cognitions and mood, first appearing or worsening after the event: **Persistent Avoidance of Stimuli** **1.** Actual or attempted avoidance of places, activities, or other physical reminders of the traumatic event. **2.** Actual or attempted avoidance of people, conversations, or interpersonal situations that elicit memories of the event. **Negative Alterations in Cognitions** **3.** More frequent experiences of negative emotions, such as fear, anxiety, sadness, or guilt. **4.** Substantially diminished desire to participate in activities or endeavors that prior to the traumatic event were meaningful to the child. **5.** Withdrawal from social activities and interactions. **6.** Diminished expression of positive emotions, such as joy.
D	The child experiences at least two of the following event-related changes in arousal levels and reactivity to stimuli, first appearing or worsening after the event: **1.** Irritable, angry, or aggressive behavior toward other individuals or inanimate objects, which may include extreme temper tantrums. **2.** Hypervigilance. **3.** Exaggerated startle response. **4.** Having difficulties maintaining concentration or focus. **5.** Disturbances of sleep, such as restless sleep or problems falling or staying asleep.
E	Symptoms must be present for at least one month.
F	Symptoms must have resulted in clinically significant distress or disturbances in social relationships or school-related behavior.
G	Symptoms are not accounted for by another medical condition or by the use of substances such as drugs or alcohol.

or less and is given the most attention in this chapter because of the similar challenges in animals and very young humans regarding documenting adult symptoms, such as the problem of obtaining reliable verbal self-reports.

Interindividual variability of PTSD symptom profiles is characteristic for the disorder in humans (Wilson, 2004). For example, in some individuals, avoidance reactions may predominate, while others may experience mostly hyperarousal and reactivity. Any one symptom prominent in one individual may be minor or even absent in another.

The course of posttraumatic distress has been well characterized in humans. For the large majority of the population, the distress after exposure to a PTE is limited to an acute, transient disturbance followed by complete recovery as neurobiological effects extinguish over time (Marshall *et al.*, 1998;

Rosen *et al*., 2010; Sherin and Nemeroff, 2011). However, a substantial minority of traumatized individuals do not fully recover but go on to develop clinical problems that create ongoing distress of varying severity. Studies in human populations exposed to a PTE have been relatively consistent in showing that the incidence of PTSD falls between 15% and 35% for most types of trauma, including sexual assault, military combat, natural disaster, motor vehicle accident, captivity, or witnessing the death or serious injury of another individual (Santiago *et al*., 2013; VanElzakker *et al*., 2014). Thus, there are two trajectories following traumatic stress: normal transient distress (i.e., resilience; successful coping response) or chronic clinical morbidity/distress (unsuccessful or partially successful coping response). This does not mean that the transiently affected individuals are free of long-term effects, as memories of the event are likely to remain, but these memories do not significantly impair the individual's functioning and ability to enjoy life.

Neurobiology and pathophysiology of PTSD

The neurobiological mechanisms underlying PTSD are incompletely understood and have been recently reviewed (Southwick *et al*., 2007; Sherin and Nemeroff, 2011; Shalev *et al*., 2017). The following is a brief overview of some of the disorder's key dysfunctional elements currently known or hypothesized.

Shalev *et al*. (2017) have suggested that four brain functions play a prominent role in the psychopathology of PTSD: threat detection, contextual processing, fear learning, and emotion regulation and executive function. It is well accepted that, broadly conceived, the primary dysfunction in the disorder involves fear mechanisms; fear conditioning as well as fear sensitization and generalization processes contribute to both the development and maintenance of the disorder (Thoeringer and Wotjak, 2013; VanElzakker *et al*., 2014).

Classical fear conditioning has been a leading paradigm for research on the neural processes of PTSD. Fear conditioning is a normal learning process critical for animal survival, and its use in modeling PTSD is based on the assumption that the underlying neurobiology of PTSD is similar in principle to that of classical fear conditioning, only more intense (Richter-Levin *et al*., 2018). However, until this assumption is confirmed, it remains possible that PTSD is a result of the failure of the normal fear responses following exposure to a severe stressor, resulting in the development of an alternative, pathological process (Richter-Levin *et al*., 2018). Accordingly, Richter-Levin *et al*. (2018) have stressed the importance of efforts to differentiate the mechanisms underlying adaptive fear memory formation from those that contribute to the development of pathology.

Evidence indicates that disturbances in PTSD occur in several interacting brain regions involved in the regulation and integration of stress and fear responses, including the amygdala, hippocampus, anterior cingulate cortex, and prefrontal cortical regions (Heim and Nemeroff, 2009; Shalev *et al*., 2017). The pathophysiology of PTSD involves both sustained hyperactivity of the sympathetic branch of the autonomic nervous system (ANS) and dysregulation and sensitization of the hypothalamic–pituitary–adrenocortical (HPA) axis (Friedman *et al*., 2007; Heim and Nemeroff, 2009). The dysfunction in this system may be associated with changes in perception, memory, motivation, personality, cognitive processing, and interpersonal relations (Wilson, 2004).

A major conceptualization of PTSD highlights the role of the amygdala in processing threatening or fearful stimuli. The amygdala in PTSD becomes hyperresponsive to stimuli (trauma-related as well as non-trauma-related) and this excessive activation is accompanied by an abnormally low response in the brain regions, such as the medial prefrontal cortex, that exert inhibitory control on amygdalar activity (Yehuda and LeDoux, 2007; VanElzakker *et al*., 2014). These changes are supported by neuroimaging studies in human patients with PTSD, which demonstrate that structures involved in fear expression over-activate, while structures involved in fear inhibition under-activate or deactivate (VanElzakker *et al*., 2014). For most individuals, extinction learning causes fear responses to trauma-related stimuli to diminish over time, such that repeated exposure to TRCs in the absence of threat forms a new and less excitatory association that competes with the original fear memory (Quirk, 2002). In individuals with PTSD, however, the extinction deficit associated with the inhibition failure of the amygdala permits conditioned fears, and the symptoms they elicit, to persist for months or years beyond the point that they would normally be extinguished (VanElzakker *et al*., 2014; Colucci *et al*., 2020; Ressler *et al*., 2022).

These two effects on fear – enhanced acquisition and impaired extinction – together result in a lowering of the threshold for fearful reactivity and prolongation of fear memories. In addition to this, PTSD is associated with an increased propensity for fear generalization (VanElzakker *et al*., 2014), which diminishes the individual's capability to distinguish between safe and unsafe stimuli (Bonne *et al*., 2004; Sherin and Nemeroff, 2011). The threatening context thereby expands to the extent that perceived danger becomes both imminent and unpredictable and almost every place is believed to be unsafe. Ultimately there is an overall loss of one's sense of security – 'the world is completely dangerous' (Bonne *et al*., 2004; Cahill and Foa, 2007; Hembree and Foa, 2010; American Psychiatric Association, 2013).

The combined effect of these neurophysiological changes is an emotional appraisal process that is biased toward the perception of threat rather than safety, producing a response bias of over- rather than underreaction (Friedman, 2001). Rather than a normal level of alertness with relaxed attention, individuals with PTSD have an elevated baseline of arousal: the individual continues to function in a 'red alert' status of readiness – hypervigilant, hyperreactive, and primed for another stressful event (Wilson *et al*., 2001a; Wilson, 2004). Patients display an exaggerated startle response to unexpected stimuli ('jumpiness') and a pronounced reaction to TRCs, are often irritable, and they experience difficulties in sleep and concentration (Bonne *et al*., 2004; Wilson, 2004; Segman *et al*., 2007; American Psychiatric Association, 2013).

Posttraumatic stress disorder in animals

ANIMAL — EXPERIMENTAL Several decades of extensive effort have been put forth to develop an animal model of PTSD. The specific emotional state that is the primary focus of investigation for many of these proposed models is conditioned fear (Siegmund and Wotjak, 2007; Bienvenu *et al*., 2021) and these studies overlap with, and use the same stressors (e.g., restraint stress, exposure to predators, being held underwater, and foot- and tail-shocks) as are used in studies on fear conditioning (Siegmund and Wotjak, 2006; Southwick *et al*., 2007). Most animal models of PTSD are based on exposure to stressors that the victim cannot control, that are unpredictable, or are both (Mallonée, 2004; Dunsmoor *et al*., 2022). There is substantial agreement that in many of the animal models the physiological and behavioral disturbances following experimental psychological trauma often match the most prominent and cardinal features of PTSD in humans (Foa *et al*., 1992; Mallonée, 2004; Southwick *et al*., 2007). Specific psychobehavioral signs produced in these models include trauma-associated contextual fear, increased anxiety-like behaviors, exaggerated startle responses, hyperarousal, avoidance behavior, cognitive impairment, and reduced social interaction (Thoeringer and Wotjak, 2013).

Some of the models include re-exposure to TRCs at a later time, which appears to replicate the events in PTSD in which the person's functional impairments and distress persist as a result of periodical encounters with reminders of the trauma (e.g., a car backfiring, which resembles the sound of gunfire during military combat). For example, in one study with rats (Louvart *et al*., 2005) an intense and prolonged footshock was followed by three weekly reminders of the event using stimuli present during the event (excluding the electric shock UC). The rats demonstrated several long-term alterations: increased anxiety behavior, reduced time spent in an 'aversive-like' context, altered social behavior, and a blunted corticosterone response to stress. Similarly, recent studies with cows have shown that a simulated wolf encounter in wolf-experienced, but not in wolf-naïve, cows elicited behavioral and physiological changes (Cooke *et al*., 2013), as well as selected brain-blood biomarkers (brain-derived neurotrophic factor and c-Fos proto-oncogene mRNA regulation; Cooke *et al*., 2017) comparable with changes documented in humans and rodent models with stress- and fear-related psychological disorders, including PTSD symptoms (Sherin and Nemeroff, 2011). These findings suggest that exposure to wolves in cows leads to the formulation of fear memories that may be elicited at a later time upon re-encountering the earlier fear-inducing stimulus.

As mentioned above, approximately 15–35% of humans exposed to a severe stressor will develop PTSD. Similar information about the course of psychological trauma in animals living natural lives (i.e., outside the laboratory setting) is lacking. However, in a series of laboratory studies, Cohen *et al*. (2006) investigated the prevalence rates of rats displaying an extreme magnitude of behavioral response to a predator stress paradigm. They reported that after exposure to the stressor almost

all animals responded 'extremely', but over the next 30 days the incidence of individuals showing extreme behavioral responses dropped to an unvarying 25%, closely conforming to the human data.

Overall, in terms of posttraumatic physiological and behavioral alterations, experimental studies in clinical populations of many human survivors with PTSD are consistent with animal studies (Anda *et al*., 2006). However, there is, to date, no single accepted animal model of PTSD; each model has its pros and cons (Whitaker *et al*., 2014; Richter-Levin *et al*., 2018; Dunsmoor *et al*., 2022); the validity and limitations of existing animal models of PTSD have been recently reviewed (Schöner *et al*., 2017; Cabib *et al*., 2019; Bienvenu *et al*., 2021; Dunsmoor *et al*., 2022). Importantly, while animal models have produced neuroendocrine alterations and phenomenology that closely resemble specific aspects of PTSD, none has replicated the human condition in its entirety (Whitaker *et al*., 2014; Colucci *et al*., 2020; Verbitsky *et al*., 2020; Dunsmoor *et al*., 2022; Gasparyan *et al*., 2022). This is not surprising, since, as mentioned earlier, many subjective features of PTSD cannot be confirmed with certainty in animals.

ANIMAL — CLINICAL The study of posttraumatic psychopathology in animals has been almost exclusively in the laboratory setting. There have, however, been a small number of cases of PTSD in a clinical context reported in peer-reviewed and non-reviewed publications. Reports of PTSD in the domestic dog will be the topic of the section following this one.

- Traumatic stress disorder was reported in an adult female wolf (*Canis lupus*) born in the wild then placed into captivity (Mallonée, 2004). The writer suggested that the wolf's method of capture, which involved being darted twice by helicopter and translocated twice, exposed her to the factors that are important in the etiology of PTSD in humans. The report described how the wolf displayed symptoms similar to those of humans with PTSD and included generalized fear, avoidance, hypervigilance, arousal, exaggerated startle reactions, and 'looking up' behavior.
- Wild elephants showed signs that Bradshaw *et al*. (2005) interpreted as resembling PTSD symptoms and meeting the diagnostic criteria for PTSD, such as abnormal startle response, depression, unpredictable asocial behavior, and hyperaggression.
- Bradshaw *et al*. (2008) reported PTSD in two sanctuary-housed female chimpanzees who had previously sustained prolonged captivity and biomedical experimentation. The animals exhibited a wide array of signs, including intense screaming, self-injurious behavior (SIB), stereotypic rocking, trance-like states, sudden and unpredictable aggression, emotional instability, self-isolation, and hitting oneself continually in the head.
- Ferdowsian *et al*. (2011) reviewed case reports (20 cases in 12 published papers) of sanctuary-housed chimpanzees who were reported to have been subjected to traumatic events, such as maternal separation, social isolation, experimentation, or other similar experiences. Using criteria for PTSD similar to those developed by Scheeringa *et al*. (1995) as alternative criteria for nonverbal human infants and children, the authors found that 44% of chimpanzees in sanctuaries fulfilled the diagnostic criteria for PTSD, compared with 0.5% of chimpanzees in the wild.
- Lopresti-Goodman *et al*. (2015) studied 253 chimpanzees formerly used in biomedical research and currently residing at an accredited chimpanzee sanctuary. Based on caregiver reports, 60 (24%) of the animals exhibited at least one symptom of psychological distress, including irritability, social withdrawal, fear of going outside, rocking back and forth while self-clasping, eating and/or smearing of feces, affect dysregulation, anhedonia, dissociative episodes, and SIB. In addition, the authors presented a detailed case study of one chimpanzee who engaged in SIB and met DSM-5 criteria for PTSD.

Without using the term posttraumatic stress, Loeffler *et al*. (2009) reported on impaired psychological health following prolonged severe stress in bears. The practice of farming bears for bile extraction is legal in China, where bear bile is used in traditional Chinese medicine (despite the fact that it is unnecessary, as more than 50 alternative herbal products with equal or greater medicinal efficacy exist; Liu, 2004). The Asiatic black bear (*Ursus thibetanus*) comprises most of the estimated 10,000 to 12,000 bears used in these farming operations; some are born in captivity and some are captured from the wild as adults. The bears are confined for their entire lives to very small cages that are only marginally bigger than the bears themselves during which they encounter the following stressors: extreme spatial restrictions, severe restriction of

species-typical behaviors, adverse substrate for sleeping and standing, deprivation of social needs, loss of the sense of control, extreme understimulation, and unpleasant interactions with humans (the bile extraction procedure is painful) (see Fig. 12.2a–d).

The study by Loeffler *et al.* (2009) assessed approximately 250 of the bears that had been rescued from bile farms and given refuge at the China Bear Rescue Center (CBRC) operated by the Animals Asia Foundation. On arrival at the CBRC,



Fig. 12.2. Bears used for 'bile farming' in Far Eastern countries are confined for prolonged periods in extremely restricted cages (a–d). If removed from the bile farm and placed in a sanctuary, they exhibit pronounced signs of psychological disturbances (e) (photos courtesy of Animals Asia).

95% of the bears exhibited signs of stereotypic behavior, which included head rolling, pacing, rocking, circling, and stepping from side-to-side or back and forth, and bobbing and weaving of the head and body (Fig. 12.2e). Some bears were unusually unresponsive and slept excessively. All but five of the bears demonstrated unusually aggressive behavior, agitation, or nervousness; some of these behaviors resulted in self-injury. Many of the behaviors, such as periodic pacing and head-swaying, persisted for years post-rescue despite intensive rehabilitation efforts.

Zanette and Clinchy (2020) reviewed studies conducted in free-living wild animals and stated that one study in wild-caught birds and one in mice in which persistence of predator-induced fear represented 'enduring effects on the brain and behavior meeting the criteria to be considered an animal model of PTSD'. However, no evaluation of the full complement of DSM-5 criteria for PTSD was presented, leaving it unclear as to whether what was observed were signs of PTS or of simply learned fear.

At the Australian Wildlife Rehabilitation Conference, Garlick and Austen (2014) reported on five kangaroos with a history of exposure to a major stressor at a young age and demonstrating chronic signs deemed to be consistent with symptoms of human PTSD. All of the joeys had been separated from or lost their mother to illness or other death; findings at the time of rescue included severe malnourishment and fractured bones and extensive wounds due to harassment and attacks by dogs and foxes. The in-care behavior observed included social withdrawal, refusing food, erratic and agitated behavior, destructiveness including SIB, and aggression toward other kangaroos.

PTSD IN THE DOMESTIC DOG Most recently, a population of dogs has arisen that has, from a clinical standpoint, provided the most complete knowledge of the animals' psychological make-up pre- and post-exposure to extreme stress, and that is military working dogs (MWDs) after exposure to combat and violent events in Iraq and Afghanistan. MWDs offer a unique opportunity to study post-traumatic disorders clinically because their histories are well known, allowing researchers to eliminate alternative explanations for post-trauma signs and symptoms and thereby definitively meet the DSM-5 requirement of 'beginning after the traumatic event(s) occurred' for PTSD Criteria B through E (American Psychiatric Association, 2013). This is in contrast to studies of other populations of dogs with suspected psychological trauma – e.g., hoarded dogs (McMillan *et al*., 2016) and abused dogs (McMillan *et al*., 2015) – for which incomplete histories did not allow potential effects of trauma to be distinguished from other antecedent factors such as inadequate early socialization.

Burghardt (2013) reported findings in 14 MWDs showing extreme psychological changes after exposure to combat in war zones. Clinical signs included hypervigilance and hyperresponsivity to environmental events, behaviors aimed at escaping or avoiding previously positive or neutral environments, failure in the performance of previously mastered critical tasks, and changes in social interaction with their human handler. A breakdown by breed found that Labrador Retrievers made up 50% of the case series but only 15% of the MWD population. By task, dogs trained to locate improvised explosive devices made up 60% of the cases but only 20% of the MWD population. Based on an estimate of the number of dogs deployed and at risk, the author estimated an incidence for this disorder of approximately 5% among deployed MWDs.

Little is known about the history of PTS in any nonhuman species, but it is interesting to note that a movie entitled *Courage of Lassie* depicted with considerable accuracy a case of canine PTS resulting from exposure to military combat (Fig. 12.3). Most intriguing is that the movie was released in 1946 – 34 years before the diagnosis of PTSD was formally recognized as a mental disorder in humans, and a full 67 years before the canine form of PTSD appeared in the scientific literature.

Other reports have described conditions resembling PTSD in the domestic dog. Yamamoto (2003) reported a 'post-traumatic stress-like syndrome (PTSD)' in a study that surveyed behavior in 155 dogs after a 2001 earthquake in western Japan. Abnormal behavior was reported in 82 (53%) of the dogs, which included trembling, howling, restlessness, scampering about, or wild excitement. Of the 82 dogs, 15 exhibited tremor, anorexia, intermittent howling, excitement, or repeated diarrhea, which persisted for a variable amount of time from days to one year. Several anecdotal reports describe signs characteristic of PTSD in canine and feline survivors of Hurricane Katrina (Anon, 2005; PBS, 2005; Anon, 2008). Signs reported in the animals were severe personality or temperament changes,



Fig. 12.3. In 1946 – decades before PTSD became an official diagnosis – the movie *Courage of Lassie* depicted a case of canine posttraumatic stress resulting from exposure to military combat. (AF archive/Alamy Stock Photo.)

new phobias, chronic chewing or paw licking, and depression (Anon, 2008); trembling, hypersalivation, pacing, aggressive behavior, loose stools, vomiting, lack of appetite, elimination in the house, and avoidance of people (Anon, 2005); and indelible fear of storms as well as nervousness, fear, or aggressive behavior in response to TRCs such as heavy winds, rain, or rushing water (PBS, 2005). Dodman (2012) described the psychological changes in a dog who was mistakenly shot by a police officer. From that day onward, the dog showed hypervigilance, extreme fear when encountering reminders of the event (such as police cars), nocturnal separation anxiety, and presumed nightmares – overall, '[meeting] all the translatable criteria of human PTSD'.

Salden *et al*. (2023) presented a systematic literature review regarding behavioral and physical changes in search-and-rescue (SAR) working dogs during or after their deployment response to five different disaster scenarios: the Oklahoma City bombing, 9/11 terrorist attacks, Haiti earthquake, Washington Oso landslide, and the Camp Fire wildfire. Minimal to no long-term behavioral changes were noted in the dogs. Importantly, a crucial difference exists between SAR dogs and MWD that may explain the discrepancy between psychological outcomes following their deployment. While disasters like the Oklahoma City bombing and 9/11 – with massive loss of life, suffering, and survivor trauma – are psychologically processed as traumatic for humans, there is no evidence to suggest that animals process such events the same way (though there is evidence suggesting that the emotional impact in dogs may be a reflection of their human handlers' emotional distress; Hunt *et al*., 2012; Sundman *et al*., 2019). Furthermore, even for humans, arriving *after* a PTE (which is the case for SAR dogs) is not the same as directly experiencing a PTE (which is the case for MWDs). Accordingly, terms such as 'trauma exposure' and 'being associated with traumatic events' must be used very carefully when discussing the psychological impact of events in animals.

DOES PTSD OCCUR IN ANIMALS? Can the severe form of PTS in animals be considered the same as the severe form, i.e., PTSD, in humans? Is it correct to say that animals experience 'human-type' PTSD? Some researchers have expressed confidence in the human PTSD being present in nonhumans, but other researchers are less convinced and are careful to describe symptoms with terms like 'analogous' or 'PTSD-like'. Siegmund and

Wotjak (2006) have pointed out that 'PTSD model' has recently become 'a somewhat fashionable term used in animal studies for almost every stress-induced behavioral alteration. Only a few cases, however, reflect the human disorder closely enough to deserve this term.'

In evaluating for the existence of PTSD in animals, similar limitations in communication (i.e., lack of verbal abilities and language barriers) between very young children and animals make applying the DSM-5 criteria for young children the most rational choice for nonhuman species (Ferdowsian *et al.*, 2011, 2012). One important caveat here is that in young children the trauma is always occurring during the developmental period, which may differ in important ways from trauma in mature animals. Hence, even if young children and animals both fulfill the DSM-5 criteria, the possibility that we may be talking about two different psychological disorders cannot be ruled out. The implications of this possibility for treatment would be substantial.

In addition to applying the child diagnostic criteria directly to animals, DSM criteria have been construed in ways to construct comparabilities between human and animal symptoms. For example, Foa *et al.* (1992) discuss an interpretive framework in which a conditioned fear response is a sign that the animal is reprocessing or re-experiencing the US, which would endorse symptom 3 of Criterion B: the child feels and/or acts as if the event were recurring. Similarly, Cabib *et al.* (2019) wrote that persistent freezing in response to conditioned stimuli is the behavioral phenotype frequently used in rodents to model the re-experiencing of traumatic memories by human PTSD patients. Others have taken a more specific, point-by-point comparison. For example, Richter-Levin *et al.* (2018) suggested that symptoms associated with the criterion of alterations in arousal levels and reactivity are straightforward to recognize in animals, and measurable by the many validated tests for irritability or aggression, hypervigilance, startle reaction, and sleep parameters. In addition, they wrote:

> intense or prolonged distress after exposure to traumatic reminders or marked physiologic reactivity after exposure to trauma-related stimuli may be measured in rodents as part of assessing [adult] criterion B 'Intrusive symptoms'. Likewise, avoidance behavior in face of trauma-related external reminders may be measured for [adult] criterion C 'Avoidance behavior'. [Adult] criterion D, of negative alterations in cognitions and mood, may be assessed by several, well-established tests such as tests of hedonic preference, social preference, and motivation.

Is it important whether animals experience 'true', that is, human-type, PTSD? We know three things. First, animals experience psychological trauma on a continuum (PTS; Fig. 12.1). Second, making a firm distinction between PTSD and less severe forms of PTS would only matter: (i) if the treatments differed appreciably between the two – and presently in humans, they do not (to be discussed in Section 12.7.1); and (ii) for purposes of health insurance and disability claims. Third, classifying the most severe cases as something special offers no advantage, and in fact may – as mentioned earlier for humans – risk denying adequate care for the individuals who fall below the diagnostic threshold of PTSD but experience significant distress (Cukor *et al.*, 2010).

So, *do animals experience PTSD?* Based on child criteria for PTSD in DSM-5, a good argument can be made that they do, or at least have the capacity to. But the more important question is, should we make for animals a distinction of PTSD separate from all of the less severe forms of PTS? With current knowledge suggesting that this offers no apparent benefit, and may even risk harm, it is proposed here that the PTS continuum best equipped to serve nonhuman animals is one that divides PTS into three roughly equal sections – mild, moderate, and severe – with no separate classification for PTSD, as depicted in Fig. 12.4. In such a diagnostic scheme, both humans and animals could be diagnosed with severe PTS, but only in humans would this include the distinct diagnostic category of PTSD.

It was noted earlier that not all posttraumatic psychopathology is captured within the PTSD diagnosis (van der Kolk *et al.*, 2005). Accordingly, as important as PTSD has become in the field of trauma research, PTSD is only one part of a continuum of PTS conditions of varying severity and complexity, and only one of a spectrum of posttraumatic responses. We turn to the latter next. Before beginning this discussion, however, an important point must be made. In humans who have experienced psychological trauma, comorbidity of PTS and mood and anxiety disorders is the rule rather

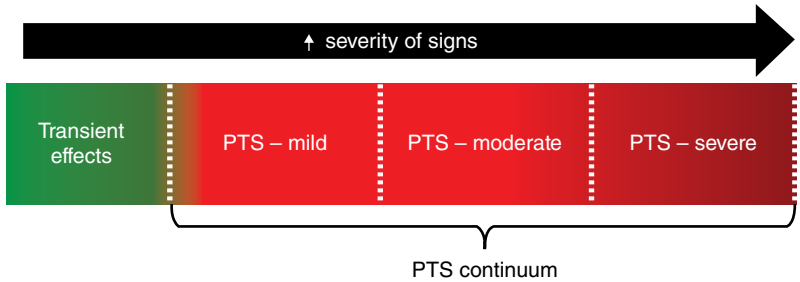


Fig. 12.4. Proposed schematic for posttraumatic stress in animals. PTS, posttraumatic stress.

than the exception (Richter-Levin *et al*., 2018). For example, PTSD and depression frequently coexist in traumatized individuals (Flory and Yehuda, 2015). Accumulating evidence in animal studies has revealed that similar comorbidity also exists in nonhuman species (Whitaker *et al*., 2014; Richter-Levin *et al*., 2018). Because of this, it can be difficult in animal models to distinguish PTSD-like behaviors as attributable to PTS versus other psychiatric conditions, in particular depression (Whitaker *et al*., 2014). Therefore, while the following discussion presents the different posttraumatic disorders as distinct entities, such diagnostic clarity is not to be expected in all animals who have experienced trauma.

12.3.2 Posttraumatic phobias – specific phobia

In both humans (O'Donnell *et al*., 2004; Bryant, 2010; American Psychiatric Association, 2013) and animals (Palestrini, 2009; Pageat and Fatjo, 2013; Overall, 2013), individuals can develop specific phobias after a traumatic event. Across species, a specific phobia is a marked and maladaptive fear or anxiety about a specific stimulus or situation that is out of proportion to the actual existing danger. The fear-inducing stimulus or situation is actively avoided or endured with intense fear or anxiety and the emotional response causes clinically significant distress or impairment in psychosocial functioning and decreased quality of life (American Psychiatric Association, 2013; Landsberg *et al*., 2023).

Most descriptions of specific phobia regard the exposure to the aversive stimulus or event as sufficient to elicit the psychopathological changes. However, for stress-induced phobias in companion animals, Overall (2013) includes the additional element of *uncontrollability* of the stimulus in situations that are injurious or potentially injurious. For example, dogs experiencing an inescapable event such as a car accident may become phobic of cars or the restraint system in use when the accident occurred (Overall, 2013).

Whereas not all specific phobias are associated with trauma, those that are may sometimes be difficult to distinguish from other posttraumatic psychopathology, in particular, PTS. In a report of 69 dogs with thunderstorm phobia, McCobb *et al*. (2001) found that approximately one-third of the dogs' owners could pinpoint a specific incident that triggered the first phobic episode, including fireworks, moving to an area with severe storms, observing a nearby lightning strike, Hurricane Andrew, and gunshots. The authors recognized the overlap of specific phobia with PTS, noting that with such lasting effects of adverse experiences, 'This type of experience may fit with the diagnostic criteria for posttraumatic stress disorder.' Other criteria have been used to distinguish these disorders. Specific phobia in both humans (Cahill and Foa, 2007) and animals (Landsberg *et al*., 2023) may exhibit generalization of the specific fear, but some features appear to distinguish posttraumatic generalized fear associated with specific phobia from that associated with PTSD. For example, studies in humans have shown that the fear generalization is greater in the case of PTSD than with specific phobia, causing individuals with PTSD to fear and avoid a wider range of cues than people with phobias, even agoraphobia (Cahill and Foa, 2007). Moreover, individuals with phobia become aroused only when exposed or in anticipation of exposure to the fearful stimulus or situation, whereas individuals with PTSD typically experience a more persistent state of hyperarousal (Friedman, 2006).

12.3.3 Generalized anxiety disorder

Another disorder known in humans (O'Donnell *et al*., 2004; Bryant, 2010) and animals (Crowell-Davis, 2009; Ferdowsian *et al*., 2012) to, in some cases, occur subsequently to psychological trauma is generalized anxiety disorder (GAD). For example, in one human study, 4% of individuals were diagnosed with GAD after the Oklahoma City Bombing (North *et al*., 1999); in another study 11% of survivors of traumatic injury developed GAD (Bryant *et al*., 2010).

In humans, GAD is a disorder consisting of excessive anxiety and worry (apprehensive expectation) about a number of events or activities causing clinically significant distress or impairment in important areas of functioning (American Psychiatric Association, 2013). In addition, the anxiety and worry are accompanied by a variety of symptoms, including restlessness or feeling keyed up or on edge, being easily fatigued, difficulty concentrating, irritability, muscle tension, and sleep disturbances.

The typical presentation of GAD in companion animals appears as constant or almost constant signs of fear and anxiety, regardless of the context or the stimuli to which the animal is exposed (Crowell-Davis, 2009; Overall, 2013; Forster *et al*., 2020). Signs may become more severe in particular situations but are evident at low levels relatively persistently. Physical and physiological signs primarily involve increased autonomic arousal with dilated pupils and increased heart and respiratory rates (Overall, 2013). Specific behaviors vary among individual animals and can include increased vigilance, pacing, and vocalizing (Crowell-Davis, 2009; Overall, 2013). Comments from the pets' owners often describe the animal as always 'miserable' or 'frightened', or that the pet is 'never happy' (Crowell-Davis, 2009).

In addition to cases reported in companion animals, GAD has been reported in sanctuary-living chimpanzees with previous histories of experimentation, orphanage, illegal seizure, or violent human conflict (Ferdowsian *et al*., 2012). Using behaviorally anchored criteria, the researchers compared chimpanzees living in wild sites in Africa (n = 196) with those in sanctuaries (n = 168) and found that 18% of the sanctuary chimpanzees met the diagnostic criteria for GAD, compared with 0.5% of those in the wild. The results suggested to the researchers that chimpanzees can exhibit behavioral clusters similar to GAD as a result of potentially traumatic experiences.

12.3.4 Depression and 'learned helplessness'

Affective (mood) disorders are relatively common following exposure to stressogenic/traumatic events and, as mentioned earlier, may occur independently of or in conjunction with PTS (O'Donnell *et al*., 2004; Cohen *et al*., 2006; Bryant, 2010; American Psychiatric Association, 2013). There is evidence in humans indicating that major depression is the most common form of posttraumatic psychopathology, even more prevalent than PTSD (Rosen *et al*., 2010). Data from the studies mentioned above for GAD showed that after the Oklahoma City Bombing 22% of people were diagnosed with depression (North *et al*., 1999), and among 1084 traumatic injury survivors depression was the most common disorder found, present in 16% of this population (Bryant *et al*., 2010).

In an experimental setting, stress-induced depression has been one of the most common research paradigms using animal models over the past five decades. Thousands of experiments reported in the literature on what was originally termed 'behavioral despair' involve exposing animals to severe stress until they exhibited signs of anhedonia, social withdrawal, decreases in investigative behaviors and locomotor activity, and learning deficits (Yan *et al*., 2010) – signs interpreted today as analogous to human depression. Stress-induced behavioral models of depression have used acute, single-exposure stress as well as chronic stress (Mangiavacchi *et al*., 2001). Much of the work in this field has involved the use of uncontrollable and/or unpredictable stress to induce a state termed 'learned helplessness', which is essentially a 'giving up' of the individual upon learning that their actions are futile in reducing the psychological impact of an aversive stimulus and has been regarded as an analog of human depression (Notari, 2009; see also Chapter 8, this volume).

In the review presented earlier describing PTSD symptoms in chimpanzees who had been reportedly subjected to traumatic events (Ferdowsian *et al*., 2011), the authors also evaluated the prevalence of signs of depression among 20 cases included in 12 published reports. Using criteria for depression similar to those developed by Scheeringa *et al*. (1995) as alternative criteria for nonverbal infants and children, the authors found that 58% of chimpanzees in sanctuaries met the diagnostic criteria, compared with 3% of chimpanzees in the wild.

Clinically, Pageat and Fatjo (2013) described a state of reactive depression – one type in puppies and one type in adult dogs and cats – which occurs after an intensely stressful event such as accidents, violent punishment, painful stimuli, or abandonment. A sign common to both puppy and adult forms is a loss of interest in the environment. The puppy form is also associated with a diminishment of normal activities, a generalized state of inhibition and immobility, and drinking less. Dogs and cats experiencing the adult form show decreased appetite and increased sleeping; dogs show increased whining behavior. As described by Pageat and Fatjo, the adult form of reactive depression appears to be comparable to 'adjustment disorder with depressed mood' in humans, which also occurs in response to an identifiable stressor (American Psychiatric Association, 2013). Overall (2013) also describes a similar reactive form of depression in dogs that occurs subsequent to a drastically altered environment over which the patient had no control, such as relinquishment, abandonment, re-homing, or death of a close human or another pet. Signs exhibited in this disorder include withdrawal from social stimuli and activities that were previously engaging and enjoyable, alterations in appetite, and alterations in sleep–wake cycles.

12.3.5 Trauma-related compulsive behaviors (OCD, stereotypies)

Two accounts of compulsive behaviors in animals subsequent to extreme stress have been reported in the literature. Pageat and Fatjo (2013) describe a dissociative syndrome in dogs that may appear spontaneously or in response to a highly stressful event. The disorder is characterized by repetitive behaviors not attributable to underlying medical pathology nor in response to an identifiable stimulus and include snapping at the air, circling, clicking jaws, jumping, and looking upward. In their study of 168 sanctuary-housed chimpanzees with previous histories of experimentation, orphanage, illegal seizure, or violent human conflict, Ferdowsian *et al.* (2012) applied behaviorally anchored criteria to compare these individuals with 196 chimpanzees living in wild sites in Africa. They found that 19% of chimpanzees in sanctuaries met the criteria for obsessive–compulsive disorder, compared with 0% of those in the wild. Alternative explanations, however, such as confinement-induced stereotypies, were not considered.

12.4 Psychological Conditions/States that May Resemble and/or Coexist with Psychological Trauma

12.4.1 Inadequate socialization

As mentioned briefly earlier, emotional and behavioral characteristics of animals deprived of adequate early socialization can closely mimic those caused by psychological trauma. Stimuli encountered (in a nonthreatening context) during neonatal cerebral development at a time of greater neuronal plasticity become neurally coded as familiar and 'normal', and fear toward these stimuli is minimized. In this way, the animal is developing the neural substrate optimally prepared for successfully coping with the stimuli that the animal will be most likely to encounter during its lifetime (Palestrini, 2009). Animals not receiving a broad range of social and environmental experiences during their early development may show substantial fear to other living beings, objects, and situations throughout life (Palestrini, 2009; Overall, 2013; Landsberg *et al.*, 2023). It is possible that abnormally high levels of fear – the predominant emotion of PTS – exhibited by companion animals with an unknown history may be due partly, largely, or solely to inadequate socialization.

This concern is relevant only for animals with incomplete histories, which includes both pretrauma histories for those with known trauma (or PTE exposure) as well as histories in which the existence of trauma itself is not known with certainty. While this problem occurs much more commonly in animals than in humans, there are situations where it is not possible to obtain detailed histories about the precise nature of a child's early experiences (American Psychiatric Association, 2013).

In humans, attachment disorders have been consistently identified in some young children following severe stimulus deprivation in early life. The conditions bearing the closest resemblance to socio-environmental deprivation in animals are *reactive attachment disorder* and *disinhibited social engagement disorder* (American Psychiatric Association, 2013; Humphreys *et al.*, 2017). Both conditions share the common etiology of extreme social neglect in early life, but the former is marked by depressive symptoms and withdrawn behavior, whereas the latter is expressed as disinhibition and externalizing behavior (American Psychiatric Association, 2013). In companion animals, the

fearful state resulting from the more extensive deprivation of social and environmental experiences (i.e., collectively termed 'inadequate socialization' in this chapter) has been referred to by Overall (2013) as neophobia and by Crowell-Davis (2009) as generalized anxiety disorder.

12.4.2 Stress-induced dishabituation

In the recent literature, some authors (Mills, 2009; Notari, 2009) have discussed a psychological phenomenon in animals which may appear after stress and consist predominantly of fear, and could therefore appear to be a posttraumatic psychopathological disorder. *Stress-induced dishabituation* has been described as that which occurs when conditions of chronic stress later in life lead to an emergence of a fear response to stimuli to which the animal was previously habituated (Mills, 2009; Notari, 2009). Notari (2009) writes that this loss of habituation can be observed in cases such as fear of noises (e.g., fireworks or thunderstorms), but also in cases of habituation to social contacts with humans or other animals and can lead to the onset of avoidance behaviors such as freezing, attempting to escape or aggressive behavior when the animal previously appeared well habituated or socialized.

12.5 Moderating Factors for Psychological Trauma: Risk and Resilience (see also Chapter 13, this volume)

Extensive empirical as well as anecdotal evidence has shown that exposure to adversity, while essential for the development of psychological trauma, does not by itself determine which individual will or will not experience posttraumatic distress, nor its severity (Ruscio *et al*., 2002). As discussed earlier, the human responses to stress and trauma vary widely; under the same stressful circumstances one individual may develop severe PTSD while others may only experience mild psychological symptoms that resolve rapidly (Southwick and Charney, 2012). Animals have shown the same pattern. Experimentally induced trauma in animal subjects, even when the stressor comprising the PTE is rigorously standardized, results in substantial individual variation in the animals' responses (Suomi, 2006). Therefore, exposure to extreme adversity appears to be a necessary but not sufficient condition to 'traumatize' an individual (Friedman, 2006; Richter-Levin *et al*., 2018).

Numerous factors appear to modulate psychological outcomes to stressors, contributing to vulnerability or risk for, or resilience against, the development of psychopathology. Understanding why some individuals develop mental disorders following trauma and others do not has the greatest importance for prevention and treatment. The currently recognized modulating factors include specific characteristics of both the stressor and the experiencer, and although a comprehensive review of all of the factors is beyond the scope of this chapter, the following discussion presents those considered to have the greatest impact on outcomes.

12.5.1 Characteristics of the stressor

Traumatic stressors exist on a gradation of severity and there is currently no clear distinction between traumatic and nontraumatic stressors (Wilson, 2004; Norris and Slone, 2007; Rosen *et al*., 2010; Wakefield and Horwitz, 2010) – a fact that is self-evident from the fact that a particular stressor may be traumatic for one individual but not another. In fact, the types of aversive stimuli used in experimental settings to cause psychological trauma in animals (e.g., immobilization, exposure to predators, being held underwater, and foot- and tail-shocks (Siegmund and Wotjak, 2006)) are the same stimuli that have been used as standard stressors in stress research for decades. Accordingly, it may not be possible in animals to identify specific stressors, or characteristics of stressors, that have the potential to cause psychological trauma above and beyond 'standard' stress.

However, several stressor-related factors have been found to influence the severity of psychological trauma in both humans and animals. Animal experiments indicate that stressor severity is a major factor: stressors of longer duration and greater intensity lead to stronger avoidance and escape responses, are more difficult to extinguish, promote greater generalization, and are more likely to produce maladaptive responses (Wyler *et al*., 1971; Cahill and Foa, 2007). Evidence from both animal and human studies suggests that certain stressors which threaten survival of the organism elicit biological and behavioral reactions that are particularly extreme and persistent (Ronan and Summers, 2008). Work using animal models has also identified the qualitative feature of (un)controllability as a key characteristic of the stressor,

which determines whether fear sensitization, a major component of psychological trauma, occurs (Maier and Watkins, 1998). As mentioned below, controllability is a characteristic of the experiencer as well as of the stressor.

12.5.2 Characteristics of the experiencer

Factors of the individual that modulate (or are otherwise linked to) the effects of the stressor fall into the general categories of risk or vulnerability factors, which indicate an increased likelihood for pathological outcomes, and protective factors, which indicate a decreased likelihood for such outcomes. The latter is incorporated into the general concept of resilience, which is generally understood as the ability to overcome, successfully adapt to, or bounce back from adversity and trauma (Southwick and Charney, 2012; see also Chapter 13, this volume). Resilience encompasses psychological and biological characteristics intrinsic to an individual that confer protection against the development of posttraumatic psychopathology after experiencing a severely stressful event or events (Hoge *et al*., 2007).

Genetics

Accumulating evidence in humans and animals supports the notion that vulnerability and resilience to stress-related psychopathology have a genetic component. Convincing evidence of a genetic contribution to the development of PTSD in humans has come from twin studies, which have shown that genetic influences account for 24–72% of the vulnerability to PTSD (Pitman *et al*., 2012; Cabib *et al*., 2019). More specifically, Xie *et al*. (2009) found that a polymorphism of the serotonin transporter gene (5-HTTLPR S-allele) interacted with adult traumatic events and childhood adversity to increase the risk for PTSD. In animals, the individual variability in coping and recovering from adverse experiences has been shown in squirrel monkeys to be, at least in part, heritable (Sanchez *et al*., 2001). Other examples include studies showing that rats which have a genetically determined blunted HPA axis response are predisposed to developing PTSD-like responses to stress exposure (Cohen *et al*., 2006) and that a genetic predisposition explained phenotypic vulnerability to stress in inbred mouse strains (Cohen *et al*., 2008).

Early life adversity

A well-documented risk factor for psychopathology in humans and animals is having experienced trauma earlier in life, particularly when exposure to stress occurs during the youngest stages of life (Sanchez *et al*., 2001; Heim and Nemeroff, 2009; Sherin and Nemeroff, 2011; D'Arcy-Bewick *et al*., 2023). Current evidence indicates that early life adversity (ELA) – which includes poor maternal care, neglect, abuse, and other highly stressful experiences – has profound and long-lasting effects on the development of neurobiological systems and epigenetic activation, in essence 'programming' a vulnerability to the development of posttraumatic psychopathology in response to stress later in life (Briere and Spinazzola, 2005; Heim and Nemeroff, 2009; Sherin and Nemeroff, 2011; Dietz *et al*., 2018; D'Arcy-Bewick *et al*., 2023; Lyons-Ruth *et al*., 2024). The psychopathology may also manifest as mental health problems such as anxiety and depressive mood disorders (Briere and Spinazzola, 2005; Heim and Nemeroff, 2009). In a review of rodent and primate models of early adverse experience, Sanchez *et al*. (2001) showed that early traumatic experiences are associated with long-term alterations in coping style, emotional and behavioral regulation, and neuroendocrine responsiveness to stress, all contributing to later development of psychopathology. Rats exposed to trauma as juveniles were more vulnerable to adverse effects of fear conditioning (Yehuda and LeDoux, 2007) and exhibited more severe PTSD-like behaviors when stressed in adulthood (Imanaka *et al*., 2006). In all, there is consistent evidence linking ELA to later mental health impairments in humans and animals, and that in animals this is a causal link (Miller *et al*., 2011).

'Stress inoculation'

Whereas ELA can *increase* risk of psychopathological outcomes when exposed to stress in later life, a process termed 'stress inoculation' produces the opposite, i.e., protective, effect. The difference lies in the severity of the initial stress. ELA is considered to be associated with a more intense level of adversity, but early stress that is mild or moderate in intensity can actually promote resilience in the face of future stressful experiences (Lyons and Parker, 2007; Santarelli *et al*., 2017). It is hypothesized that exposure to a challenging but manageable and controllable stressful event enhances

emotional processing, cognitive control, curiosity, and neuroendocrine regulation, resulting in enhanced coping efforts in the face of subsequent challenges (Lyons and Parker, 2007). This phenomenon has been well-demonstrated experimentally in animals, in particular, rodents and nonhuman primates. For example, a study with squirrel monkeys showed that moderately stressful early experiences strengthen socioemotional and neuroendocrine resistance to subsequent stressors (Parker *et al*., 2004).

Perception of control

Having control over a stressor can involve *actual* control or *perceived* control. Actual control can be a characteristic of the stressor (e.g., a physical barrier is weak and able to be overcome) or a characteristic of the individual (e.g., the prey animal is able to run faster than the predator). In contrast, a *perception* of control over the stressor is a characteristic of the experiencer and can be present whether or not actual control is present; for example, an individual may perceive that they can escape a threat via a tunnel, but unbeknown to the individual the tunnel is blocked at the other end. Research in humans and in animals has shown that it is the perceived control that has the greatest psychological benefits and has the most protective effects against posttraumatic psychopathology (Bollini *et al*., 2004). Conversely, the perception of uncontrollability increases vulnerability to detrimental psychological outcomes. A review of the literature using animal models for PTSD (Foa *et al*., 1992) showed that all other factors being equal, the less controllable and predictable a stressor is, the more likely the victim will be to develop PTSD symptoms. The issue of control as it pertains to mental health and well-being is discussed in more depth in Chapter 8 of this volume.

Social support (social buffering)

There is a large body of literature demonstrating that the presence of a compatible conspecific can buffer stress reactions and protect against posttraumatic psychopathology in a wide variety of animal species (Rault, 2012; Wang *et al*., 2021; Haag *et al*., 2023). Benefits are derived from social support during as well as after a stressful event. The issue of social support as it pertains to mental health and well-being is discussed in more depth in Chapter 9 of this volume.

Overlaps in factors associated with risk and resilience

As is the case for many psychological phenomena, certain factors and concepts are not clearly distinguishable. For example, risk and protective factors are often inseparable, as they frequently interact in complex ways (Fairbank *et al*., 2007; Heim and Nemeroff, 2009). To illustrate, research with children indicates that vulnerability in the genetic domain may be offset by resilience elsewhere, such as with increased social support (Kaufman *et al*., 2004). In addition, factors associated with the stressor and those with the experiencer may not be distinct from one another. The most evident example here is that the individual's perception and subjective appraisal, and not the stressor, often influences the severity of the stressful event (Foa *et al*., 1992). As mentioned above, the (un)controllability of the stressor may be a characteristic of the stressor (the stressor either actually is controllable or is not) or of the experiencer (the stressor is *perceived* as controllable or not). A two-axis model can conceptually represent the effect of interacting modifying factors on the degree of psychological harm (Fig. 12.5) (Briere and Spinazzola, 2005).

12.6 Challenges in Distinguishing and Diagnosing Posttraumatic Psychological Disorders in Animals (see also Chapter 25, this volume)

To a degree, some of the challenges in distinguishing psychological disorders and conditions in animals also plague human psychiatry. However, the challenges are much greater in animals due to a multitude of factors including language barriers (for the entire population, not only the very young or mentally impaired), the higher incidence of incomplete and unknown histories, and the greater contribution of inadequate socialization. In this way, when trauma is part of the history these three factors can all but erase any lines between PTS, phobia, and GAD in animals.

There are a number of reasons why it is important to distinguish psychopathologic conditions from each other as well as from conditions that may resemble them: (i) accurate assessments inform treatment; (ii) to determine prognosis where euthanasia may be a consideration; (iii) to determine risk factors for the specific disorders; and (iv) to determine the potential of certain environments, e.g., zoos, agriculture, animal

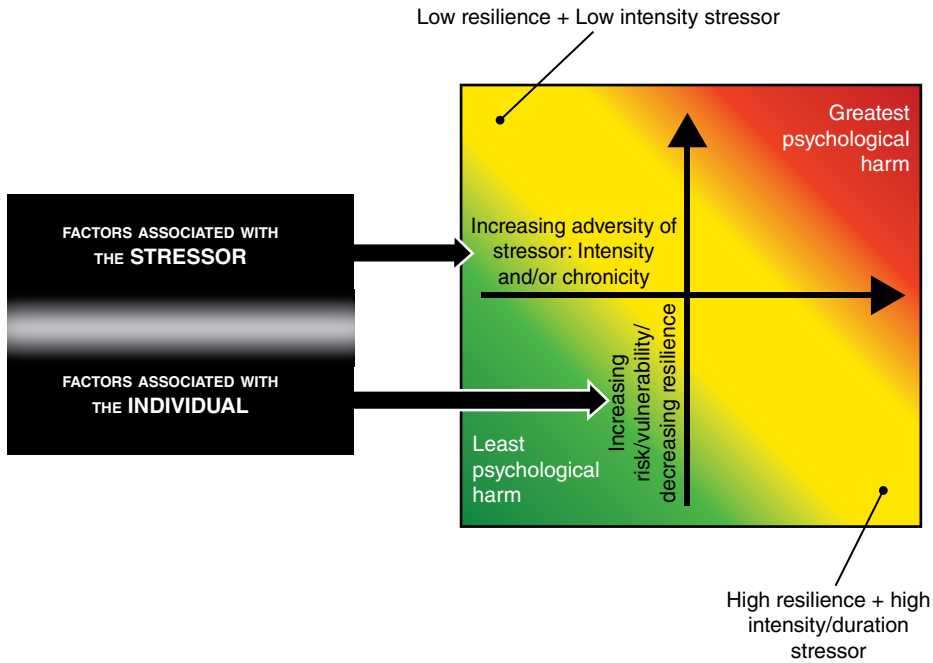


Fig. 12.5. A conceptual representation of the effect of interacting modifying factors on the degree of psychological harm (factors are not quantified to scale of impact; based on Briere and Spinazzola, 2005).

shelters, etc., to cause psychological harm – and to monitor success of reforms. Clinical distinctions in animals consist of different types.

12.6.1 Necessary distinctions in diagnosis

Distinguishing trauma history from no trauma history

In humans, knowledge of a patient's traumatic history is often relevant to treatment, such as to guide pharmacotherapeutic decisions (Marshall *et al*., 1998). Moreover, specific features of the trauma may be important, as the choice of the most appropriate treatment method is a function of variables such as type, duration, and repetition of trauma (Lindy and Wilson, 2001).

For companion animals, the importance of determining a trauma history has not received much attention. Does treatment differ, for example, whether a dog's current fear of humans is a result of trauma or from some other cause? This basic question has yet to be answered. One example of trauma information affecting treatment is the dissociative syndrome in dogs described by Pageat and Fatjo (2013). Among 99 dogs, those with the stress-induced form of the disorder, in contrast to those with the disorder not associated with stress, responded better to a specific therapeutic protocol at significantly lower doses of medications and exhibited a longer interval between outbreaks.

In animals, determining a trauma history also involves distinguishing posttraumatic psychopathology from inadequate socialization. Here, too, the question as to whether this distinction influences treatment decisions remains unanswered. A similar issue challenges pediatric psychiatrists, as there appears to be considerable diagnostic overlap between Reactive Attachment Disorder (found in young children following severe early life stimulus deprivation) and PTSD in infancy and early childhood (Hanson and Spratt, 2000). Symptoms consistent with each disorder may occur when trauma occurs in the context of an infant's primary attachment relationship (e.g., domestic violence, physical abuse, etc.) (Hanson and Spratt, 2000).

Distinguishing among the spectrum of posttraumatic disorders (e.g., PTS, GAD, phobia, depression)

In humans, this distinction equates to making an accurate psychiatric diagnosis and plays a crucial

role in treatment decisions (Marshall *et al*., 1998). One example is that in the treatment of PTSD in people the use of benzodiazepines, which are proven anxiolytic agents, has been shown to be not simply ineffective, but harmful: adverse outcomes include worse overall symptom severity, significantly increased risk of developing PTSD when used after recent trauma, worse psychotherapy outcomes, aggression, and depression (Friedman, 2001; Resick *et al*., 2007; Guina *et al*., 2015). However, as Rosen *et al*. (2008) have noted, due to symptom overlap between, as well as comorbidity of, posttraumatic disorders, distinguishing between presentations of phobic reactions, depression, and PTSD can be a challenge to the clinician's diagnostic skills.

Distinguishing PTSD from subthreshold PTSD (distinguishing levels of the PTS continuum)

As discussed in Section 12.3.1, meta-analytical studies have indicated that PTS is a dimensional rather than categorical disorder, which makes it improbable if not impossible to draw any distinct lines within the continuum. However, in considering treatment decisions for humans (see Section 12.7), several authors (Ruscio *et al*., 2002; Friedman *et al*., 2007; Cukor *et al*., 2010) have contemplated the need for distinguishing PTSD from less severe forms of PTS. For example, Friedman *et al*. (2007) wrote, 'it would be important to determine whether partial/subsyndromal PTSD responds to treatments shown to be effective for full PTSD, or whether better results might be achieved from different therapeutic approaches'. The first study to report results from a pharmacological intervention for subthreshold PTSD (Naylor *et al*., 2013) found that paroxetine, FDA-approved for the treatment of PTSD, showed substantial promise for treatment of the less severe forms of PTS. Another study of the treatment of individuals with partial PTSD (Dickstein *et al*., 2013) determined that Cognitive Processing Therapy is an effective form of treatment among military veterans, and that its effectiveness does not differ between subthreshold and threshold groups. As a whole, although much less attention has been given to the treatment of subthreshold PTSD (Bergman *et al*., 2015), methods of treatment of full PTSD and subthreshold PTSD have not been shown to differ in any meaningful way. As alluded to earlier, there is currently no evidence to suggest that making a clear distinction of PTSD from less severe forms of PTS would have any benefit for treatment decisions in animals.

12.6.2 Diagnostic methods

As mentioned earlier, the diagnostic criteria contained in the fifth edition of the DSM (American Psychiatric Association, 2013) serve as the current 'gold standard' for a diagnosis of PTSD, which, unfortunately for animal applications, heavily rely on patients' subjective reports (Pitman *et al*., 2012). As Keane *et al*. (2007) have noted, however, the objectivity that psychophysiological measurements would provide increases its value for use in individuals impaired in their ability to communicate their subjective states, such as young children and individuals with brain damage. Research to identify specific biomarkers that could discriminate PTSD sufferers from individuals not meeting the diagnostic criteria for PTSD has had a degree of success, but no factors yet identified possess the specificity and sensitivity necessary to be regarded as a standalone diagnostic test for PTSD (Pitman *et al*., 2012).

In humans, measures of physiological reactivity have shown considerable promise in the diagnosis of PTSD. Increased heart rate reactivity to loud tones and to trauma-related stimuli has been the most consistently documented effect for PTSD (Southwick *et al*., 2007). Similarly, an increased startle to sudden, loud tones is a well-replicated psychophysiological marker for PTSD (Segman *et al*., 2007). Abi-Dargham *et al*. (2023) recently reviewed the current status of PTSD biomarker research, presenting data for the current methods of neuroimaging, heart rate variability and respiratory sinus arrhythmia, fear potentiated startle response, cortisol levels, inflammation markers, and proteomics. All measures demonstrated weak or marginal links to PTSD, leading the authors to conclude that, 'to date, the overwhelming majority of these measures have not been proven sufficiently reliable, valid and useful to be adopted clinically'.

12.7 Rehabilitation and Treatment: Healing Psychological Trauma

12.7.1 Treatment principles and goals

Very little information about the clinical treatment of psychological trauma in animals can be found in the veterinary behavior literature. And although it

is too early to use specific treatments for human PTSD in animals, many of the general goals and principles of human PTSD treatment have applications for treatment in animals. (The discussion here will focus on PTS – for treatments of other posttraumatic disorders, such as specific phobia, GAD, and depression, the reader is referred to relevant texts, e.g., Overall, 2013; Landsberg *et al.*, 2023.)

The foremost principle guiding therapy is that there are no universally standardized protocols for treatment of PTSD and it is essential to individualize therapy based on the patient's PTSD phenotype (Wilson *et al.*, 2001b). Additional principles include (Herman, 1997; Wilson *et al.*, 2001c):

- Patients must be permitted to progress in processing the trauma at their own pace.
- PTSD symptoms wax and wane over time, and regressions and relapses can be expected.
- Recovery should never be considered complete and final; symptoms are likely to recur under stress.
- The best indices of resolution are the survivor's restored capacity to take pleasure in his/her life and to engage positively in social relationships. The world becomes trustworthy, no longer something to fear.

Specific treatment goals that have relevance in treating animals include (Herman, 1997; Friedman, 2001; Wilson *et al.*, 2001a,b,c; Bryant, 2010):

- Restore the patient's sense of safety (and decrease the sense of vulnerability).
- Restore for the individual a sense of control over life events.
- Facilitate the restorations of healthy social attachments and relationships.
- Provide social support.
- Identify trigger stimuli for hypervigilance, exaggerated startle response, and conditioned fears associated with the trauma.
- Facilitate normalization toward homeostatic functioning through the reestablishment of the normal (healthy) stress response to the extent possible.
- Facilitate accurate appraisal of stimuli rather than irrational fear or avoidance behaviors.

Martin *et al.* (2021) reviewed treatment guidelines for PTSD published between 2004 and 2020 and found that both psychotherapies (prolonged exposure (PE) and cognitive-behavioral therapy (CBT)) and pharmacotherapies are considered to be first-line treatments in PTSD. More recently Merians *et al.* (2023) noted that most published guidelines for the treatment of PTSD recommend psychotherapy as first-line treatment and pharmacotherapies only as second-line treatments, based on reviews and meta-analyses showing that pharmacotherapies are less effective than trauma-focused psychotherapeutic interventions in reducing PTSD severity. High-quality evidence also now exists for the effectiveness of eye movement desensitization and reprocessing (EMDR) for treating PTSD (Merians *et al.*, 2023).

Prolonged exposure

Among the treatments available for PTSD in humans, exposure therapy has received the most empirical support (Hembree and Foa, 2010). Exposure therapy is conceptually based upon fear extinction, which is impaired in PTSD, and involves fear confrontation through measured exposure to progressively stronger TRCs to create a new association between those cues and safety (i.e., CS followed by no US) (VanElzakker *et al.*, 2014; Ressler *et al.*, 2022).

Systematic desensitization (SD), which consists of repeated and brief confrontations with the feared stimuli, was the first exposure procedure used (Wolpe, 1958). However, based on findings showing that long exposures are more effective than short ones, a shift away from SD and toward PE has occurred in recent years (Foa and Meadows, 1998).

Cognitive behavior therapy

Cognitive behavior therapy comprises several specific treatment approaches, including cognitive therapy, cognitive processing therapy, and stress inoculation therapy (Resick *et al.*, 2007). Authors of contemporary models of PTSD cognitive therapy suggest that the PTSD sufferer's traumatic memories create continued distorted cognitive assessments of events, and using a combination of cognitive and behavioral techniques can help patients identify and modify these distorted beliefs (Shubina, 2015). A thorough description of these therapies is beyond the scope of this chapter and have been recently reviewed (Shubina, 2015; Syros, 2017).

Eye movement desensitization and reprocessing

As mentioned, empirical studies have shown that EMDR is effective for treating PTSD (Merians *et al*., 2023). EMDR is based on the observation that specific types of eye movements can lessen the intensity of traumatic memories. While focusing on the traumatic memory or thought, the patient uses their eyes to follow the back-and-forth movement of the therapist's finger (Cuijpers *et al*., 2020). It remains controversial and highly debated as to the mechanisms by which EMDR works, and its use in animals is clearly limited due to the challenges of having an animal focus on specific thoughts and memories.

Pharmacotherapy

Several well-controlled studies in humans have determined the selective serotonin reuptake inhibitors (SSRIs) to be the treatment of choice as first-line drugs for treating PTSD (Matar *et al*., 2006; Martin *et al*., 2021; Schrader and Ross, 2021; Merians *et al*., 2023). Two SSRIs, sertraline and paroxetine, currently have FDA approval for treatment of PTSD (Gasparyan *et al*., 2022). Empirical data have demonstrated effectiveness of SSRIs in reducing the three PTSD symptom clusters of intrusion, avoidance, and hyperarousal, and in improving and sustaining quality of life during treatment (Friedman, 2001; Rapaport *et al*., 2002). However, several meta-analysis studies suggest that the efficacy of such treatments is minor and in some cases equivalent to that of treatment with placebos (Kozarić-Kovačić, 2008; Ragen *et al*., 2015). As mentioned earlier, benzodiazepines have been found to be ineffective for PTSD treatment and prevention, and should be considered relatively contraindicated for patients with PTSD (Guina *et al*., 2015).

12.7.2 Treatment in animals

Administering CBT in animal patients requires special considerations due to the obvious limitation of communication integral to talk therapies. Siegmund and Wotjak (2006) agree that the same principles of fear extinction apply to animals. Based on laboratory work, they suggested that aversive memories could be weakened through repeated non-reinforced presentation of TRCs, during which the animal eventually learns that a particular stimulus no longer predicts the occurrence of an aversive consequence. This concept underlies both PE and desensitization approaches, and although the former has not been clinically adapted to animal patients, desensitization, along with counterconditioning, has shown considerable effectiveness in treating fearful animals in general and traumatized military dogs in particular (see below).

In animals, experimental studies have also demonstrated effectiveness of SSRIs to alleviate detrimental effects of stress on the HPA stress response system (Penza *et al*., 2003). In animal models of PTSD using predator exposure and single prolonged stress, SSRIs reversed PTSD-like symptoms (Yamamoto *et al*., 2009). However, not all findings have relevant applications to clinical cases of psychological trauma in animals. For example, Matar *et al*. (2006) found that sertraline reduced anxiety-like responses, avoidant behavior, hyperarousal, and the overall incidence of extreme (PTSD-like) behavioral responses, but only when the drug was administered immediately after stress exposure and by an intraperitoneal route daily for 7 days. Clinically, the presentation of an animal immediately after a PTE would be highly improbable, rendering this type of drug administration regimen impractical.

A few reports of treatment of psychological trauma in animals have appeared in the literature. Burghardt's (2013) work with 14 military working dogs, which he acknowledges is largely anecdotal, describes the first step being relieving the dog from military duty. The dogs are moved to a quieter and less stressful environment, where the dog receives exercise and practices work skills and social interaction with the handler. Some dogs with acute or subacute signs were provided behavioral enrichment along with scheduled task training in a non-combat setting. Acute cases also appeared to respond well to anxiolytic drugs such as alprazolam or buspirone, often combined with a beta-blocker (e.g., propranolol). Dogs exhibiting chronic signs were most often treated with a tricyclic antidepressant (e.g., clomipramine) or SSRI (e.g., fluoxetine), and the treatment may also include a beta-blocker (Lagutchik *et al*., 2018). When practical and safe, desensitization with counterconditioning using TRCs (e.g., gunfire, concussive noise, working locations) showed efficacy in chronic cases. Progress of the initial treatment plan is evaluated after several weeks and if signs of distress are

still evident the dog would be returned to the United States where desensitization and counterconditioning are instituted in a nonthreatening environment with some TRCs present. Medications are used when necessary.

Other authors (e.g., Huntingford, 2013; Overall, 2013) have stressed the value of play therapy, such as having the opportunity to run and chase other dogs, play with people, swim, retrieve, or run an agility course, in facilitating the recovery in dogs with psychological trauma. Overall (2013) suggests another consideration with regard to treating fears, noting that, 'protection is undervalued as a treatment strategy'. Recognizing that the cost and effort required to treat some fears may be prohibitive for some pet owners, and that treatments are not always effective, she points out that pet owners who can protect dogs from the objects of their fear might choose protection as a strategy. She stresses, however, that the pet owner must be certain that they can continuously provide the protection for a decade or more.

Outcomes in Burghardt's 14 MWDs showed a variable prognosis. Approximately 50% of dogs treated for four months responded well and were able to return to military service. The other 50% did not respond sufficiently to be reexposed to potential triggering stimuli and were either transferred to roles where encountering TRCs would be less likely (such as security or police work in the US) or retired and adopted as pets to private individuals. None of the dogs in the report was euthanized for behavioral or medical problems.

Garlick and Austen's (2014) report of five kangaroos with presumed PTS resulting from early life adversity described a treatment plan consisting of several principles: create a safe environment that builds confidence and minimizes fear from vulnerability and exposure, promote development of social bonds between kangaroos and between kangaroos and human carers, and short-term use of psychotropic medications. Four of the five kangaroos exhibited a favorable outcome.

Lopresti-Goodman *et al*. (2015) stressed a multimodal approach to treatment of chimpanzees diagnosed with PTSD. Key features of therapy included:

- Establish a safe, stable, and predictable environment, including providing places for retreating from other chimpanzees and relaxing.
- Encourage positive relationships between human caregivers and the chimpanzees, allowing a building of the animals' trust in humans.
- Promote social relationships through gradual introductions to other chimpanzees and integrations into a large social group.
- Empower the animals with the ability to make decisions about everyday aspects of their lives, such as allowing them to decide what activities to engage in. This involves creating complex physical environments that are cognitively stimulating and ethologically appropriate, including providing access to large outdoor areas with climbing structures, opportunities to forage for food, and cognitively enriching games, puzzles, and toys.
- Provide adequate veterinary care.
- Use antianxiety and antipsychotic medications as needed for anxiety and in cases of SIB.

An important final note on prognosis is that in humans PTSD can be successfully treated and resolved; however, symptoms may recur and even intensify later in response to reminders of the original trauma, ongoing life stressors, or newly experienced traumatic events (Wilson, 2004; American Psychiatric Association, 2013). Accordingly, human patients should not be led to expect that any treatment is absolute or final. Laboratory and clinical data in animals suggest that similar cautionary recommendations would be wise for those caring for animals recovering from psychological trauma.

Note

[1] For the sake of brevity, the terms 'socialize' and 'socialization' will refer to experiences with both social and non-social stimuli, and 'inadequate socialization' will be used to denote the more accurate 'deprivation of early socio-environmental stimulation and experiences'.

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13 Psychological Resilience in Animals – Focus on Dogs

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Why do certain individuals exhibit rapid recovery from neglect, abuse, or bad experiences, whereas others are traumatized from considerably milder adverse circumstances for life? In this chapter, I review important findings in resilience research observed across various species while focusing on one of the most popular pets worldwide, the domestic dog. The dog serves as an example of an animal species that has not been widely studied in terms of resilience. However, there have been various studies focusing on several resilience-associated factors, both environmental and genetic. Thus, although species-specific resilience studies are still few in numbers, we can learn from resilience research involving other species.

13.1 What is Resilience?

In this chapter, I discuss psychological resilience and the factors affecting the resilience of an individual. Why do some individuals bounce back from hardships, while some become traumatized from a single bad experience without ever recovering their mental well-being? In this chapter, resilience is defined as an individual's ability to overcome adversity or stress, or achieve a positive outcome despite negative life experiences (Rutten *et al.*, 2013). Rodents and humans have often been the target species in resilience research. In many studies, resilience is discussed in relation to the risk of psychiatric disorders in humans. Recent studies have also discussed resilience regarding animal production, positive welfare, and the potential measures of resilience in animals (Colditz, 2022). In this chapter, resilience research in other species is reflected against what we know about the dog, one of the most common pets worldwide (Tiira, 2019). Issues related to the mental well-being of dogs are often expressed as behavioral problems, and thus in this chapter, in addition to reviewing known factors of human and animal resilience, I review a number of elements that are known to affect the problematic behavior, personality, and stress coping of dogs.

13.2 Neurobiology of Resilience

Stress neurobiology is relevant for the neurobiology of resilience, as resilience is considered to be a process that maintains or regains homeostasis in stress conditions (Rutten *et al.*, 2013). Stress biology is present in everyday life where individuals cope with different situations, stressors, and cognitive challenges. Both the rapid activation of a stress response (to an acute stressor) as well as the effective termination of the stress system are associated with resilience (Russo *et al.*, 2012; McEwen *et al.*, 2015). The ability to adapt to stressful situations has been an important trait for natural selection in the course of evolution, since the individual who adapts positively to stress will have a higher chance of survival (Spencer-Segal and Akil, 2019). Stress affects the brain where glucocorticoids together with excitatory amino acids alter brain chemistry (McEwen *et al.*, 2015). The hypothalamic–pituitary–adrenal (HPA) axis, the sympathetic nervous system, and the glutamatergic, dopaminergic, and serotonergic neurotransmitter systems are all involved in the stress response. The hippocampus is one of the main areas controlling the HPA axis and is also affected by stress hormones. Thus, the hippocampus is very sensitive to stress (Liu *et al.*, 2018). Furthermore, early life stages and the adolescent

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phase are especially sensitive periods for the adverse effects of stress in the brain. It is well known that the brain exhibits great plasticity during an individual's life; however, the biological changes behind this flexibility are currently unknown (McEwen *et al.*, 2015).

Nevertheless, stress is not always a bad thing. Life stressors can also promote 'good stress', which helps the individual adapt to future challenges (McEwen *et al.*, 2015). It has been suggested that glucocorticoids may increase positive adaptation to stress (Spencer-Segal and Akil, 2019). Good stress is further discussed in Section 13.4.1.

13.3 Protecting and Predisposing Personality

In human studies, certain personality traits have been found to be the most important factors affecting an individual's psychological resilience (Oshio *et al.*, 2018), and the same findings have also been suggested in animal studies (Colditz, 2022). Individuals scoring high in the neuroticism personality trait experience more negative emotions, such as fear or anxiety. In humans, high neuroticism scores have been suggested to predispose one to lower resilience (Sarubin *et al.*, 2015; Oshio *et al.*, 2018). This is hardly surprising, given that neuroticism has been associated with several mental disorders, such as anxiety, mood and substance-use disorders, as well as outcomes such as divorce, occupational attainment, and mortality (Ormel *et al.*, 2013). On the other hand, certain personality traits such as extraversion, openness, agreeableness, and conscientiousness seem to serve as protective factors for resilience (Sarubin *et al.*, 2015; Oshio *et al.*, 2018). Individuals who score high in optimism and self-efficacy may be more resilient because they are better able to maintain a positive outlook in life and believe in their ability to overcome challenges (Wu *et al.*, 2013). Similarly, individuals with a high score in emotional stability may be more resilient because they are more adept at regulating their emotions and maintaining a sense of control.

Dogs, like most animal species, lack universally accepted personality classification. However, there are several personality traits that appear consistently in canine research. Fearfulness (very similar to neuroticism in humans) and sociability (similar to extraversion in humans) are among the most frequently found personality categories in dog personality research (Svartberg and Forkman, 2002; Jones and Gosling, 2005; Ley *et al.*, 2008; Salonen *et al.*, 2020). Fear is a crucial emotion for survival in both animals and humans (Bateson *et al.*, 2011); however, if fear is generalized, it may cause problems in everyday life. For instance, an extremely fearful dog may never recover from the same negative experience from which a bold individual would recover in a matter of seconds. Fearfulness in dogs is associated with many behavioral problems, such as aggression, noise sensitivity, and problems of being alone (Overall, 2013; Tiira *et al.*, 2016; Salonen *et al.*, 2022). Moreover, it is common for a dog who is fearful towards unfamiliar people to also be afraid and stressed in new situations, and thus fearfulness and sociability are often correlated (Svartberg and Forkman, 2002; Tiira *et al.*, 2016). From my perspective, sociability, meaning how a dog reacts to unfamiliar people, is one of the most important aspects of a dog's resilience, as in our society, dogs frequently meet new people. Indeed, a dog's fear of people or desire to avoid them, or, on the other hand, the experience of positive feelings when meeting strangers, have a major influence on the dog's moods and thus their daily emotional states.

Personality may also predispose dogs to various health issues. In a study, dogs that were afraid of unfamiliar people had shorter lifespans, and dogs with environmental fear and separation anxiety had more skin diseases (Dreschel, 2010). In a metabolomics study including German Shepherds and Great Danes, blood metabolites of fearful and bold dogs were compared. Metabolites associated with chronic stress were clearly elevated in fearful dogs regardless of breed, age, and gender, which may indicate prolonged stress in these dogs (Puurunen *et al.*, 2016, 2018). Fearfulness as a personality trait can thus have serious consequences for the dog's well-being and health, whereas boldness may be a protecting factor against stress. For example, bolder dogs were observed to have a stronger resistance to illness during stressful stages of life (time spent in kennel conditions) (Corsetti *et al.*, 2018).

Heart rate variability (HRV) in humans is associated with the ability to regulate emotions and to adapt to life adversities. In humans, low HRV has been associated with emotional imbalance, poor self-regulation, lower resilience, and many psychiatric syndromes, whereas high HRV has been found to be connected to adeptness at regulating emotions (Craig *et al.*, 2017). It has been suggested that HRV might also disclose something about canine resilience, as low HRV has been found to be

linked to aggressive behavior (Craig *et al.*, 2017) and anxiety (Wormald *et al.*, 2017) in dogs. The ability to control impulses (self-control) has also been identified as one of the resilience-protective personality traits in children (Zolkoski and Bullock, 2012). In dogs, high impulsivity seems to be associated with problematic behavior (Wright *et al.*, 2012; Junttila *et al.*, 2024) similarly to humans, as well as with difficulties in training (Junttila *et al.*, 2024). High impulsiveness may thus create a conflict between a dog and an owner, and thus predispose both to difficulties in everyday life.

A recent study addressed the concept of resilience in dogs, and to examine this, a psychometric instrument, 'The Lincoln Canine Adaptability Resilience Scale (L-CARS)', a questionnaire directed to dog owners, was developed (Mackay *et al.*, 2023). The questionnaire was designed by mimicking and modifying human resilience questionnaires and directing it to dog owners. Researchers identified two main components, namely 'adaptability/behavioral flexibility' and 'perseverance'. A dog exhibiting high scores for the adaptability/behavioral flexibility domain has a good ability to adapt to (and potentially even thrive) despite changes in life. This kind of a dog has the capacity to modify its behavior as per varying circumstances. Questions targeted specifically at resilience were linked to the adaptability/behavioral flexibility component. Moreover, this component was also associated with problematic behavior such as aggression and fearful behavior (Mackay *et al.*, 2023). Perseverance, which in humans is related to maintaining the best effort when facing adversity, was poorly loaded with resilience questions, and thus may not be a commonly recognized concept of dog resilience. Alternatively, L-CARS may not measure perseverance accurately enough.

Does resilience in dogs vary by breed? Studies show that breeds differ in personality, especially in terms of fearfulness, sociability, and impulsiveness (Svartberg, 2006; Salonen *et al.*, 2020, 2023; Junttila *et al.*, 2022). In addition, small-sized breeds seem to be more fearful and anxious, and they are also suggested to exhibit a size-associated genetic predisposition for fearfulness (McGreevy *et al.*, 2013; Zapata *et al.*, 2016). The most popular dog breed around the world is the Labrador Retriever, which is ranked as number one in both curiosity/boldness and sociability in a large study comparing dog breeds in a test situation (Svartberg, 2006). As sociability and boldness most likely also correlate with resilience in dogs, it could be that more resilient breeds are also favored by dog owners. However, it also seems that we have created and continue to breed dog breeds that are less resilient than others. For example, breeds such as Shetland Sheepdog and Spanish Water Dog are breeds that appear to have a high amount of stranger-directed fear in test situations (Junttila *et al.*, 2022) and in an owner-derived questionnaire study (Salonen *et al.*, 2020). Non-social fearfulness is common in Rough Collie, and this breed suffers from many fear-related problems (Arvelius *et al.*, 2014). Most likely the ability of an average dog individual of one breed to bounce back from adversity is significantly lower when compared to an individual of some other breed. For the welfare of dogs, it is crucial that the qualities associated with resilience, such as certain personality traits, are given high priority when selecting the individuals to be used for breeding.

13.4 Environmental Factors

Life full of adversities most likely negatively affects the individual's resilience. In the case of dogs, this is most clearly seen in abandoned kennel or shelter dogs. Dogs adopted from rescue centers (Wells and Hepper, 2000) or pet shops (reviewed in McMillan, 2017) have a higher probability of showing fear and aggression. More than 68% of rescue dogs showed fear according to their new owners (Wells and Hepper, 2000). At a minimum, these dogs have most likely experienced unsuccessful dog–owner relationships, separation from the original owner, and the new, often harsh kennel environment. Traumatic events may also affect a dog's long-term health. Dogs with sensory problems or health issues had more likely experienced one or more of the following traumatic experiences in their life: a change of owner, time spent in a kennel (shelter), a traumatic injury or prolonged disease, being lost (runaway dogs), and a change in owner's family structure (divorce, death of family member, etc.) (Wallis *et al.*, 2018).

13.4.1 Early life history

The effects of socialization on puppies have been known for a long time – a lack of socialization increases fear and anxiety in adulthood (Scott and Fuller, 1965). Getting to know one's living surroundings safely and meeting different kinds of people of

different age and sex at a young age are thus crucial building blocks of an individual's resilience (Tiira and Lohi, 2015; Puurunen *et al.*, 2020). It has been shown that the adoption age of 8 weeks provides the best results in terms of the dog developing its personality: puppies adopted at this age had less fearfulness and other problematic behaviors as adults when compared to earlier and later adoption periods (Jokinen *et al.*, 2017; Puurunen *et al.*, 2020). The sensitive socialization period in dogs is considered to take place between 3 and 12 weeks of age, and thus the adoption age of 8 weeks leaves abundant time for the new owners to familiarize the puppy into their new surroundings.

An early growing environment that is lacking appropriate social, emotional, or sensory stimulation can lead to brain circuitry dysfunction in rodents (Kolb *et al.*, 2017). In contrast, environmental enrichment has been shown to increase individual resilience in rodents (Russo *et al.*, 2012). In dogs, environmental enrichment and extensive socialization (for puppies 1–6 weeks old) have been demonstrated to reduce anxiety and touch sensitivity in a group of working dogs (Vaterlaws-Whiteside and Hartmann, 2017). Similarly, exposure to video images at a young age reduced neophobia in puppies (Pluijmakers *et al.*, 2010).

Maternal care has been shown to strongly affect individual stress susceptibility. Studies conducted mostly in rodents have shown that offspring that received low-quality maternal care were more stress prone, fearful, and less social when compared to offspring that received good-quality maternal care (Meaney, 2001). In dogs, only a few studies have investigated the effect of maternal care. A low amount of maternal care was found to be associated with increased fearfulness and stereotypic behavior in two Finnish questionnaire studies (Tiira *et al.*, 2012; Tiira and Lohi, 2015), increased stress reactions in Beagle puppies in a novel situation (Guardini *et al.*, 2016), and decreased sociability, persistence, and playfulness in German Shepherd dogs over one year old (Foyer *et al.*, 2016).

Even though early life adversity is mostly linked to negative effects, sometimes stress is beneficial to the individual. A moderate stress exposure during the early stages of life or adolescence can promote resilience (Zolkoski and Bullock, 2012). For example, in monkeys and rats, experiencing short time periods of separation from the mother at the early stages of life actually promotes individual resilience (Levine and Mody, 2003). In dogs, this beneficial stress coping boost has been taken into practice by working dog breeders. Early gentling and handling of small puppies (early neural stimulations, ENS) coupled with being briefly separated from the mother is routinely practiced by some dog breeders. Some studies find positive effects in this method (Gazzano *et al.*, 2008; Gazit *et al.*, 2022); however, other studies do not find differences between handled and non-handled puppies (Schoon and Berntsen, 2011; Boone *et al.*, 2022). Negative effects from puppy handling have not been observed.

13.4.2 Exercise

The positive effects of exercise on psychological resilience are well documented. Exercise is known to reduce anxiety, to elevate mood, and to work as a buffer against stress, in addition to which it is generally linked to good mental health outcomes in humans (Tsatsoulis and Fountoulakis, 2006; Shamus and Cohen, 2009). The same phenomenon has also been observed in rodents (Rutten *et al.*, 2013; Kochi *et al.*, 2017). Especially brain resilience has gained significant attention in human and rodent studies. Some research suggests that not only the exercise performed by the individual but also the mother's pre-natal and post-natal physical activity increase their children's academic success (Arida and Teixeira-Machado, 2021). In addition to several neurological and molecular changes in the offspring's brain, the cognitive abilities (e.g., memory and spatial learning) of the offspring were also improved if rodent mothers engaged in swimming or treadmill running during their pregnancy (cited in Arida and Teixeira-Machado, 2021).

In dogs, several studies have found that a low amount of daily exercise is associated with many behavioral problems, including fearfulness, separation anxiety, and aggression (Lofgren *et al.*, 2014; Tiira and Lohi, 2015; Puurunen *et al.*, 2020). Causality in these canine studies is unclear, as it also could indicate that owners may be reluctant to walk fearful or aggressive dogs. However, there should not be a reason why a dog suffering from separation anxiety gets less physical activity. Moreover, a study involving dogs with noise sensitivities demonstrated that the individuals who engaged in more exercise developed noise sensitivity later than those having less exercise, therefore suggesting the same phenomenon as in other animals (Tiira and Lohi, 2015). Exercise has also been linked to better brain resilience in dogs – at an

older age, dogs that had engaged in more physical activity exhibited fewer cognitive dysfunction symptoms (Bray *et al.*, 2023).

13.5 Social Relationships

Social support is one of the key environmental elements affecting resilience in humans. It starts from the child–parent relationship, but in later life, other robust social relationships, as well as a supportive and caring atmosphere within the family, also play an important role in how individuals recover from life adversities (Rutten *et al.*, 2013). Social isolation, on the other hand, is a psychological stressor both in animals and in humans (Mumtaz *et al.*, 2018). The consequences of social isolation are various and include alterations in stress reactivity and social behavior, as well as changes in neuroendocrine function that may last until adulthood (Mumtaz *et al.*, 2018). The amount and the degree of the consequences of social isolation depend on the social organization of the species. Dogs originate from the wolf, a species with a rich social organization and a stable pack structure, and their well-being has therefore become highly dependent on social relationships. Another important factor is the age at which the isolation is experienced; early life isolation is particularly harmful (Scott and Fuller, 1965).

When social animals (including humans) are with their conspecifics, they often have increased stress resistance. This 'social buffering' has been observed in rodents, humans, and dogs (McMillan, 2016; see also Chapter 9, this volume). During the long domestication process of the dog, new selection pressure may have created specialized skills that aid dogs in living with humans, such as the enhanced ability to understand human gestures and a higher capacity for attention towards humans (reviewed in Bonanni and Cafazzo, 2014). The dog's social world is widened during domestication from conspecifics also to us, humans. In fact, it may be that human companionship may be even more important for a dog's resilience than the company of other dogs (McMillan, 2016).

13.5.1 Dog–owner relationship

The dog–owner relationship has been suggested to resemble the child–parent relationship in many ways. In humans, the attachment between a child and a parent is a crucial building block of resilience (Rutten *et al.*, 2013). Dogs are also attached to their owners and have been observed to have similar variation in their attachment styles as children (Payne *et al.*, 2015). If the attachment style is secure, dogs seek owner support in stressful situations, miss their owner when being separated from them, and are more eager to explore novel spaces and objects when the secure base (owner) is present (Payne *et al.*, 2015). This attachment style seems to also affect how the dog copes with stress: a study showed that dogs that are classified to have a secure attachment style had lower cortisol levels in stressful situations (Schöberl *et al.*, 2016).

But it is not only the dog that forms an attachment but also the owners who develop various attachment styles with their pets. Owners may have the anxious attachment style, which is associated with a tendency to worry that something bad might happen to the dog, as well as a need for a high level of proximity. The avoidant attachment style, in contrast, is characterized by a need for physical and emotional distance from the pet, as well as *not* seeking support from it. High levels of the owner's anxious attachment have been found to be associated with high levels of caregiving and attentiveness towards the dog or pet (Coy and Green, 2018). This attachment style seems to be linked to the owner's personality as well as the dog's behavior – high neuroticism and poor mental well-being in owners is associated with the owner's anxious attachment style to the pet. Furthermore, this style correlates with heightened fearful behavior in dogs (Ståhl *et al.*, 2023), a finding consistent with results of an earlier study by Chopik and Weaver (2019) demonstrating that high owner neuroticism was linked to the dog's fearful behavior. Owners with anxious attachment might also be overprotective of their dog, and, as in child–parent relationships, this may cause dogs to become more fearful (Segrin *et al.*, 2013; Triger, 2013). In addition to fearful behavior, some studies have suggested that high owner neuroticism is associated with other behavioral problems in dogs, for example, destructiveness in the owner's absence and stereotypies (e.g., tail-chasing) (O'Farrell, 1995), and aggressive behavior (Gobbo and Zupan, 2020). Another explanation is that fearful dogs seek more comfort and contact from their owners, which might increase the feeling of emotional closeness (Wedl *et al.*, 2010).

In children, physical punishment is a major risk factor for later psychiatric problems (David and Jones, 2008). Also in dogs, owners using harsh

training methods have been found to more frequently have dogs with behavioral issues, such as aggression, fear, or attention seeking (Blackwell *et al*., 2008). It is clear that violent training methods and punishment-based training have a substantially negative effect on the resilience and stress coping of a dog. However, this connection found in dog studies is correlational, and causality cannot be shown. 'Difficult' dogs (aggressive, active individuals) may also drive the owners to use more harsh training methods, which has also been observed to occur with more 'demanding' children. A child's coercive and challenging behavior has been observed to push the parents to use more harsh discipline (Rutter, 2006).

13.5.2 Is a dog companion a resilience booster?

Do dogs benefit from the company of other dogs? The wolf, the dog's ancestor, is a social animal that lives in either family groups or in a larger pack. The research on the importance of the company of conspecifics to the domestic dog's welfare is largely lacking. We know from other social animals that the bond between individuals is very important for survival and fitness. For example, in female baboons, the best predictors of offspring survival and longevity were the sociality index and the partner stability index (Silk *et al*., 2012). In dogs, a few studies suggest that dogs might also benefit from the company of other dogs. Social isolation has been found to be a major stressor in laboratory dogs, where dogs that are housed individually display more abnormal behavior when compared to dogs that are housed as groups (reviewed in McMillan, 2016). Also, among family dogs, multi-household dogs were reported to have less fearfulness and aggression in comparison to dogs living without conspecifics (Tiira and Lohi, 2015; Serpell and Duffy, 2016; Puurunen *et al*., 2020). Dogs can form relatively similar relationships with both humans and other dogs, and sometimes the relationship with the conspecifics is much stronger than that with the owner (Cimarelli *et al*., 2019). The company of a familiar dog has also been shown to expedite the recovery from stress in a study involving dogs with noise sensitivities (Dreschel and Granger, 2005).

13.6 Genetic and Epigenetic Factors

Several genes have been linked to the stress response, which can affect how well we cope when facing adversities. The genes implicated in regulating the HPA axis, including glucocorticoid receptor (GR) and FKBP5, have been linked with individual resilience. Moreover, studies across rodent and human populations have revealed associations between resilience and the genes responsible for serotonin transporter functions, COMT, BDNF, and the encoding of neuropeptide Y (NPY) (Feder *et al.,* 2009).

In livestock studies, several traits associated with resilience have been found to have moderate heritability, and thus breeding for resilience has been suggested as one possible tool in the pursuit to increase positive welfare in production animals (Colditz, 2022). We know that individual personality is affected by genes, and heritability estimates of human personality range from 17% to 65% (Sanchez-Roige *et al*., 2018), thus indicating that the ability to bounce back involves a heritable component. In fact, a heritability of 30% has also been calculated for the resilience trait in humans, focusing on psychiatric resilience (Amstadter *et al*., 2014). As in humans, the personality heritability estimates in dogs vary between 20% and 50% (Goddard and Beilharz, 1982, 1983; Van Der Waaij *et al.,* 2008; MacLean *et al.,* 2019). Genome-wide association studies have revealed associations between genomic regions and fearfulness and noise sensitivity in dogs (Sarviaho *et al.,* 2019, 2020), hence verifying the genetic basis of these traits. Therefore, also in dogs, breeding seems likely to become an effective tool to increase the number of resilient dogs worldwide.

Early life events have profound effects on individual resilience; moreover, these effects may last for several generations due to the epigenetic mechanism (Meaney, 2001; Turecki and Meaney, 2016). Early life adversity, trauma, or poor level of maternal care can produce changes in gene expression, which in turn causes changes in stress susceptibility. These changes can continue to exist for several generations. Methylation is one of the epigenetic mechanisms that generate changes in gene expression. The methylation of GR has been observed to be associated with early life adversity in several human and animal studies (Turecki and Meaney, 2016). In a recent study in dogs, the methylation level (across 3000 loci) was linked to stranger-related fear and energy level, and the authors suggest that these behaviors are partially predictable based on individual DNA methylation level (Sanders *et al*., 2022).

13.7 Measuring Resilience

In animal production, there have been several types of measurements that have been considered to reflect animal resilience and welfare (Colditz, 2022). In livestock production, many factors that maximize the efficient production of milk, eggs, and meat are often detrimental for individual resilience and welfare (Scheffer *et al.*, 2018), and thus productivity itself is not a measure of resilience. For example, cows that have high milk production have lower resilience (Poppe *et al.*, 2020). Factors such as pathogen load, disease resilience, and immune competence have been used in animals as one measure of resilience (Scheffer *et al.*, 2018). Also, the structure and especially the complexity of behavior have also been suggested to be one way to measure resilience and welfare, as behavioral complexity is reduced in stressful conditions (Asher *et al.*, 2009).

Various personality and mental tests have been developed for dogs, many of which measure the reaction and recovery from novel and potentially frightening situations. Most likely these tests also provide information on the dog's personality-related resilience, since the ability and speed to recover from frightening situations are among the main traits of interest in these tests. Although personality is rather stable in dogs from one year onwards, sometimes individual resilience might change due to environmental factors; traumatic events can increase fearfulness and aggression in dogs (Wallis *et al.*, 2020). In this case, the detailed observation of small changes may become important.

Small changes in the dynamic system may be good indicators of an approaching 'tipping point' – characterized by a 'critical slowing down' (Scheffer *et al.*, 2009). This phenomenon has been proposed for mood systems in humans, where a slowing down may manifest as a slow recovery of mood from a bad experience, and may be an indicator of the possibility that the person may 'tip' to a transition into depression (van de Leemput *et al.*, 2014). As noted by Scheffer *et al.* (2009), 'The interpretation of resilience takes a special twist in systems that have a tipping point', as the individual's resilience will vary with the stability of mood-related tipping points. If equally applicable to nonhumans, it could mean that small changes in dog mood recovery may indicate changes in resilience, which gives important information for the dog owner when monitoring their dog's welfare.

13.8 Conclusions

Resilience research in other mammals combined with the current knowledge of the dog offer us substantial knowledge of dog resilience as well, even though this concept has not yet been extensively studied in dogs. It seems that personality plays a major role in dogs, and most likely in other animals as well. Because personality has a relatively high heritability, it can be expected that resilience in dogs can be increased (and decreased) by breeding. The same also applies to other species in cases where humans are responsible for their breeding. Breeding for a bold and social personality most likely also increases resilience and resistance to stress and traumatic events. Social relationships as well as the early growing environment are also crucial factors of resilience in dogs, and consequently for their mental well-being as well. Sufficient socialization, good maternal care, and environmental stimulation of puppies also support their stress resistance. In the end, the keys to stronger resilience in dogs and other domestic animals are in the hands of the owners and breeders.

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14 Emotional Disorders and Problem Behavior: A Psychobiological Perspective with Implications for Diagnosis and Humane Treatment

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14.1 Introduction

Historically there have been two fundamental approaches/traditions to studying animal behavior and elucidating its function. These can be characterized as the ethological/evolutionary approach of Lorenz, Tinbergen, and von Frisch (Font, 2023) and the experimental psychology/behaviorist approach of psychological science pioneers such as Skinner (1938) and Pavlov (2010). Ethology was typically undertaken in a field setting, with hypotheses tested from observations of the relationships between events and behavior in more naturalistic settings. The focus was often on the adaptiveness and evolution of certain behavior strategies. By contrast, experimental psychology was classically undertaken in a highly controlled laboratory environment so that the effect of specific variables on behavior could be deduced, and the 'laws' governing the expression of behavior, elucidated. Both are notable for their emphasis on observable events and have come to epitomize opposite ends of the nature–nurture debate concerning the role of genes and innate processes versus the environment and learning on the regulation of animal behavior. An alternative way of framing this is to consider the greater emphasis given by ethology versus psychology, respectively, to the importance of ultimate versus proximate factors in the study of behavior (Mayr, 1993). As highlighted by Tinbergen (1963) in his seminal work, the key questions to be addressed in order to understand animal behavior can be divided into four areas of interest: phylogeny (evolutionary history), adaptive value, ontogeny (lifetime development) and mechanism (but see Bateson and Laland, 2013 for a more nuanced appreciation of this). When nonhuman animal behavior is labeled as problematic, however, academic study seems to have taken its lead from the human field and perhaps neglected the first two of these levels of explanation of behavior, focusing instead on ontogeny and mechanism through the disciplines of psychology and psychiatry. This perhaps arose from a largely subconscious hegemony within science that has favored physical reductionism (Rosenberg, 2001). Accordingly, the emphasis given to the environment by psychology and to genes and metabolites by psychiatry in sculpting behavior has dominated our thinking on this topic. There is a risk that this approach overlooks the essential evolutionary and functional considerations that were traditionally provided by the ethological study of behavior. Indeed, the medicalization of behavior within human psychiatry often results in the reframing of problem behavior (and associated mental health issues) in terms of various forms of non-functional pathology or disorder. This perspective (epitomized by what is commonly described as biological psychiatry; Trimble and George, 2010)

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can covertly, or overtly, imply that there is some form of qualitative difference at the biological level that defines the disorder and separates it from 'normal' behavior. Not only have years of scientific progress failed to identify reliable biomarkers of psychiatric problems (Venkatasubramanian and Keshavan, 2016), but there is growing awareness that this perspective is at odds with the mechanistic continuum expected within biology. Concerns over the traditional psychiatric paradigm and its failure to place human mental illness within a proper evolutionary (and thus biological) framework have increased demand for psychiatry to embrace a stronger evolutionary framework (McGuire and Troisi, 1990, 1998; Nesse, 1990, 1998, 2019; Murphy and Stich, 2000; Troisi, 2015, 2024). A similar concern has been raised in relation to medical models of problem animal behavior (Mills, 2003), with a more recent proposal for a psychobiological approach by the author (Mills, 2022).

Fundamentally a psychobiological approach involves a synthesis of contemporary psychology, neurobiology, and ethology alongside related disciplines with an interest in the study of animal behavior to offer explanations of problem behavior that are not only predictive but also have validity within an evolutionary framework. As such, the psychobiological approach generally rejects the compartmentalizing of the underlying mental processes by reference to disorders, or on the basis of concepts of normality and abnormality that is such a prominent feature of the medical model of problem behavior. Indeed, as argued below, the concept of abnormality may confuse our thinking about the link between problem behavior and welfare.

14.2 Behavioral Abnormality and the Concept of Disorder: A Psychobiological Perspective

Historically the concepts of normality and abnormality have been central to considerations of animal welfare; for example, the five freedoms that form the basis of much animal welfare legislation internationally include reference to the importance of animals having the opportunity to perform most normal patterns of behavior. However, it is not clear what 'normal' means in this context and therefore what is acceptable in practice, since some responses like fear responses are clearly a normal part of an animal's behavior repertoire that keeps them safe, but may be undesirable from a welfare perspective. Literally, the term 'abnormal' means away from the norm and the norm is conventionally defined in a statistical sense as that which covers 95% of the population. However, behavior varies with context, and so the question arises: what context or contexts should be used for the point of reference for defining the norm? For example, stereotypic behavior might be considered abnormal because it is generally not seen in free-roaming animals, but given that behavior varies with context, it can be argued that we would not expect animals that have adapted well in captivity to behave the same way as when in the wild. However, if horses in captivity are considered as our reference point, then using a statistical approach it might be argued that it is not abnormal for horses to repetitively weave since it occurs quite frequently depending on context (for example, according to one report, over 20% of breeding mares were reported to weave (Benhajali *et al.*, 2014)). Simply labeling a behavior as abnormal because of its rarity adds nothing by way of value to our consideration of any mental health implications. There is no logical reason why a rare behavior should necessarily be related to suffering and thus welfare. However, this is just one way in which the term normal (and abnormal) may be used, and herein lies another problem with the use of the term. Wittgenstein (1958) argued that many conceptual categories are defined by shared features; so whilst things that belong within a given category have certain resemblances, they do not necessarily share all of the same features. In relation to abnormality, Seligman *et al.* (2001) have identified seven other features (beyond statistical rarity) that contribute to individuals choosing to refer to something as abnormal, and several are highly subjective. Thus, the term 'abnormal' may also be used to describe a behavior that features any of the following:

Vividness and unconventionality: This refers to behaviors that stand out because they do not appear to be the 'norm'. The observer's personal frame of reference is important in determining what stands out to them (which might be its rarity and so related to the statistical concept discussed above). Accordingly, this usage is insufficient to link abnormality with any form of suffering or disease.

Unpredictability and loss of control: Behaviors that cannot be predicted are often described as abnormal because it is not possible to identify what is

controlling the behavior. It is possible that this is due to a genuine breakdown in behavioral control, but it is perhaps more often a reflection of the knowledge of the observer. Accordingly, once the occurrence of the behavior can be predicted, it may cease to appear abnormal. For example, an owner who cannot predict their dog's aggression may describe it as abnormal, although a clear stimulus may be discerned by a clinical animal behaviorist who is asked for help with managing the problem. Once the owner appreciates this and, as a result, can predict the behavior, they may stop thinking of the behavior as abnormal but rather focus on its inconvenience to them and others. Thus, the use of the term abnormal in this sense is not logically necessarily linked to any pathology or suffering.

Violation of ideal standards: Universal (rather than personal) standards of behavior may be set which, if they are breached, may result in the behavior being referred to as abnormal. For example, it is generally accepted that domestic species such as cats, dogs, and horses should not be aggressive towards people, so if this should occur then it may be considered abnormal, even if it can be understood. Again, there is no logical necessity for behavior described as abnormal in this way to be related to suffering or pathology

Irrationality and incomprehensibility: Similarly, if the function of a behavior cannot be understood, it may be described as abnormal until it is explained. Some displacement behaviors (simple behaviors that appear out of context, often when the animal is conflicted) are often described as a form of abnormal behavior; however, there is growing evidence to suggest that these may serve a role in helping to reduce arousal at times of motivational conflict (Broom, 2019). Thus, in this example, although the behavior might occur at times of psychological discomfort, the behavior itself may be functionally important in serving to reduce this.

Observer discomfort: If a behavior causes concern to its observer for any reason (although the reason for this should be given and justified), then it may also be described as abnormal on this basis. This is especially the case when the behavior appears to breach some conventional norms. For example, dogs may mount an individual or object such as a cushion when frustrated as a form of displacement activity. This behavior may be a source of some embarrassment to the owner who is likely to describe it as some form of abnormal sexual behavior as a result. Some of these behaviors may be associated with poor welfare, but this is not necessarily the case, and any link to disease is similarly nebulous.

Maladaptiveness: This refers to a behavior that fails to fulfill its goal at either an appetitive or consummatory level, e.g., a failure to return the animal to a desirable homeostatic state (Craig, 1918). This includes suboptimal behaviors such as the ingestion of a non-nutritive foodstuff. In some cases, these behaviors may be incidental and have little impact on well-being; however, often these are a cause for concern (and thus further investigation) if we are interested in the individual's mental well-being.

Suffering: Behaviors that are believed to be related to suffering are often described as abnormal, as suffering is not considered to be the normal state in which an individual should exist (see Chapter 11, this volume, for a more extended discussion of suffering). This includes a range of behaviors associated with negative emotional states like fear and frustration. There are several ways in which behavior and suffering may be related. The behavior may be a sign of suffering or cause harm to the performer (e.g., self-mutilation) or to another (e.g., aggressive behavior). Any behavior associated with a large effort may cause mental suffering if it is prolonged, even if the animal does succeed in adapting, because of the drain on physical and psychological resources arising from the response. When the term abnormal is used in this context, then there is clearly a relationship with mental well-being. In which case, it might be preferable to say the behavior is indicative of suffering rather than refer to it being abnormal and risking it being misunderstood since, as noted above, being 'abnormal' is not sufficient to indicate that suffering may be occurring. It would then be preferable to indicate how the behavior relates to suffering. Thus, the term 'abnormal' is superfluous in this context because it adds nothing useful about welfare beyond what has been captured by the term 'suffering'.

Likewise, it can be argued that the term 'disorder' is equally unhelpful because it may be taken to imply a state of mechanistic disruption, when the behavior may be functionally normal even if it is maladaptive from a biological perspective. (This topic is discussed further with examples from the horse in Chapter 17 of this volume.) From a psy-

chobiological perspective, functionality refers to the extent to which the behavior follows the rules associated with its evolutionary (ultimate) function, whereas adaptiveness is used to refer to the degree to which the behavior helps the animal adapt to the environment in the short term (i.e., in a proximate rather than ultimate sense (Mills, 2003)). In the natural world, natural selection will ensure that functionality and adaptiveness are closely aligned. However, this is not aways the case in the domestic situation where the animal may face novel environmental challenges that affect its behavior, for example, absolute restrictions to its free movement. In this situation the individual can only apply the evolutionary rules of thumb that helped its ancestors to successfully adapt in the wild. Thus, a natural response to a barrier in the wild might be to walk around it or to try to break through it, if there is a desire to be on the other side. These are functional responses (from an evolutionary perspective), but when the barrier is a solidly fenced enclosure or building that cannot be broken down, then welfare problems can arise. The animal may be caught in a repetitive cycle of walking round the enclosure or harm itself in its attempts to break down the barrier, if there are cues outside that continue to attract the animal, or stimuli within the enclosure from which it wishes to escape. This is a maladaptive response, in so far as the behavior is not achieving the goal. Whilst it might be argued that the rational thing to do would be to accept the limitation, this degree of rationality may be beyond the cognitive ability of the individual; indeed, such a passive response might have actually been selected against in a wild situation as it might keep the individual in a dangerous situation or reduce its chances of exploiting a valuable resource. In this situation, the animal will struggle to adapt to the unresolved challenges, and both mental health and welfare can be expected to be compromised. By labeling such responses as disorders, it is easy to overlook their functional basis and the degree to which the animal is operating in a fundamentally healthy way. The temptation may then be to intervene to redress some supposed chemical imbalance, which is seen as the cause of the problem (movement disorder, self-mutilation disorder, etc.), which can downplay or obscure the biological significance of the interaction between the animal and its environment as the origin of the problem. Appreciating these wider psychological, neurobiological, and ethological dimensions to the situation is in line with a psychobiological perspective of the problem. However, another important feature of psychobiological philosophy concerns an appreciation of the wider nature of the cause of the behavior beyond its environmental antecedent. This is discussed in the next section.

14.3 The Concept of Cause – A Psychobiological Perspective

In the previous section we considered some of the problems arising from the medicalization of problem behavior into distinct disorders, and the inability to define a clear biochemical marker or cause of the disorder. Whilst all behavior has a biochemical basis, the failure to find distinct markers probably reflects the complexity of the processes involved in the expression of such behavior, and the limits of a reductionist approach in such a complicated system. A similar issue arises from the physical reductionism, which has also laid the foundation (albeit in a different way) to a second major approach to problem behavior: the behavioral approach. This can trace its origins back to behaviorism and its influence on the animal-training world. Whilst reductionism's ability to dissect out elements of the complexity of a problem has undoubtedly been instrumental to many scientific advances within the field of behavioral biology, the limits of this approach need to be placed in context. The elegant work of behaviorists working in highly controlled (and thus often barren) laboratory environments has teased out many important 'laws' of behavior. However, as noted above, these show how certain events can influence behavior and not what necessarily are the main influences in the complex natural world in which most animals live. The behavioral approach to problem animal behavior has aligned itself with the discipline of Applied Behavior Analysis within clinical psychology (Sarafino, 2011). The behaviorist tradition means processes within the central nervous system, like emotional state, are not the focus of attention in either the assessment or management of problem behavior, although many practitioners are clearly concerned about animal welfare (e.g., Pryor, 2009; Bailey and Burch, 2016; Protopopova *et al*., 2016). Instead, the focus is on the behavior of the individual and the observable events that appear to control it, with treatment coming through the management of reinforcement schedules relating to the behavior (e.g., Dorey *et al.,* 2012; Protopopova *et al*., 2016). It is

probably for this reason that so much focus has been given to the antecedent stimulus as the cause of behavior. However, behavior arises within the context of the state of the brain which is not simply responding to the physical features of immediate antecedent events like the stimulus or trigger but placing them within the much broader context of the wider general environmental context and the current neuro-endocrinological state of the individual (Fig. 14.1). The architecture underpinning this state of the brain is the product of general ontogenic (lifetime) experiences and influences at key maturational stages (sensitive phases/critical periods), neonatal and prenatal periods in its early development, as well as the cultural experience of the individual (especially in terms of setting the norms for responding). These are themselves built upon the form of brain that developed because of genetic and other inherited (epigenetic) factors that have their origins in the individual and phylogenetic (evolutionary) history that produce both species and breed-typical behavioral predispositions to certain types of stimuli. In short, there is no simple cause of behavior but there is a need to appreciate that these are represented in the brain and have an important impact on the likelihood of a response to a given stimulus. It seems futile to try to quantify all of these influences separately in any given case, but their sum effect can be indexed from the wider behavioral predispositions of the individual.

In this regard the psychobiological approach integrates consideration of three levels of influence that are encoded in the state of the brain at any given time. These three levels of influence are often described in relation to their temporal features:

- The perception of current events and associated predictions. These create a short-lived dynamic status within the brain (emotional reactions) and influence related behavioral motivations.
- Internal episodic states that create a time-limited bias in behavior (e.g., mood). This includes factors like the influence of physiological changes arising from the breeding cycle or whilst recovering from illness.
- Relatively persistent architectural predispositions in behavior (e.g., temperament and personality traits). These are the predispositions that arise as a result of the interaction of genes and the environment over the lifetime of the individual (the brain is constantly developing).

These all impact the likelihood of a given response, at a given time, in a given context, and while each of these can be offered as explanations of the cause of a given behavior, such explanations are incomplete from a psychobiological perspective. For example, when explaining why the dog bit the child, someone might say it was because the child got too close, because the dog had just had pups and so was protecting them, or because it is an aggressive breed. None of these explanations are factually incorrect statements, but each oversimplifies the situation and fails to articulate the complexity of the nature of cause. The psychobiological approach seeks to integrate these within a much more holistic framework, with an important distinction made between motivation and emotion as key psychological constructs. Both motivation and emotion each have three forms of expression in the brain and related behavior, based on three temporal frames described above (dynamic reactions, episodic states, and persistent predisposition). The short-lived dynamic reactions are typically described in terms of forms of specific behavioral outputs that have high motivation at that time (e.g., eating) or short-lived emotional (e.g., fear) reactions; the episodic states are described in terms of specific motivational predisposition (e.g., hungry) or mood in the case of an affective state (e.g., irritable); and the relatively persistent predispositions are expressed using the language of personality (e.g., greedy) in the case of motivational predispositions and temperament (e.g., nervous) in the case of emotional predispositions. Before discussing these further, it is worth noting the way in which motivation and emotion are conceptualized within the psychobiological approach.

14.4 The Concepts of Motivation and Emotion and their Interrelationship

While there is no clear scientific consensus on the definition of an emotion, there appears to be increasing agreement on some of the building blocks that characterize emotional behavior (emotion primitives *sensu* Anderson and Adolphs, 2014), i.e., persistence, scalability, valence, generalization, global coordination, prioritization, and social communication.

Historically, there has been a lot of inconsistency in the language associated with motivation and emotion, such that problem behavior may be described in relation to each as if they are interchangeable or interconnected (e.g., emotional motivations). However, within a psychobiological perspective, emotions prepare animals for action by

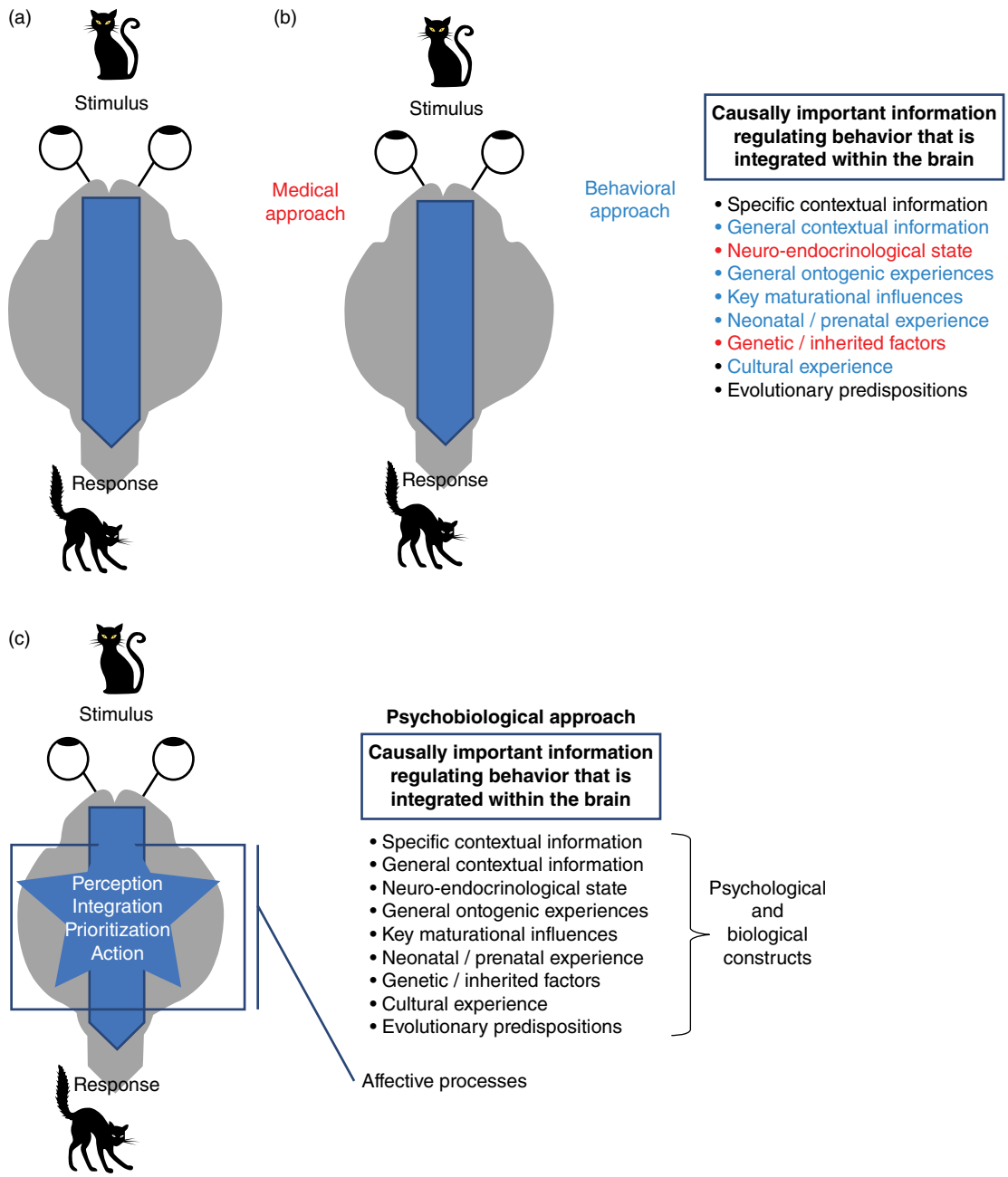


Fig. 14.1. Representations of behavioral cause. (a) Traditional view of cause in terms of an immediate antecedent stimulus triggering a response. The trigger is the cause in only a very limited sense. It is the immediate antecedent that might predict a certain response, but its impact is probabilistic and not deterministic as it acts through the animal. The response is not inevitable in the real world. There is always uncertainty. (b) Showing different causally important information that is integrated within the brain, which is emphasized by the two traditional approaches (blue, behavioral approach; red, medical approach) to problem behavior in animals in addition to the specific context. (c) The psychobiological approach considers all relevant information by using a range of biological and psychological constructs, whilst also emphasizing how the external environment is reconstructed as subjective perceptions that create the animal's umwelt.

creating behavioral predispositions or action tendencies, while motivations relate to the regulation of a specific behavior. If a dog is described as being protective when he bites, then the emphasis is on the motivation of the behavior (protection), whereas if the dog is described as being scared when he bit, the explanation is referring to the emotional state of the dog. Failure to recognize that these are two different aspects of the same state can result in diagnostic assessments that suggest multiple problems when only one exists, e.g., that the dog has both protective and fear-related aggression (Mills and Ewbank, 2016). An important feature of the psychobiological perspective is a specific distinction between motivation and emotion as described below.

From the psychobiological approach's perspective, the term '*motivation*' is used to describe specific biological function (goal) of a behavior and the motivational state refers to an intervening variable that encapsulates the tendency to perform a given behavior. The brain integrates the three levels of influence on a specific behavior described above, within the context of competing motivations at any given time. Thus, motivational state reflects a potentially diffuse state of activity within the brain that includes the evaluation of other behavioral options and priorities at the time. Motivation is, nonetheless, considered to be a behavior-specific construct, i.e., we can talk about the motivation behind a threatening gesture. By contrast, the term '*emotion*' is used to describe a complex, individualized reaction pattern within the brain to a personally significant matter or event that results in certain physiological and behavioral tendencies that support a particular strategic goal. Thus, unlike motivation, it is not behavior specific; we may talk about fearful behavior arising as a result of a perceived threat, but there are many behavioral options associated with the state of fear (the classical three 'F's of fight, flight, and freeze), but which of these is expressed at a given time depends on the strength of the *motivation* for each in the circumstances, though they all serve the specific functional goal of reducing the risk of harm to the individual. In other words, an emotional response has organizational effects and, amongst other things, creating a state of readiness, such as certain behavioral tendencies, associated with a specific biologically important goal (survival in the face of a perceived threat in the case of fear); however, which behavioral option is selected will be dependent on another level of behavioral regulation, i.e., motivation (Fig. 14.2). Thus, emotional state refers to the psychological position of an individual within this multidimensional affective space, based on perceived personal priorities at a given time, and, hence, this model of emotion shares similarities with the state-space model of motivation proposed by McFarland and Sibly (1975); however, within the psychobiological approach, this affective layer of responding is a separate intervening variable, which is hierarchically organized above that which relates to motivation and more discrete motor outputs (Fig. 14.2). This separation of emotion and motivation is necessary, since emotional responses are much more pervasive in their effects, affecting not only behavior but also attention, memory recall, and a wide range of cognitive processes.

Of particular interest to those concerned with mental well-being are the emotional feelings that arise as a result. These serve to inform the organism of its state (Damasio, 2021) and reflect the state of the brain when it consciously represents ongoing emotional processes and priorities, which is one of the many components of emotion. Damasio (2001, 2004, 2021) argues that the evolution of feelings is derived from an interplay of the development of the diencephalon alongside the systems involved in homeostatic monitoring of the self. At its simplest, this system can alert the body to something not being right either internally or externally, and this deviation from ideal may be registered as some form of 'discomfort' or aversive state that the animal can choose to respond to or not, depending on circumstances. It seems adaptive that depending on circumstances this is given some more specific quality based on the related biological strategies required to address this discomfort. The strategy will vary with the nature of the challenge being posed (see discussion below on affordance categorization) and there is no reason to suppose this is a unique human or primate ability, since dogs have been shown to possess some form of multi-sensory emotional categorization process (Albuquerque *et al*., 2016). It is worth emphasizing at this point that the process of functional categorization of emotion by the brain should not be confused with its verbal labeling by the individual experiencing it, which is a much rarer phenomenon based on the individual's linguistic ability, i.e., being able to verbally label an emotional state is not a prerequisite for its categorization.

Emotional responses are thus multicomponent (Scherer, 1984), in that they affect several key subsystems (Table 14.1) including:

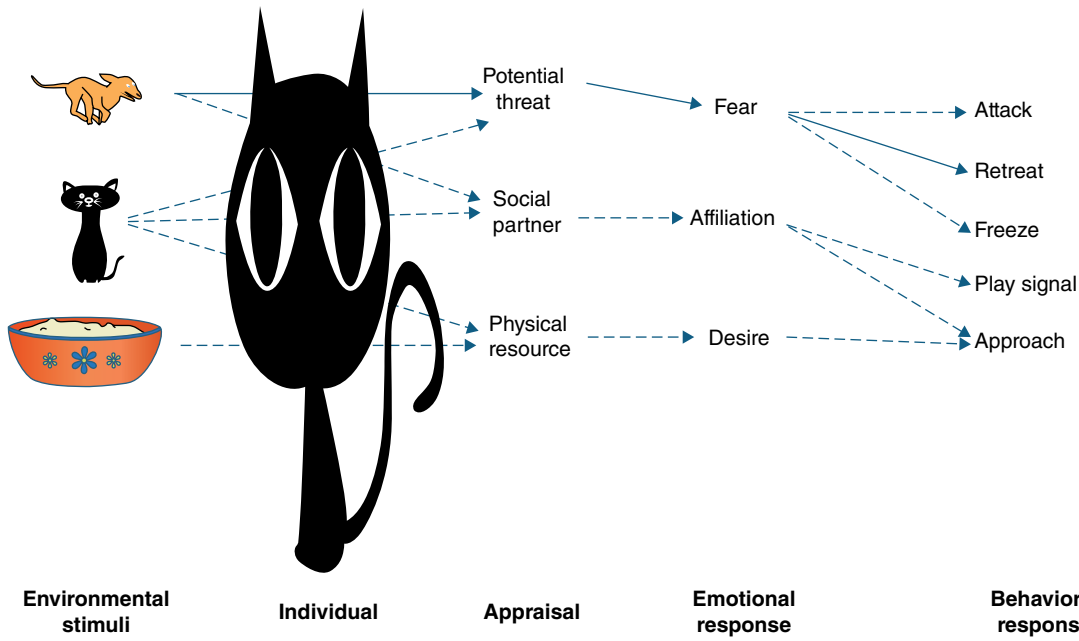


Fig. 14.2. Hierarchical organization of emotional and motivational systems in relation to behavioral control. In a stimulus-rich world, animals respond to the stimulus/stimuli that are most salient at a given time. This depends on how competing stimuli are appraised and their associated emotional response. The emotional reaction has an organizational role by setting the tone physiologically and for different types of behavioral predisposition. Which behavior is actually expressed amongst those associated with the predominant emotional response will depend on motivational strength for a given response given the current context.

Table 14.1. The multiple components of emotion, the subsystems involved, and associated function.

Component	Subsystem	Function
Cognitive Appraisal	Information processing	Evaluation of events and objects
Neurophysiology Bodily signs / arousal	Support	System regulation and preparation
Motivation Action tendency	Executive control	Direction of action
Motor expression General (e.g. stylistically distinct form of a response) and Specific (e.g., facial) behavior	Action	Communication of reaction and intention
Subjective feeling Experience	Monitor	Monitoring and coordination of internal state relative to organism–environment interaction

- those subsystems involved in information processing and especially the appraisal of both internal and external stimulus information, which is being continuously presented to the brain;
- those involved in supporting the organism through neurophysiological regulation to ensure an optimal state is maintained (through predictive allostasis) or reacquired efficiently (through reactive homeostasis);
- those involved in the executive control of behavior to prioritize certain behavioral tendencies associated with specific life goals (e.g., self-preservation, maintenance, reproduction, etc.);

- those involved in communicative action that signal intent and internal state; and
- those involved in conscious monitoring of the individual's state, which is expressed in terms of feelings.

Within the psychobiological approach, it is argued that the appraisal component is focused on the affordance qualities of potentially relevant stimuli in the environment. Affordance theory (Gibson, 1966) argues that the world is perceived not just in terms of its physical properties, but also in terms of its relationship with and value to the perceiver. To this end, various events may be appraised as relevant to achieving particular goals of particular importance to the individual. Thus, depending on the relationship between the individual and the observer, a female of the opposite sex to the observer might be appraised as a mother-like figure (carer), as like an offspring (dependent), a potential sexual partner, a social group member, or a potential social threat. Depending on the appraisal made, the observer will tend to behave in a particular way towards the individual on the basis of the emotional state arising from this appraisal. For example, if the individual is appraised as a potential mate, then a range of behaviors may be shown that are functionally directed towards the opportunity to mate, but if the individual is appraised as a dependent then the suite of behaviors expressed will reflect protection and nurturance of the individual. This emphasizes the organizational role of emotional response, and indicates that emotional states can be considered in relation to a limited number of fundamental psychobiological goals (see below). This perspective also reinforces recognition of emotional arousal as a pervasive state within the brain that infuses a wide range of brain functionality at any given time, rather than emotional states existing as discrete centers within the brain. Accordingly, from a mechanistic perspective we have to consider emotional experience as the product of much more diffuse emotional networks in the brain than the discrete circuits (affective systems) identified by the pioneering affective neurophysiologist Jaak Panksepp (1998). This perspective of emotion as affordance-defined categories also helps to explain the individual variability noted by those who favor a more constructivist view of emotion (Lindquist *et al*., 2012). From a psychobiological perspective, Panksepp's (1998) proposal for relatively hard-wired circuits (albeit modified by learning) and Barrett's (2017) argument that they are largely constructed are not irreconcilable. Some of the hardware relating to core affective processes may indeed be relatively hard-wired, but that does not mean that animals cannot construct emotional categories at a higher level based on their experiences. The two extremes are in effect opposite ends of the nature–nurture debate (i.e., the extent to which behaviors are innate versus learned), which has a long history in animal behavior that persists to this day.

Emotional states and related feelings are thus also multidimensional in that they are a blend of specific emotional responses related to different biological goals, each of which is scalable (i.e., varies in intensity). Thus, the experience of fear in response to a threat and frustration at the inability to find safety is different to the experience of frustration at being unable to access a resource, which is accompanied by fear from the threat of anticipated punishment from an owner trying to stop the animal from accessing the resource, even though both involve a blend of fear and frustration.

Since the emotional impact of a potential stimulus will depend on the wider circumstances of the individual, the relationship between stimulus and emotional response may be less reliable in the sensorially complex world in which an individual naturally lives than in a controlled laboratory environment. Accordingly, relevant stimuli are referred to as 'emotionally competent stimuli' (or ECS), to convey the sense they have the potential (competence) to give rise to a particular emotional response, but do not necessarily do so (Damasio, 2004). Their effect will depend not only on how they are perceived, but also how this perception sits relative to others and the predictions being made about the environment by the brain. From a practical perspective, it is important to appreciate the distinction between the specific stimulus characteristics that might be related to a particular emotional response and how it is appraised. Thus, emotionally competent stimuli related to fear include sudden and or loud noises because these are appraised as a potential threat to the individual. Using this approach, it is possible to develop a suite of stimulus characteristics associated with particular emotional states that can be understood within an evolutionary framework. From a clinical animal behavior perspective, where the emphasis is on identifying the functional biological basis to problem behavior and devising practical solutions, it is suggested that it is useful to distinguish at least nine classes of emotional response (Table 14.2).

Table 14.2. Nine classes of emotional responses, related unconditioned emotionally competent stimulus features, and affordance quality as a result of appraisal of these characteristics as a 'rule of thumb'.

Emotion	Emotionally competent stimuli	Affordance quality following appraisal
Fear	Looming/shadow projection, spatial properties depending on species (e.g., open areas, height, etc.), predator odor, unpredicted intense stimuli or changes in the environment, large discrepancies in expectation, species-typical threat behaviors and signals	Potential threats to the physical integrity of the individual
Frustration	Thwarting/restrictions to movement, touch/surface irritation, approach towards/crossing key spatial boundaries (e.g., personal space, territory), barriers to resources and reinforcers, unmet reward expectations (incl. insoluble problems), novelty associated with approach–avoidance conflict	Threats to autonomy: inability to execute a motivated behavior; uncertainty, denial, or absence of things that the animal wants
Desire	Reward prediction contingencies, mild novelty, unexpected rewards, intermittent variable reinforcement, general homeostatic deviations	Resources and reinforcers
Pain	Nociceptor stimulation, overstimulation of any sensory system, chemical signals of tissue damage	Tissue damage
Affiliation	Behavioral synchronization, reinforcement from shared social activity, species-typical play signals	Those with whom an affectionate bond is shared leading to future collaborative activity / mutual benefit
Attachment	Sources of key resources including sustenance, security and safety, pheromonal signals (appeasines)	Attachment figures and objects
Care	Paedomorphic features, care solicitation behaviors, certain chemical signals especially within a certain hormonal state	Dependents
Lust	Pheromonal reproductive signals, social signals of fitness and maturity	Potential sexual partners
Repulsion	Unfamiliarity/out-group membership including absence of relevant group markers, excessive losses/costs related to social interaction/inclusion, rejection by other in-group members	Out-group members

This has given new insights into some emotional states, such as the concept of anxiety. From a psychobiological perspective, this is a non-specific term used to describe the brain in a state where it predicts some form of aversive event. While anxiety is commonly equated with the state of fear, it need not necessarily relate to the prediction of bodily harm (the quality associated with fear), but might also relate to a loss of control (i.e., frustration from a psychobiological perspective). These insights are already yielding new benefits within the author's clinical behavioral practice in terms of the nature and reliability of intervention needed for effective management of different forms of anxiety. Whilst both might involve what are commonly described as systematic desensitization and counterconditioning protocols (Sherman and Mills, 2008), in the case of fear-related anxiety, the optimal strategy often appears to be to recalibrate the fear response using habituation and desensitization to lower levels of the provocative stimuli, before instigating counterconditioning to build coping capacity. However, in the case of a frustration-related anxiety, our experience indicates that the optimal strategy is to teach a coping response through some form of operant counterconditioning first and then to build resilience through desensitization to the provocative stimuli. These differences are entirely consistent with the psychobiological perspective. Fear-related responses are concerned with self-preservation and potential risk of harm. They are essential for survival and therefore have the potential to override ongoing behavior in order to 'save the individual'. Fear-related problems often involve an issue with the indexing of fear-related stimuli, such that non-threatening stimuli are unnecessarily perceived as a significant threat (Nesse, 2019). Thus, the activity of the patient is frequently disrupted by these responses. Accordingly, it is logical to focus on recalibrating the sensitivity of this system through

exposure to very low intensity stimuli before trying to teach the animal how to cope with them. By contrast, frustration responses relate to a loss of autonomy, and the teaching of a reliably reinforced specific response provides the animal with a specific behavioral strategy that can help to re-establish a sense of control over the environment when faced with the relevant stimuli at a later date.

In conclusion, the psychobiological approach invokes the concepts of motivation and emotion as intervening variables to explain the complex of distributed (diffuse) and localized (segregated) processes that operate within the brain. The concept of motivation is used primarily to understand specific responses, while emotion is a much more pervasive state. This conceptualization of emotion and motivation has helped to clarify thinking about the normal psychological and biological (evolutionarily functional) basis to much problem behavior, whilst avoiding some of the issues related to labeling problem behaviors as abnormal or a form of disorder. Problem behavior is thus typically seen to be a response based on normal functioning systems. Systematic evaluation of both the motivational and emotional elements of a problem response in a way that allows logical inferences to be made is not only an integral part of the diagnostic process within the psychobiological approach, but also a feature that makes this approach scientifically rigorous (Mills, 2022). The evaluative process is thus outlined in the next section.

14.5 Context, Motivation, and Emotion: The Three Elements of Problem Behavior Evaluation

Diagnoses are inferences about an individual and to be scientific require the assessment of evidence concerning alternative explanations. In effect, these explanations are hypotheses and like any scientific hypothesis they should be subject to testing. Thus, we must not only seek evidence in support of a given explanation, but crucially we must look for evidence that might falsify it, otherwise there is a risk of the diagnostic assessment being subject to confirmation bias, which is a common problem in clinical behavior practice (Wilson *et al*., 2024).

Assessment begins with a description and evaluation of the context in which the problem behavior arises. This means both when and where the behavior occurs, but just as importantly, when and where it does not. Associated with this is also a wider consideration of when and where the quality of the behavior might vary, e.g., in intensity. It is therefore important to establish a good description of the form of the response so that variation can be identified. On this basis, we can start to speculate about the underlying motivations for the specific responses, before evaluating the underlying emotions.

The assessment of motivation involves an adaptation of a process commonly described as a functional analysis of behavior (Hanley *et al*., 2003). This was somewhat ironically developed by behavior analysts (Baer *et al*., 1968), who, given their background in behaviorism, generally seek to avoid reference to internal psychological states like motivational state (Dixon *et al*., 2012). As part of this process, the antecedents, behavior, and consequences related to several examples of the behavior are carefully documented, in order to potentially identify potential reinforcers/punishers of the behavior. However, within the psychobiological approach, the product of this assessment is the generation and testing of hypotheses concerning the underlying motivational state of the individual in these circumstances. Greater weight is given to those explanations that are most consistent across circumstances. Relevant factors that might result in fluctuations in motivation between one context and another (described above in relation to their temporal persistence in Section 14.3) are also identified at this time (these are often referred to as 'motivating operations' within the behavior analysis literature (Michael, 1982)). This includes motivational predispositions relating to personality that might explain variation between individuals, since this reflects to a large extent how historical factors influencing behavior are encoded in the brain's functional architecture (see Section 14.3). This may also help with explaining to an owner why one dog behaves in a certain way but another does not, and is also integral to the process of risk assessment. With this information, the clinician can test predictions about a wider range of circumstances that have not yet been described when the behavior might occur or not. A hypothesis about the motivational state also allows the identification of a wider range of biologically relevant reinforcers, which might be most effective in the immediate management of the problem behavior. The identification of what has been tried but not worked can give important insights in this regard.

The assessment of the emotional aspect of the behavior builds on this assessment of motivation, using a process termed a functional analysis of

emotion (Mills, 2017). Functional analysis of emotion involves the triangulation of evidence derived from each of the first four components of emotion (Table 14.1) that can be described in nonhuman animals (subjective feeling cannot be evidenced in a scientifically defensible way). Thus, we evaluate the circumstance related to responses in terms of the potentially relevant emotionally competent stimuli or appraisals being made (Table 14.2), the nature of any arousal (this can be particularly useful in distinguishing emotional from non-emotional behavior), the behavioral tendencies or motivations exhibited by the individual at the time, and finally the semiotic content of any communicative gestures. Central to the process is the weight given to evidence that allows falsification of a competing emotional explanation for a given case (Mills, 2022).

Despite many popular texts describing the emotional basis to a range of animal signals (e.g., in dogs: Milani, 1986; Aloff, 2018; Krauss and Maue, 2022), a particular challenge to the study of emotion in animals has been the identification of the meaning of communicative signals and the signals that convey a particular meaning. Whilst behaviors may be co-opted for multiple reasons (e.g., animals run to both escape and to catch something), by definition emotional communicative signals should have significant predictive value, i.e., component process theory posits that a given signal should reduce uncertainty about the emotional state of an individual.

The functional analysis of emotion provides a scientific framework for the generation of material in both the laboratory and field setting to improve our assessment and understanding of emotional signals, by postulating observation-based hypotheses that can be tested in line with the traditions of ethology. For example, the failure to identify specific signals associated with a postulated emotional state might challenge the hypothesis that such a state exists in this species (i.e., it is beyond their experiential capacity), while signals that differentiate one emotional state from another may give insight into the emotional quality of other animals' lives. Critical to this process is the differentiation of motivational from emotional signals provided by the psychobiological perspective. Signals communicating the motivational intent can be expected to be relatively context/stimulus specific, whereas signals communicating the emotional state should be common across related stimuli (Bremhorst *et al.*, 2019). Thus, if we identify signals associated with a dog anticipating a food reward, we cannot distinguish between the anticipation of food and the anticipation of a reward; however, if we look for common signals across a range of reinforcers, e.g., toys as well as food, then we can identify markers of positive anticipation (desire, Table 14.2). This approach has been adopted in a number of recent laboratory studies examining both the specific signals associated with a particular emotional state and relative to another emotion arising in similar circumstances (Bremhorst *et al.*, 2019, 2022). However, the functional analysis of emotion also allows the generation of similar data from field settings that can be used in a similar way (Caeiro *et al.*, 2017). These datasets naturally have a lot of 'noise' within them, but they can potentially be generated much more quickly. Recent developments in computer vision and learning mean that the development of relevant datasets from the field can now be assessed and then subjected to automated analysis to generate classifiers for specific emotional states (e.g., Feighelstein *et al.*, 2022). This process will be further enabled through the generation of validated datasets of animal emotional expressions, which whilst currently unavailable, are now a realistic goal through the application of the functional assessment of emotion procedure described above. A key advantage of the artificial-intelligence-based approach is that we can move away from a focus on specific gestures (Bremhorst *et al.*, 2022), but examine the behavior and expressions of animals in a more holistic way to identify meaningful signals. Such global/configural assessment is arguably much more in line with how brains evaluate individuals than the identification of specific markers, which researchers have focused on to date out of necessity from the methods available to them.

Thus, although developed within the context of clinical animal behavior and problem behavior management, the psychobiological approach has much broader scientific applications within the field of animal behavior and welfare. Hypotheses about the emotional state of an individual, generated in this way, can be evaluated scientifically as it is a replicable process based on testing the falsifiability of hypotheses concerning specific states. This will hopefully lead to much deeper insight into the mental lives of animals.

14.6 Implications for Humane Treatment Strategies

By providing a focus on underlying psychological constructs like motivation and emotion, the psychobiological approach also puts a spotlight on the psychological impact of different forms of intervention as well, since these are centered on addressing these aspects of the behavior (see Fig. 14.3 for a case study of the clinical application of the psychobiological approach). Accordingly, interventions based purely on the behavior and context, e.g., treatments for food-related aggression, will be nonspecific and could be harmful. Only if the underlying motivation and emotion are elucidated can more specific interventions be offered. In some instances, such as where the problem is limited to a specific motivation in a single or very limited number of contexts, it may be appropriate to focus on the motivation for the behavior. Humane strategies that focus on the motivational basis of problem behavior include:

- Altering the specific target of the motivation, such as by redirecting the behavior using environmental enrichment and positive reinforcement of the behavior when it is expressed towards a suitable substrate. This might be appropriate when the behavior itself is important to the animal but it occurs towards a part of the environment that makes it a problem, e.g., problematic environmental scratching or latrine-related behavior by cats.
- Altering motivation for a specific behavior in the circumstances, such as through the use of incentives and rewards within the context of operant counterconditioning or differential reinforcement schedules to teach the animal a more appropriate behavior. This might be used, for example, in the context of a dog who jumps up to greet in order to teach it to sit to greet.

However, many problems involve problematic forms of emotional response or appropriate emotional responses of a problematic intensity. This is often evident from the individual presenting with multiple problems relating to the same type of emotional response and may be evident from high ratings in temperament features such as frustration, reward sensitivity, aversion sensitivity, and/or impulsivity, all of which can be assessed in dogs using validated scales (see Mills, 2023, for a review of these). In this case, humane strategies for intervention should focus on either:

- Controlling the intensity of arousal if emotion-appropriate, such as through techniques like systematic desensitization and possibly extinction, if the animal can cope with the associated frustration that this inevitably produces. Systematic desensitization is widely used in the management of fears and extinction may be appropriate for some attention-seeking behaviors. These techniques are often combined with positive reinforcement of alternative, more acceptable behaviors offered by the animal in the circumstances.
- Altering the type (quality) of emotion if emotion-inappropriate, such as through the use of emotional substitution, whereby a particular behavior associated with a positive emotional state is put on cue and positively reinforced. This is then used in low-intensity versions of the problematic situation. Over time, as the animal learns to cope and offer a more desirable emotional response and behavior, the intensity of the trigger can be gradually increased until the animal no longer shows the problematic response in the originally problematic circumstance. External cues may then be faded so that the environment now becomes the trigger for the new positive emotional response.

Response to treatment is also a potential test of the hypotheses of the underlying emotional and motivational basis to the problem. Thus, emotional and motivational assessment are ongoing processes that do not end with the initial diagnostic assessment. Using this approach, we have been able to not only simplify treatment by focusing on what we predict is necessary, but also develop new intervention programs (see discussion above of treatment of anxiety related to fear versus frustration, Section 14.4). This is important because many owners find the implementation of behavior modification plans demanding, and so reducing and simplifying such programs can be expected to increase client compliance.

Failure to focus on the underlying psychobiology of problem behavior can lead to the use of strategies that focus on suppressing the behavior, such as through the use of restriction or the use of aversives. These not only fail to improve the animal's mental well-being but may actively compromise it. Only if relevant psychological states are addressed appropriately is mental health improved. Thus, the psychobiological approach encourages the use of interventions that are not only efficacious but also focused on improving mental health and thereby humane.

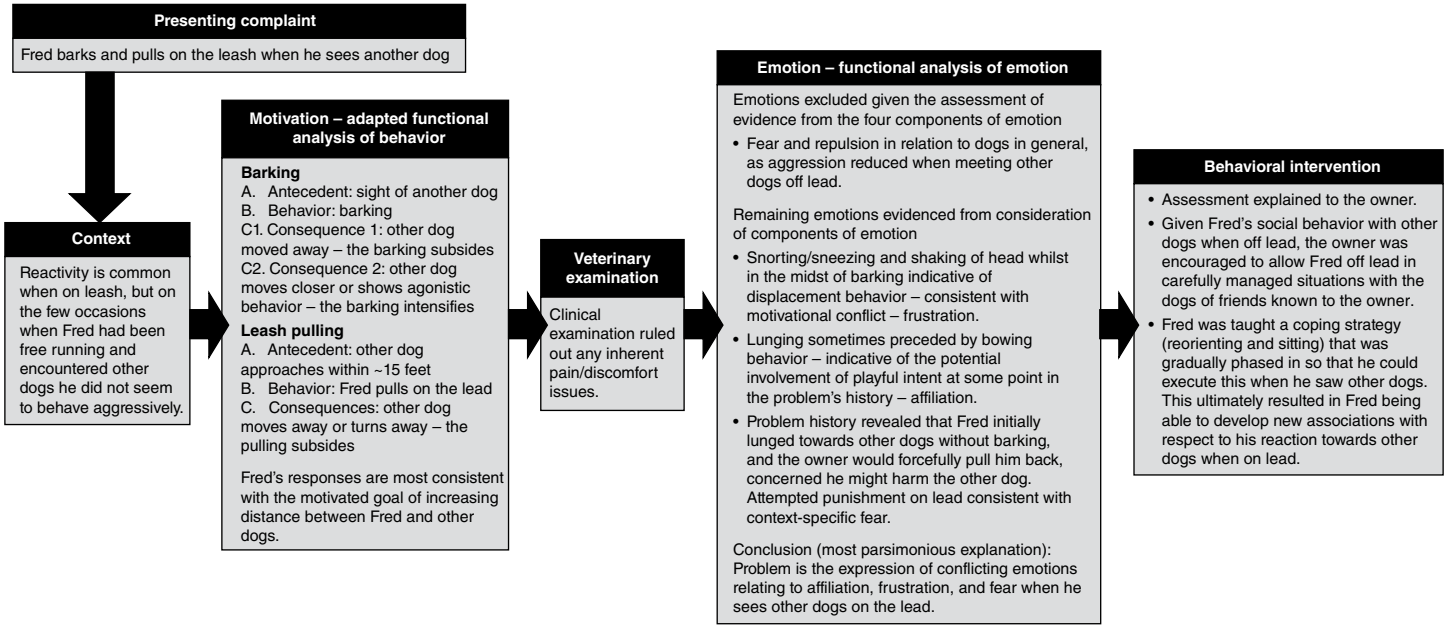


Fig. 14.3. Illustration of the application of psychobiological approach: Fred, the dog-reactive dog.

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Part 4 Mental Health Issues in Special Populations

15 Cognitive and Emotional Disorders in the Aging Pet

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Cognitive and emotional disorders are common in older domestic dogs and cats. In humans, there is significant interplay between cognition and emotion, with disorders in one increasing the likelihood of disorders in the other. This interplay is complicated by other conditions common in older age including comorbidities which can contribute to similar clinical signs. Recent work has focused on the impact of chronic pain, which has marked effects on emotion and cognition in humans (Gerrits *et al.*, 2014). These same interactions are present in companion dogs and cats (Mills *et al.*, 2020) and understanding and appreciating the presence and impact of cognitive and emotional disorders is important for maintaining and improving quality of life (Reaney *et al.*, 2017).

Pet owners and veterinarians may be tempted to dismiss changes in cognition and emotion as a normal part of aging in dogs and cats. Pet owners may even fail to recognize clinical signs of treatable disease; therefore, it is important for health professionals to proactively inquire about the behavior of aged patients using standardized history questions or questionnaires. Engagement with owners and discussion of signs to watch for can increase detection and earlier diagnosis of problems that might otherwise escape notice until they were significantly more advanced. Underlying changes in the brain (many of which are like those seen in the brains of aged humans with dementia) are associated with a list of identifiable clinical signs in pets and, importantly, treatments exist that can slow the progression of disease.

Among the most recognized conditions in aging dogs and cats is cognitive dysfunction syndrome (CDS), a progressive neurodegenerative disease. Although clinical signs are most reported in pets over 11 years of age, age-related cognitive decline can appear in animals as young as 6 years (Araujo *et al.*, 2005a; Salvin *et al.*, 2010). The disease manifests in the form of behavioral changes, impaired learning and memory, altered awareness, and confusion. In dogs, clinical signs can be categorized by the acronym DISHAAL: **D**isorientation, altered social **I**nteractions, **S**leep–wake disturbances, loss of **H**ousetraining and other learned behaviors, increased or decreased **A**ctivity levels, increased **A**nxiety or fear, and impaired **L**earning and Memory (Osella *et al.*, 2007; Rème *et al.*, 2008; Azkona *et al.*, 2009; Madari *et al.*, 2015; Pan *et al.*, 2017). Clinical signs in cats are similar, but often nighttime vocalization is a prominent clinical sign detected by owners, prompting the recommendation of the revised term VISHDAAL in cats (Sordo and Gunn-Moore, 2021). Basic functions such as self-hygiene, eating or drinking behavior, and response to stimuli can be compromised or altered (Rofina *et al.*, 2006), and sensory decline in vision, olfaction, and hearing may be present (Fefer *et al.*, 2022a; Khan *et al.*, 2023). In the laboratory, validated neuropsychological tests

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reveal quantifiable impairment in the learning and memory of affected animals (Milgram *et al.*, 2004; Tapp *et al.*, 2004; Pan *et al.*, 2010, 2013; Araujo *et al.*, 2012). Deficits have also been shown in pet dogs participating in clinical research (Fefer *et al.*, 2022b) but these assessments are not yet in widespread clinical use.

In practice, CDS is a diagnosis that requires identification of clinical signs and exclusion or management of comorbidities or alternate diagnoses that can mimic or worsen clinical signs. When clinical signs and signalment are appropriate, the next step is for the veterinarian to conduct a complete medical evaluation including physical, neurologic, and orthopedic examinations and labwork (e.g., CBC (complete blood count), serum biochemistry, urinalysis, thyroid panel) and other testing, including radiographs, based on findings. It is important to note that CDS can be (and often is) comorbid with other medical conditions, but these must be evaluated and controlled as much as possible to appreciate the contribution of CDS to the patient's signs. A recent study found that 66% of owners of dogs with CDS reported that their dogs had other diseases, with the most common being diseases of the musculoskeletal system (Haake *et al.*, 2024). Evaluation is complicated by the anxiety and fear that can also occur or worsen in pets suffering from CDS. Emotional disorders can occur across the lifespan and are addressed similarly. As CDS occurs most commonly in senior/aged pets, this chapter will explore the clinical picture of CDS in dogs and cats, its identification or diagnosis, and available treatment options.

15.1 The Clinical Picture

15.1.1 Characteristics of CDS

Across several studies, the most common signs of CDS in dogs were found to include decreased daytime activity and nighttime restlessness (Fast *et al.*, 2013; Madari *et al.*, 2015), particularly as disease severity increased. Also common early in disease progression are changes in social interaction and activity, with house-soiling and spatial disorientation seen in more affected dogs (Madari *et al.*, 2015; Haake *et al.*, 2024). In cats, affected animals aged 11–14 years were most likely to show altered social interactions, while cats over 15 years of age most commonly displayed aimless activity and vocalization (Landsberg *et al.*, 2010, 2011; Sordo and Gunn-Moore, 2021). While many clinical signs affect quality of life for both pets and their owners, disrupted sleep is perhaps the most significant with higher caregiver burden reported for owners of dogs who wake them up at night (Taylor *et al.*, 2024).

Freedom from fear and distress is crucial for all animals, and safety can be compromised when an animal signals for increased distance using aggression. Clinically, there is a concern because pets with CDS may experience increased agitation or aggression (Fast *et al.*, 2013), but also because these pets may be the target of aggression by other household pets. Due to decreased awareness (particularly if coupled with sensory decline or decreased mobility), cognitively impaired dogs or cats can fail to read the social signals of other pets or, due to their atypical behavior, be perceived as alarming by housemate pets. It is important to note that chronic pain is more frequently associated with aggression and irritability than CDS – an observation that makes sense given overlaps in neural pathways related to both pain and emotional regulation (Bruehl *et al.*, 2009). For pets with signs of aggression or irritability a safety plan must be in place for the welfare of themselves and the other pets in the home.

15.1.2 Prevalence

The reported prevalence of canine CDS in animals over 8 years of age varies by study and methodology, with reported ranges from 14% to over 60% (Neilson *et al.*, 2001; Osella *et al.*, 2007; Azkona *et al.*, 2009; Salvin *et al.*, 2010; Madari *et al.*, 2015; Haake *et al.*, 2024). Moderate to marked cognitive dysfunction was reported to occur in 13–16% of dogs aged 8–11, and in 87–100% of dogs greater than 13 years (Katina *et al.*, 2016). One study found that 35% of cats over 11 years of age were diagnosed with CDS, with 28% of cats 11–15 years and 50% of cats over 15 years affected (Gunn-Moore *et al.*, 2007). These studies have varied with their methodology and whether they relied on owner report via survey or incorporated veterinary evaluations into the diagnoses; however, across studies the prevalence of disease is high and strongly impacted by age.

Several studies have noted the disconnect between signs of CDS and both owner and veterinary diagnosis of the condition. For example, Salvin *et al.* (2010) found that in 479 dogs over the age of eight, 14.2% fit the clinical picture for CDS despite only 2% of these having been previously diagnosed. Biannual hospital visits with questionnaire

screening for clinical signs of CDS are recommended in pets over 8 years of age to provide the earliest possible diagnosis (Landsberg *et al.*, 2010; Katina *et al.*, 2016). Several questionnaires are available, including the Canine Dementia Scale (CADES), the Canine Cognitive Dysfunction Rating Scale (CCDR), the Canine Cognition Assessment Scale (CCAS), and the DISHAAL scale (Fig. 15.1;

SENIOR CANINE BEHAVIOR SCREENING QUESTIONNAIRE

Date: _____ **Owner:** _____

Pet's Name: _____ **Breed:** _____

Weight: _____**lb / kg BCS (out of 9)**____

Male ___ **Neutered: Y**__ **N**__

Female ___**Spayed: Y**__ **N**__

INSTRUCTIONS: The purpose of the questionnaire is to identify behavior changes or the onset of new behavior problems that have arisen since the age of 8 using the following key:
Scoring Key (severity): **0** = *none* (*no change*) **1** = *mild* **2** = *moderate* **3** = *severe*

BEHAVIORAL SIGNS	Score
A. Disorientation	
gets stuck, difficulty getting around objects, goes to hinge side of door	
stares blankly at walls, floor or into space	
does not recognize familiar people or pets	
gets lost in home or yard	
less reactive to visual (sights) or auditory (sounds) stimuli	
B. Social Interactions	
more irritable / fearful / aggressive with visitors, family or other animals	
decreased interest in approaching, greeting or affection / petting	
C. Sleep wake cycles	
pacing / restless / sleeps less / waking at night	
vocalization at night	
D. Housesoiling, Learning and Memory	
Less able to learn new tasks or respond to previously learned commands / name / work	
Indoor soiling of urine __ or stools __ – decreased signaling to go out	
Difficulty getting dog's attention / increased distraction / decreased focus	
E. Activity	
Decrease in exploration or play with toys, family members, other pets	
Increased activity – aimless pacing / wandering	
Repetitive behaviors e.g. circling___ chewing___licking__star gazing	
F. Anxiety	
Increased anxiety when separated from owners	
More reactive / fearful to visual (sights) or auditory (sounds) stimuli	
Increased fear of places / locations e.g. new environments / going outdoors	

Fig. 15.1. Senior canine behavior screening questionnaire. A score of 4–15 is consistent with mild, 16–33 is moderate, and >33 is severe CDS (Purina Institute, n.d.). (Created by Dr Gary Landsberg, CanCog Technologies, with support of Nestlé Purina PetCare. Used with permission of Dr Gary Landsberg and CanCog Technologies.)

Purina Institute, n.d.). Use of questionnaires is reviewed in Haake *et al.* (2024); the selection of questionnaire may depend on clinical need, but consistent use of one questionnaire by a practice will allow tracking of progression over time.

15.1.3 Progression

CDS is a chronic progressive disease, and treatment is aimed at slowing progression. In dogs aged at least 11 years, 22% who were free of clinical signs developed signs within 12–18 months, and 48% of dogs with impairment in one category developed impairment in at least one additional category within this time frame (Bain *et al.*, 2001). In dogs at least 8 years of age, over a 6-month period 42% developed mild impairment and 24% progressed from mild to moderate impairment, while over 1 year, 71.4% developed mild impairment, and 50% progressed from moderate to severe impairment (Madari *et al.*, 2015). These studies highlight the gradually progressive nature of the disease, the importance of biannual screening, and that if signs rapidly worsen, patients should be re-evaluated for medical conditions.

15.1.4 Risk factors

Age is, of course, the key risk factor for canine CDS, and a strong positive correlation has been found between age and cognitive decline in dogs across multiple studies (Neilson *et al.*, 2001; Azkona *et al.*, 2009; Katina *et al.*, 2016; Fefer *et al.,* 2022b).

The impact of body size is complex as absolute age appears to be more influential on cognitive function than relative age (Watowich *et al.,* 2020), and larger-breed dogs tend to have shorter lifespans. Fractional lifespan (the animal's age divided by their expected lifespan) has been used in several studies but is generally not as strongly associated with clinical signs relative to age. Four studies have found no impact of body size on memory or cognitive impairment (Neilson *et al.*, 2001; Salvin *et al.*, 2010; Fast *et al.*, 2013; Katina *et al.*, 2016). CDS was found to be similarly prevalent in small and medium/large dogs aged 8–11 years, but more common in larger breeds aged 11–13 years (55% versus 41%).

A clear influence of sex or castration status has also not been found. Females were suggested as more likely to exhibit CDS (Azkona *et al.*, 2009), but several other studies did not find support for this difference (Neilson *et al.*, 2001; Fast *et al.*, 2013; Katina *et al.*, 2016). CDS was found by two studies to be more prevalent in castrated individuals (Hart, 2001; Azkona *et al.*, 2009). However, others did not identify a difference in prevalence between castrated and intact older dogs (Fast *et al.*, 2013; Katina *et al.*, 2016).

Nutritional risk factors associated with accelerated brain aging and Alzheimer's disease (AD) in humans include docosahexaenoic acid (DHA) deficiency, high homocysteine, low B vitamin levels, high blood pressure, chronic oxidative stress, and chronic low-grade inflammation. In one study, dogs fed low-quality commercial diets or table scraps were significantly more likely to develop CDS than dogs fed commercial diets formulated for age, size, or health (Katina *et al.*, 2016). There is also evidence of an association between periodontal disease and cognitive dysfunction scores, independent of age (Dewey and Rishniw, 2021).

Increasing evidence supports that environment may also play a role in the development of neurodegenerative disease, likely through increased neuroinflammation (Zhang *et al.*, 2024). Dogs from areas with high air pollution exhibited early occurrence of β-amyloid plaques and elevation of proinflammatory markers that preceded by several years similar changes in the brains of dogs living in an environment with low air pollution (Calderon-Garciduenas *et al.*, 2008).

15.2 Evaluation: Identifying Welfare Concerns

15.2.1 Pathophysiology

Changes in the brain range from macroscopic to submicroscopic. MRI scans of dogs with CDS may reveal ventricular enlargement, frontal and temporal lobe atrophy, an increase in lesions in the frontal cortex and caudate nucleus, and a decrease in the diameter of interthalamic adhesions (Tapp *et al.*, 2004, 2006; Hasegawa *et al.*, 2005; Su *et al.*, 2005). Imaging also reveals decreased cerebral regional blood volume in the brains of cognitively impaired dogs, and microhemorrhage and infarcts may contribute to the signs of CDS in dogs and cats. Although changes are not as notable as those seen in dogs, aged cats likewise demonstrate cerebral atrophy, ventricular enlargement, and a widening of sulci (Landsberg *et al.*, 2010; Chambers *et al.*, 2015; Sordo and Gunn-Moore, 2021) (Fig. 15.2).

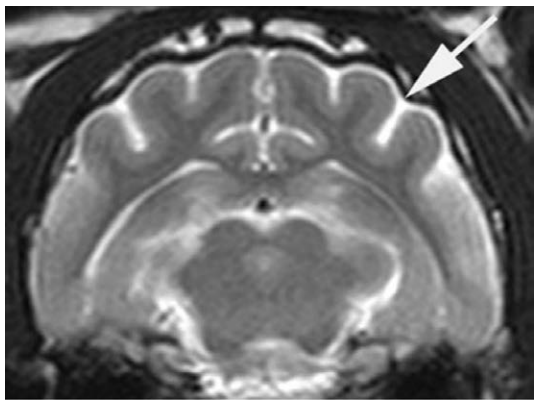


Fig. 15.2. MRI of an aged cat brain showing widening of the sulci (*arrow*) indicating brain atrophy. (Reprinted by permission from Springer Nature: Springer; *Canine and Feline Dementia: Molecular Basis, Diagnostics and Therapy* by Gary Landsberg, Aladár Mad'ari, Norbert Žilka (eds.); © 2017.)

Microscopically, CDS in dogs is characterized by meningeal calcification, an overall reduction in neuronal density (Borras *et al.*, 1999; Colle *et al.*, 2000; Tapp *et al.*, 2004; Rofina *et al.*, 2006), and activated, dystrophic microglia (Smolek *et al.*, 2016). As in humans with AD, cognitively impaired dogs have significantly decreased numbers of noradrenergic neurons in the locus coeruleus (Insua *et al.*, 2010), and plasma neurofilament light chain concentrations (a relatively non-specific marker of neuronal injury) has been found to increase in dogs with increasing age and cognitive dysfunction questionnaire scores (Panek *et al.*, 2020).

Aged cats also display multiple brain changes consistent with neuronal loss. The molecular layer of the cerebellum in 12- to 13-year-old animals shows neuronal loss relative to that of 2- to 3-year-old cats. Ultrastructural and electrophysiologic experiments in aged cats suggest loss of dendrites in the caudate nucleus, loss of function in which may be associated with impaired motor function and/or habituation to repeated stimuli (Levine *et al.*, 1986; Levine, 1988). Hippocampal neuron loss is seen in cats over 14 years (Chambers *et al.*, 2015).

Analogous to changes seen in human Alzheimer's patients, the brains of aged dogs and cats display accumulations of diffuse beta-amyloid plaques, as well as cerebral amyloid angiopathy and perivascular infiltrates (Cummings *et al.*, 1996b; Colle *et al.*, 2000; Tapp *et al.*, 2004; Rofina *et al.*, 2006; Gunn-Moore *et al.*, 2007; Nešić *et al.*, 2015; Smolek *et al.*, 2016) (Fig. 15.3). Multiple associations have been found between the amount and location of plaque deposition and the severity of cognitive deficits in dogs (Cummings *et al.*, 1996a,b; Colle *et al.*, 2000; Rofina *et al.*, 2006). Reversal learning deficits indicative of executive dysfunction are associated with amyloid deposits in the prefrontal cortex, and poor size discrimination with deposits in the prefrontal cortex (Cummings *et al.*, 1996a,b; Tapp *et al.*, 2004). Increased soluble Aβ levels in the cerebrospinal fluid (CSF) co-occur with decreased cognitive performance even prior to amyloid deposition (Head *et al.*, 2010; Borghys *et al.*, 2017).

Although the brains of aged cats also show evidence of Aβ plaques, these are more diffuse than those seen in dogs. Prevalence is increased in cats over 10 years of age, which may correlate with increasing cognitive decline (Cummings *et al.*, 1996b; Nakamura *et al.*, 1996; Brellou *et al.*, 2005; Head *et al.*, 2005; Gunn-Moore *et al.*, 2007; Chambers *et al.*, 2015). Tau hyperphosphorylation occurs in both dogs and cats and has been associated with cognitive decline in dogs (Head *et al.*, 2005; Gunn-Moore *et al.*, 2007; Chambers *et al.*, 2015; Smolek *et al.*, 2016), but neurofibrillary tangles are not consistently found in either species.

Even at a metabolic level, differences exist between the aging brain and brains of cognitively normal younger animals. Impaired cerebral glucose metabolism results in dogs with severe cognitive dysfunction showing increased CSF levels of pyruvate, lactate, and potassium (Pugliese *et al.*, 2005; Borghys *et al.*, 2017). One potential source of neurodegeneration in aged dogs is an increase in oxidative stress and reduced antioxidant capacity. These are linked to cognitive deficits and may be due to age-related mitochondrial dysfunction (Head *et al.*, 2002, 2009; Skoumalova *et al.*, 2003; Rofina *et al.*, 2004, 2006; Hwang *et al.*, 2008; Opii *et al.*, 2008). Muscarinic receptor numbers are reduced in multiple brain regions in aged dogs (Reinikainen *et al.*, 1987, 1990; Araujo *et al.*, 2011b). Impaired cholinergic function may contribute to decreased cognitive and motor function, as well as sleep–wake cycle disturbances (Zhang *et al.*, 2005; Pugliese *et al.*, 2007; Araujo *et al.*, 2011b).

15.2.2 Diagnosis

Definitive diagnostic criteria have not been established. Identification of representative brain pathologies can occur only postmortem, with confirmation

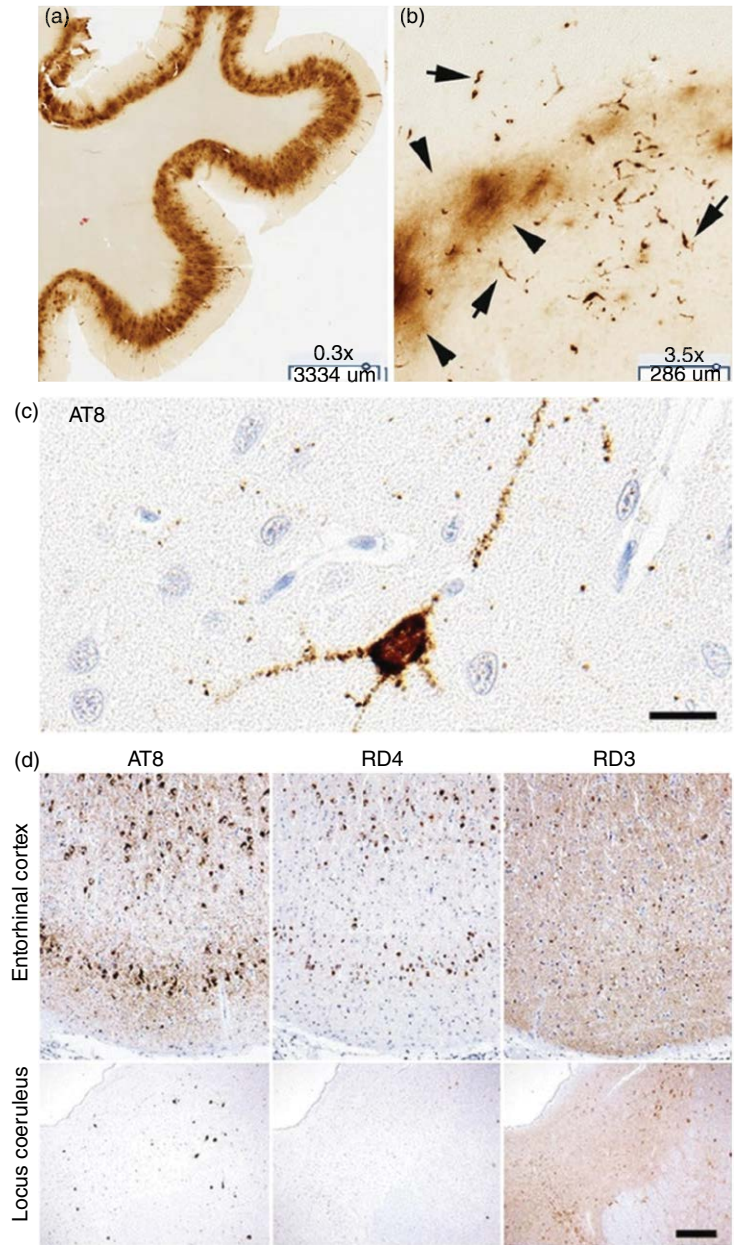


Fig. 15.3. Neuropathology in aging dogs and cats. (a) Aβ immunostaining (6E10 antibody) in the parietal cortex of an aged pet dog (15-year-old Siberian Husky) shows extensive plaque deposition affecting deep cortical layers. (b) CAA (6E10 immunostaining – arrows) in the parietal cortex of an aged dog (14-year-old Sheltie) shows that vascular pathology can be extensive and tends to occur in clusters. Diffuse plaques are also identified by arrowheads. (c) Immunohistochemistry of the entorhinal cortex of a cat with mild hyperphosphorylated tau accumulation (15-year-old, case no. 13) (AT8). The neuronal soma and dendrites are positively stained for hyperphosphorylated tau. Bar = 20 μm. (d) Immunohistochemistry of the entorhinal cortex and locus coeruleus of a cat with severe hyperphosphorylated tau accumulation (14-year-old, case no. 12) for AT8, 3-repeat tau (RD3), and 4-repeat tau (RD4). AT8-positive aggregates are also positively stained for 3-repeat tau and 4-repeat tau on consecutive sections. Bar = 300 μm. (Reprinted by permission from Springer Nature: Springer; *Canine and Feline Dementia: Molecular Basis, Diagnostics and Therapy* by Gary Landsberg**,** Aladár Mad'ari**,** Norbert Žilka (eds.); © 2017.)

of microscopic changes in the brain. Imaging can suggest disease pre-mortem but is rarely performed due to the need for general anesthesia to complete MRI in dogs and cats. When performed, brain atrophy on MRI is compatible with, although not diagnostic for, CDS and allows exclusion of other diseases such as brain tumors or vascular infarcts. Standardized tests for evaluating cognitive function provide an invaluable research tool and questionnaires can be used in clinical practice to identify affected animals. In all cases, evaluation of differential diagnoses (both intra- and extracranial) that mimic or exacerbate the signs of cognitive dysfunction is paramount. In a recent study in which dogs were excluded due to possible medical causes for altered behavior, 15 of 100 dogs were excluded due to baseline laboratory findings alone (Pan *et al.*, 2017).

There is an extensive list of medical considerations for each category comprising the DISHAAL group of signs (see Table 15.1). For instance, both acute and chronic pain has been associated with increased irritability, withdrawal, altered activity levels, decreased playfulness, and aggression (Camps *et al.,* 2012; Malkani *et al.*, 2024). Hyperthyroid cats may display sleep–wake disturbances, increased vocalization, aggression (particularly related to food), and repetitive behaviors. Other medical conditions may include sensory decline and diseases of the cardiovascular, endocrine, gastrointestinal, or urinary systems. Diseases of the central and peripheral nervous systems may also directly alter mentation and responsiveness.

Full evaluation for each differential may require diagnostics beyond basic physical exam and history. For instance, any dog or cat with polyuria, polydipsia, periuria, dysuria, or house-soiling urine is a candidate for a complete urinalysis with urine cytology, urine protein:creatinine ratio, urine culture, and imaging where indicated. Careful neurological evaluation for lateralized signs should be performed, and MRI and/or CSF analysis can be considered and offered to clients prior to establishing a presumptive diagnosis of CDS where indicated. An algorithm for the diagnosis of canine CDS is presented in Fig. 15.4. In the future, electroencephalogram (EEG) may be useful as a diagnostic tool, as differences in EEG features have been found in dogs with CDS and at risk for CDS compared to healthy dogs (Mondino *et al.,* 2022). There is potential for biomarkers (such as amyloid-beta and neurofilament light chain) to be used in the diagnosis of CDS (Panek *et al.*, 2020; Stylianaki *et al.*, 2020), but these are not in common clinical use at this time. Importantly, identification of a medical condition does not exclude CDS as a diagnosis; however, medical conditions must be managed in order to evaluate their contribution to the clinical signs observed.

15.2.3 Comorbidity with affective disorders

Of great concern from a welfare perspective is the comorbidity between CDS and a number of affective disorders related to abnormal levels of fear or anxiety. In animals with CDS, a change in environment, schedule, or medical status may increase baseline level of stress or anxiety. Aggression may be directed toward a trigger, such as a child or another pet, that was only recently introduced to the family. Changes in schedule or a move to a new environment may cause a relapse or onset of separation-related problems. Noise fear that presents later in life has been associated with musculoskeletal pain (Lopes Fagundes *et al.,* 2018).

Anxiety is the feeling of unease or apprehension that an undesirable or unsafe situation may occur. It can lead both to increased and decreased activity levels, as well as altered interactions with owners (either due to change in activity level or to attention-seeking behaviors). Fear and anxiety may also contribute to aggression to or avoidance of both humans and other pets. Cats may eliminate outside the litterbox or urine mark as a result of anxiety and stress.

Chronically anxious pets may exhibit impaired memory, learning ability, or ability to perform previously learned behaviors (Landsberg and Araujo, 2005). Hypervigilant animals may show altered sleep–wake cycles (Ohl *et al.*, 2008), which is a common presenting complaint in cases of CDS (Landsberg *et al.*, 2011; Landsberg, 2024) and disruptive to both the pet and owner physical and mental well-being. Repetitive pacing as a displacement behavior caused by anxiety may occur throughout the day but be most noticeable to owners in the evening or at night (Landsberg and Denenberg, 2009; Landsberg *et al.*, 2011).

A learned component may also exist for some behavior problems. Attention or food given by the owner may reinforce behaviors, such as excessive vocalization. Although punishment may reduce a behavior's frequency, it can increase anxiety and fear, does not address the animal's underlying motivation, and is contraindicated (Landsberg *et al.*, 2011).

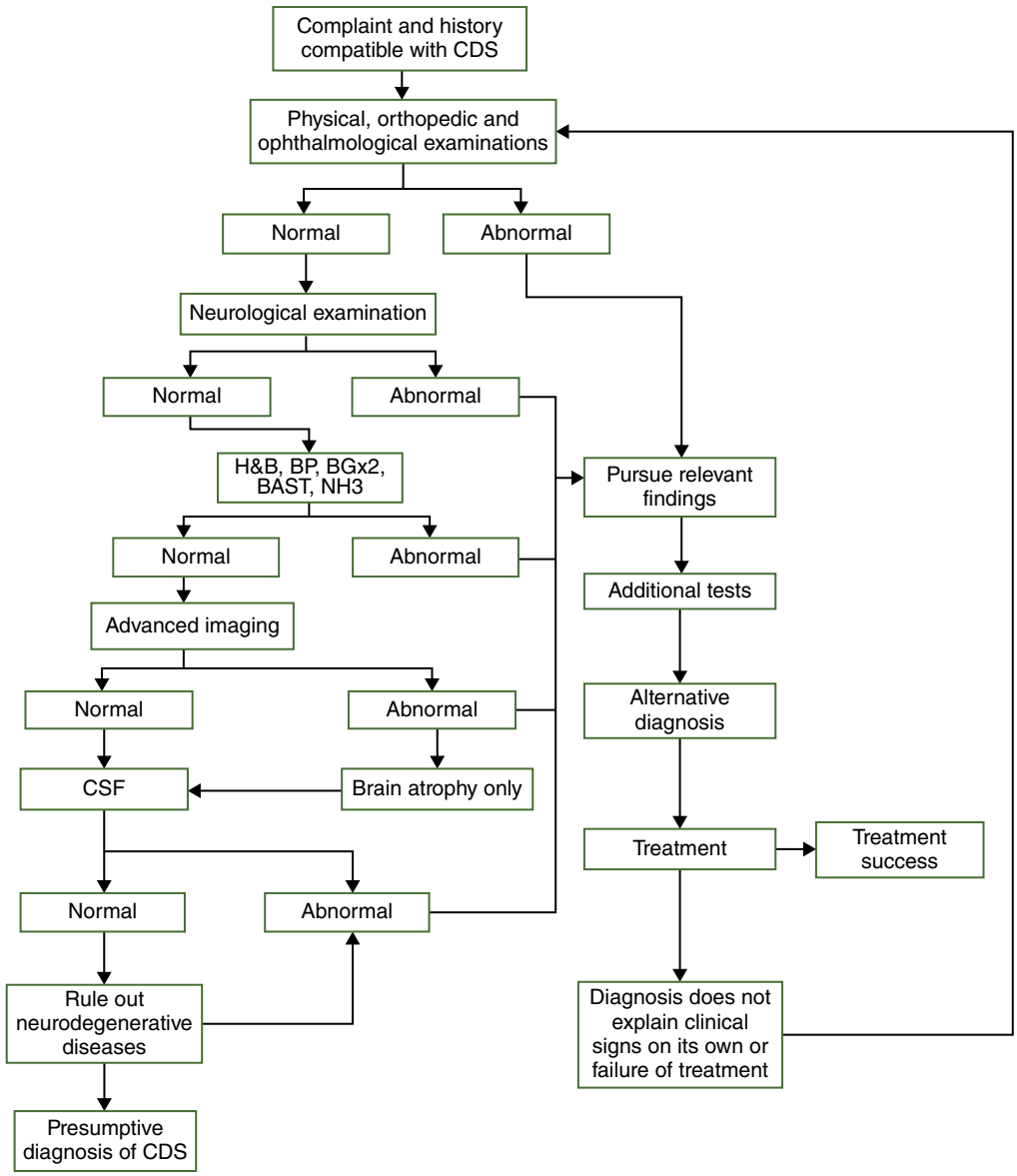
Table 15.1. Medical differentials of cognitive dysfunction in dogs and cats.

System	Possible causes	Possible behavioral signs
Sensory	Cataracts/lenticular sclerosis	Fear/anxiety
	Loss of vision	Disorientation
	Loss of hearing	Decreased response to stimuli
		Reduced learning ability
		Aggression
		Avoidance
		Vocalization
Pain/ musculoskeletal	Degenerative diseases	Avoidance of interaction or activities associated with pain
	Osteoarthritis	Reduced interest in exercise or play
	Muscular dystrophy	Altered response to stimuli
		Aggression/irritability
		Reduced activity and movement
		House-soiling
		Reduced self-hygiene
		Increased vocalization
Cardiovascular	Mitral insufficiency	Disorientation
	Hypertension	Tiredness or reduced interest in play and activity
	Cardiomyopathy	Withdrawal/avoidance
		Irritability
		Fear/anxiety
		Changes in appetite
		Vocalization
Endocrine	Diabetes mellitus	All signs of cognitive dysfunction
	Insulinoma	House-soiling/urine marking
	Diabetes insipidus	Appetite – increased/decreased
	Hypothyroidism	Activity – increased/decreased/apathy
	Hyperthyroidism	Irritability
	Hyperadrenocorticism	Aggression
	Hypoadrenocorticism	Changes in sleep–wake cycle
		Stereotypic behavior, e.g., licking
		Restlessness, e.g., pacing
		Vocalization
Digestive	Dental diseases	Reduced appetite
	Hepatic diseases	Aggression/irritability
	Infectious/inflammatory	Avoidance/withdrawal
	Constipation	Night-time waking
	House-soiling	Stereotypic behavior, e.g., pacing, licking
	Nutritional imbalances	Coprophagia
	Pain	
Urinary	Renal diseases	House-soiling/marking
	Urinary tract infection	Aggression
	Idiopathic cystitis	Withdrawal/avoidance
	Urolithiasis	Pacing
	Urinary incontinence	Sleep–wake changes

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15.3 Treatment: Addressing Welfare Concerns

Treatment for cognitive and emotional disorders in aging pets will follow the same principles of treatment used across the lifespan: address underlying medical conditions (including pain), environmental modification and enrichment, behavioral modification, nutritional support, and medication (see also Chapter 26, this volume, for more on treatment of emotional distress in animals). In this section, we



H&B, hematology and biochemistry; BP, blood pressure; BGx2, blood glucose X 2; BAST, bile acid stimulation test; NH3, ammonia; CSF, cerebrospinal fluid; CDS, cognitive dysfunction syndrome

Fig. 15.4. Algorithm for the diagnosis of canine cognitive dysfunction syndrome. (Reprinted by permission from Springer Nature: Springer; *Canine and Feline Dementia: Molecular Basis, Diagnostics and Therapy* by Gary Landsberg, Aladár Maďari, Norbert Žilka (eds.); © 2017.)

will outline treatment specifically for CDS, given its primacy in behavioral conditions in aging pets; however, other sections may be referred to for addressing signs.

15.3.1 Enrichment

When used in combination with medical and nutritional therapies (discussed below), physical exercise and mental enrichment have been shown to slow

the progression of cognitive impairment (Milgram *et al.*, 2004; Head, 2007; Head *et al.*, 2009). Aged dogs trained to run on a treadmill for 10 minutes daily showed acutely improved performance on a concurrent discrimination task and a novel object location task (Snigdha *et al.*, 2014). When this exercise regimen was continued, dogs showed improved performance on an object location memory task. A large-scale study by the Dog Aging Project also found that physical activity was strongly negatively associated with severity of cognitive dysfunction (Bray *et al.*, 2023) and Mondino *et al.* (2023) showed that decreased physical activity was associated with working memory deficits. In humans, exercise is known to benefit brain function and has been shown to delay the onset of cognitive decline associated with AD. This may be due to increased growth of neurons and blood vessels, as well as improvement in this organ's ability to cope with oxidative stress (Radak *et al.*, 2007). Enrichment in aged dogs protected against neuronal loss in the hippocampus (Siwak-Tapp *et al.*, 2008).

Exercise and enrichment must allow for limits of age and disease in some older patients. Senior pets should be provided with the opportunity to retreat to a quiet location protected from the chaos of children, visitors, and other pets. Desired resources such as resting spots or litter boxes should be available in this location. Additional enrichment can take the form of operantly conditioned behaviors (ranging from simple tricks to sports such as nosework), play, time on walks spent exploring novel environments, and food toys or puzzles. Although novelty can be a source of enrichment, moderation is suggested. Aged dogs and cats, perhaps especially those with cognitive or sensory deficits, may be less anxious if their routine and environment are kept structured and predictable. There is also some evidence that participation in a senior dog class (including educational information on senior dog behavior and management and interactive training sessions with their dogs) may mitigate progression of CDS signs and improve quality of life (O'Brian *et al.*, 2021). If structured classes are not available, clinicians can provide information to owners on health and behavioral changes and demonstrate ways to maintain engagement and interaction.

Environmental modifications can also help maintain activities of daily living. Even simple considerations, like providing secure footing and non-slip surfaces, can help dogs and cats continue to participate in activities that are important for their quality of life. With the overlap between chronic pain, negative emotions, and cognitive function, it is critical to provide modifications that allow species-specific behaviors and promote comfort.

15.3.2 Nutraceuticals and prescription diets

The goal of nutritional therapies for cognitive decline is to reduce oxidative stress, correct metabolic changes associated with impaired cognition, and improve mitochondrial function and neuronal signaling (Head *et al.*, 2002, 2009; Milgram *et al.*, 2004; Araujo *et al.*, 2005a; Kidd, 2005; Sullivan and Brown, 2005; Scarmeas *et al.*, 2006; Gunn-Moore *et al.*, 2007; Head, 2007; Siwak-Tapp *et al.*, 2008; Landsberg *et al.*, 2010; Pan *et al.*, 2010, 2013, 2017; Pop *et al.*, 2010; Dowling and Head, 2012; Fahnestock *et al.*, 2012; Pan, 2021; see also Chapter 4, this volume). Many owners administer supplements to their dogs with signs of CDS (Haake *et al.*, 2023), and several supplements have been demonstrated to benefit patients with cognitive dysfunction. The most common contain one or more of the following components: phosphatidylserine, a cell membrane component postulated to aid in neuronal signal transduction and cholinergic transmission (Tsakiris and Deliconstantinos, 1985; Heath *et al.*, 2007; Osella *et al.*, 2007); vitamin B6 (pyridoxine), which may exert a neuroprotective effect (Dakshinamurti *et al.*, 2003); polyunsaturated fatty acids, which have roles in cell membrane structure and in decreasing inflammation (Pan, 2021; Dighriri *et al.*, 2022); and S-adenosylmethionine, which may help maintain cell membrane fluidity and receptor function, regulate neurotransmitter levels, and decrease oxidative stress (Rème *et al.*, 2008; Araujo *et al.*, 2012).

Multiple diets specifically formulated for dogs and cats with cognitive dysfunction have been studied. Prescription Diet b/d Canine (Hill's Pet Nutrition) is supplemented with omega-3 fatty acids, antioxidants (vitamins C and E, beta-carotene, selenium, flavonoids, carotenoids), and dl-alpha-lipoic acid and L-carnitine. A three-year longitudinal study of 48 beagle dogs aged 8–12 found improvement in a landmark task within 2 weeks, subsequent improvement in oddity discrimination, and maintenance of reversal learning. Greatest benefit occurred in dogs receiving both the diet and added behavioral enrichment (Milgram *et al.*, 2004; Araujo *et al.*, 2005a; Head, 2007;

Head *et al.*, 2009; Dowling and Head, 2012; Fahnestock *et al.*, 2012). These dogs showed decreased oxidative damage, as well as increased brain-derived neurotrophic factor and neuronal health (Milgram *et al.*, 2004; Head, 2007; Head *et al.*, 2009; Pop *et al.*, 2010; Dowling and Head, 2012; Fahnestock *et al.*, 2012). Young dogs fed the diet showed no cognitive changes (Scarmeas *et al.*, 2006). As of May 2025, b/d diet has been discontinued and replaced by a cognitive plus mobility diet that retains the nutrient combination and is available for dogs and cats.

Other diets for senior pets are supplemented with medium-chain triglycerides (MCT). Dogs at even 6 years of age show significantly reduced cerebral glucose metabolism compared with dogs at 1 year of age, and MCTs provide ketone bodies as an alternative energy source for aging neurons (London *et al.*, 1983). Compared with controls, dogs fed a diet supplemented with 5.5% MCT over 8 months showed significantly better performance in landmark discriminations, an egocentric learning and egocentric reversal task, and a variable oddity task (Pan *et al.*, 2010; Pan, 2021). Treated dogs demonstrated elevated levels of the ketone body β-hydroxybutyrate (Sullivan and Brown, 2005; Taha *et al.*, 2009). A double-blinded placebo-controlled clinical trial of ProPlan Veterinary Diets Neurocare in dogs with CDS found significant improvement in all categories of DISHAAL signs over a 3-month period. This diet is supplemented with 6.5% MCT and a brain protection blend (BPB) containing B vitamins and antioxidants, amongst other components (Pan *et al.*, 2017).

No prescription diets are formulated for cats, and High percent composition MCT diets have lower palatability for cats. In addition to the cognition plus mobility diet, many diets for senior cats and joint-specific diets are formulated with antioxidants and polyunsaturated omega-3 fatty acid supplementation and may have benefit for older cats.

15.3.3 Prescription pharmacotherapy

In North America, selegiline hydrochloride is the only pharmaceutical that is approved for use in dogs suffering from CDS. Selegiline is a selective irreversible inhibitor of monoamine oxidase B (MAOB), although its mechanism of action in dogs is not entirely clear. Concurrent use with other MAO inhibitors or serotonergic drugs is contraindicated. Administration results in several effects in the central nervous system: enhanced dopaminergic and catecholaminergic function in the cortex and hippocampus, increased release and reduced reuptake of norepinephrine, increased free radical scavenging enzymes, and neuroprotective effects. Its metabolites L-amphetamine and L-methamphetamine can enhance cognitive function and improve behavior (Milgram *et al.*, 1993, 1995; Ruehl *et al.*, 1996) and may be particularly useful in resetting the sleep–wake cycle when given in the morning (as recommended).

When given in laboratory dogs at a dose of 0.5–1 mg/kg in the morning, selegiline resulted in reduced clinical signs of CDS and improved working memory. Improvement was seen at 2 weeks in some dogs; others took up to 2 months to respond (Ruehl *et al.*, 1995; Head *et al.*, 1996; Campbell *et al.*, 2001). Although selegiline's use in cats is extra-label, improvement in disorientation, vocalization, and decreased affection have been reported at a dose of 0.5–1 mg/kg in the morning (Landsberg, 2006; Gunn-Moore *et al.*, 2007; Landsberg *et al.*, 2010).

In some countries in Europe and in Australia, propentofylline is also licensed at a dose of 5 mg/kg twice daily for use in dogs showing mental dullness, lethargy, and tiredness in the absence of any other identifiable cause. Propentofylline is a xanthine derivative that may increase oxygenation in the brain and periphery, by means of improving microcirculation and inhibiting thrombus formation (Parkinson *et al.*, 1994). However, aged beagle dogs treated with propentofylline in a laboratory trial showed no change in behavioral activity (Siwak *et al.*, 2000). In cats, there are anecdotal reports of efficacy at a dose of 12.5 mg per cat twice daily (Gunn-Moore *et al.*, 2007; Landsberg *et al.*, 2010).

Anticholinergic drugs may accelerate cognitive decline, and avoidance in aged pets is suggested (Araujo *et al.*, 2005b, 2011a,b; Cai *et al.*, 2013; Cross *et al.*, 2016). Drugs that enhance cholinergic transmission, such as donepezil and phenserine, might theoretically improve clinical signs in CDS patients (Araujo *et al.*, 2005b).

15.3.4 Symptom-based anxiolysis

As previously discussed, dogs and cats suffering from cognitive dysfunction may experience an increase in anxiety. This can result in sleep–wake disturbances, cause or exacerbate agitation or aggression, and generally compromise the welfare of both patient and owner. Therefore, symptomatic treatment for night waking and anxiety is often

useful. Clomipramine, amitriptyline, and paroxetine should be avoided, as anticholinergic drugs are contraindicated. Fluoxetine, sertraline, or buspirone can be considered (Araujo *et al.*, 2005b, 2011a,b). Trazodone can also be considered, either alone or in combination with a selective serotonin reuptake inhibitor (SSRI) or buspirone. Serotonergic drugs should not be used concurrently with selegiline.

Benzodiazepines do carry the risk of exacerbating cognitive deficits, as well as causing sedation or ataxia. However, they can provide anxiolysis, and importantly mitigate nighttime waking. Lacking active intermediate metabolites, lorazepam or oxazepam might be preferred. Adjunctive use of propranolol, clonidine, or oromucosal dexmedetomidine may inhibit release or block the effects of noradrenaline, exerting anxiolytic effects. Gabapentin may reduce reactivity, as well as provide analgesia in a painful senior pet (Landsberg *et al.*, 2011). Although not directly beneficial in slowing the progression of CDS in the manner of those listed above, other natural products can be used to directly treat anxiety: pheromones, L-theanine, alpha-casozepine, L-tryptophan, or *Phellodendron* and *Magnolia* extracts.

15.4 Conclusion

Almost every veterinarian has likely heard a client relate, 'Well, my dog or cat's behavior has changed, but I think he or she is just getting old.' Although age is not a disease, diseases associated with aging can affect the central nervous system as well as other systems of the body. Behavior change can be a manifestation of disease both centrally and peripherally, and it is the job of the veterinarian to tease out contributing causes. While behavior change is common in older pets, pathologic cognitive aging results in clinical signs including: **D**isorientation, altered social **I**nteractions, **S**leep–wake disturbances, loss of **H**ousetraining and other learned behaviors, increased or decreased **A**ctivity levels, increased **A**nxiety or fear, and impaired **L**earning and memory. These changes can be associated with accumulations of diffuse beta-amyloid plaques, as well as distinctive macro- and microscopic degeneration, within the brain. CDS is not a curable disease, but its progression can be slowed through use of enrichment, diet change and nutraceuticals, and medication. It is worth noting that this disease carries a high caregiver burden, with increasing severity of CDS associated with increased burden (Taylor *et al.*, 2024). Associated increases in fear, anxiety, and aggression should also be treated symptomatically to improve quality of life in affected pets and their owners.

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16 Promoting a Good Life for Farmed Animals

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16.1 A Brief History of Farming Animals and Implications for a Good Life

Hominins have been eating meat for around 3 million years and since around 1 million years ago were commonly eating both terrestrial and aquatic animals, engaging in cooperative hunting, performing complex butchery, and transporting and storing animal products (Daujeard and Prat, 2022). However, domestication of farmed animals, where humans begin to control the animals through captivity and/or breeding, has occurred much more recently, around 11,000–4000 years ago, and after the advent of plant agriculture (Larson and Fuller, 2014).

Three main mechanisms of domestication have been proposed, including for species now farmed for food or non-food products such as silk, usually following a period of pre-domestication where associations with humans became stronger (Zeder, 2012). Commensal domestication, where animals gradually associate themselves more closely with humans, perhaps feeding on waste food or vermin, is the suggested pathway for pigs (*Sus scrofa*, two separate sites at 10,000 and 8000 years ago), guinea pigs (*Cavia porcellus*, 5000 years ago), chickens (*Gallus gallus*, 4000 years ago), pigeons (*Columbia livia*, 3500 years ago), and most recently at 2500 years ago for ducks (*Anas platyrhynchos*), geese (*Anser anser*), and carp (*Cyprinus carpio*). Whereas the commensal pathway did not encompass human intentionality in the domestication process, the second 'prey' pathway involved humans acting to better manage the large animals they were hunting, for example, by aiming to kill younger males and leaving females to breed. Despite these management efforts it appears domestication may have been a response to overhunting, to ensure supply of these animals, and this is the path for sheep (*Ovis aries*, 11,000 years ago), goats (*Capra hircus*, 10,500 years ago), humpless cattle (*Bos taurus*, 10,000 years ago), cattle (*Bos indicus*, 8000 years ago), llama (*Lama glama*, 6000 years ago), and most recently water buffalo (*Bubalus bubalis*) and yak (*Bos grunniens*, 4500 years ago). Finally, there are some species that humans set out to domesticate including the honeybee (*Apis mellifera*, 4500 years ago) and silkworm (*Bombyx mori*, 5000 years ago), equids (horses *Equus caballus,* and donkeys *Equus asinus*, both around 5000 years ago), camels (*Camelus bactrianus*, 4500 years ago and *Camelus dromedarius,* 3000 years ago), rabbits (*Oryctolagus cuniculus*, 1000 years ago) (Larson and Fuller, 2014), and all species more recently than that, for example, Atlantic salmon (*Salmo salar*, within the last 100 years).

During the domestication period when breeding became controlled by humans, we were able to select for desirable traits of farmed animals and over generations bring about long-term changes to the animals. Selecting for certain characteristics such as coat color and size led to the development of breeds or strains of farmed animals. More recently, over the last century or so, we have increased the pace of change of the main farmed animal species through increased understanding of genetics, monitoring of progeny, and centralizing in large, sometimes global, companies of parent animals, which can produce many offspring, especially when artificial reproductive techniques are employed. Whilst early domestication selections

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promoted animals that were easy to manage, for example, reducing the size of aurochs (Ajmone-Marsan *et al*., 2010), more recently huge increases in productivity have been achieved. As an example, between 1957 and 2005 the growth rate of chickens farmed for meat increased by over 400%, meaning chickens that previously took 56 days to reach around 900 g can now reach over 4 kg in the same time, and even more extraordinarily they can grow so rapidly with a 50% improvement in food conversion ratio (Zuidhof *et al*., 2014). Likewise, laying hens can now produce over 300 eggs/year, far more than the clutch of 4–7 eggs of the jungle fowl (Anwar *et al*., 2016), dairy cow milk production in the USA has increased from 1800 liters/year in the year 1900 to over 8000 liters/year by 2000 (VandeHaar and St-Pierre, 2006), and sows in many countries now wean over 30 piglets per sow per year (PIG333, 2023), far more than the 4–8 produced by wild boar (Gethöffer *et al*., 2007).

One might imagine that the selection for domestication and productivity traits may have fundamentally changed the innate characteristics or 'telos' (i.e., the 'pigness of the pig' or 'cowness of the cow') (Rollin, 2007) of the farmed animal species. Whilst it is true that domesticated silkworm moths can no longer fly or survive in the wild and farmed turkeys cannot mate due to their size, the behavioral repertoire of domesticated animals when in wild/semi-wild settings is remarkably similar to their wild counterparts (Hall, 1989; Stolba and Woodgush, 1989; Olsson and Keeling, 2005; Garnham and Lovlie, 2018). The evolutionary lineage for some behaviors, especially those we might consider contribute to the 'telos' of an animal, run deep, reinforced by positive and negative experiences over many, many more thousands of years than the relatively recent domestication period (see Chapter 2, this volume). For example, we have not bred out the strong motivations to forage in pigs and chickens, even in the presence of *ad lib* food (Beattie and O'Connell, 2002; Lindqvist and Jensen, 2008), and which, if not fulfilled in the farm environment, may be redirected to harmful tail biting in pigs (EFSA, 2007) and injurious pecking in chickens (Lambton *et al*., 2010). Further, dairy cows still choose to spend time with their calves if given the chance, despite generations of cows and calves being separated shortly after birth (Johnsen *et al*., 2021). The recognition of the importance of underlying biology in farmed animal welfare has been elucidated by animal welfare science, sometimes in the face of opposition by farmers themselves, who may be familiar only with animals that do not have the opportunity to fulfill their needs. Mental well-being in farmed animals, as for all animals, depends on their capacity for positive and negative experiences, the ability to fulfill basic needs, and avoiding harm and the opportunities for pleasures. Paying heed to the behavioral biology and ecology settings of our farmed animals is an essential starting point to evaluating the strength of motivations for aspects that make up a good life.

16.2 Scale of Suffering Among Farmed Animals Today

The development of modern farming systems has been successful in producing large quantities of animal protein, which, if distributed equitably, would today be sufficient for the minimum protein requirements of the projected 2050 global population of 9.7 billion people (Berners-Lee *et al*., 2018). This has been achieved through the farming of billions of animals every year for food (see Fig. 16.1) alongside farming for other purposes. The largest number of animals farmed each year are insects, with over 1 trillion estimated to be killed each year for food or animal feed (Rowe, 2020), including at least 420 billion silkworms (Rowe, 2021). Whether insects are sentient, able to experience positive and negative feelings (Broom, 2022), is currently unclear, but is at least the subject of increasing scientific scrutiny, driven in part by the unparallelled numbers of animals involved and a laudable desire to avoid suffering if it is found to exist. Based on the available evidence, Birch *et al.* (2021) recommended that cephalopod molluscs and decapod crustacea (which includes shrimp and prawns, the species with the largest number of animals, 230 billion, on farms at any one time (Waldhorn, 2023)) be considered sentient within UK animal welfare law. Shrimp are often farmed in crowded, unenriched conditions where potentially painful eyestalk ablation of females is standard practice to increase productivity, and are slaughtered without stunning – all of which constitute a welfare risk to a sentient species (Crump *et al*., 2022). Nevertheless, important evidence is still lacking about the extent of sentient capacity in these animals, particularly in relation to positive experiences. Despite the large numbers of finfish being farmed in high stocking density situations (e.g., 13.9 billion tilapia, 5.8 billion

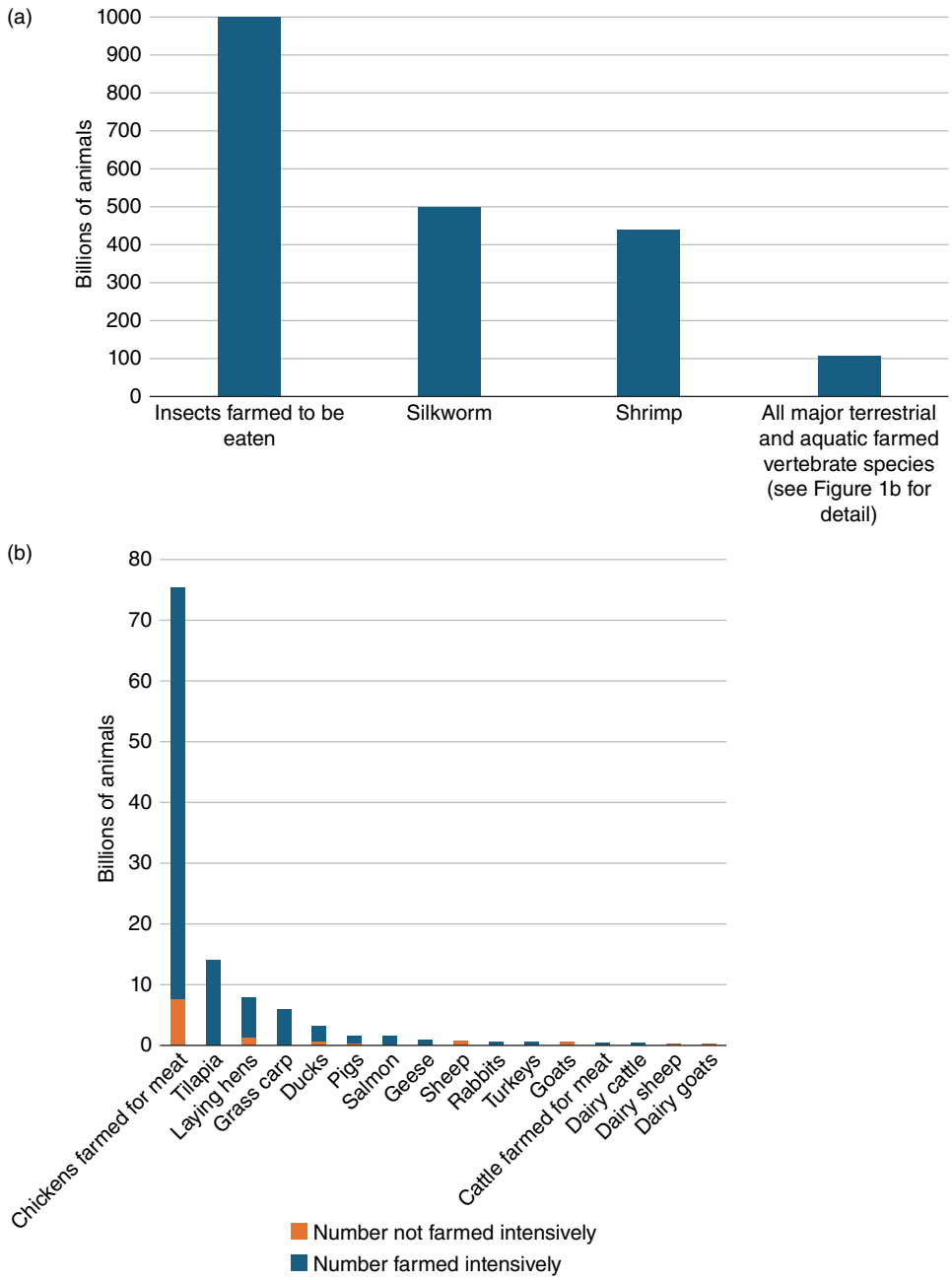


Fig. 16.1. The numbers of animals of each species farmed every year. (a) Species with more than 100 billion/year. (b) Species with fewer than 100 billion/year with estimates of the numbers farmed in restrictive conditions. Data sources: terrestrial vertebrates, Food and Agriculture Organization of the United Nations (2022b); insects, Rowe (2020, 2021); shrimp, Waldhorn (2023); fish, estimated based on average size at slaughter from Food and Agriculture Organization of the United Nations (2022a). Proportions of animals kept in intensive conditions: broilers, Compassion in World Farming (2024); hens, Guyonnet (2022); pigs, Maes *et al*. (2020); other species estimated from author's knowledge.

grass carp, and 1.4 billion Atlantic salmon killed each year, estimated from data provided by the Food and Agriculture Organization of the United Nations, 2022a) and the recognition of their sentience, a number of welfare risks during farming and slaughter have been highlighted (Saraiva *et al*., 2019). However, consideration for these animals' positive experiences remains mostly lacking.

Commonly farmed terrestrial vertebrate species of chickens, pigs, and cattle, and to a lesser extent sheep, ducks, geese, turkeys, and rabbits, have a substantial body of scientific literature focused on identifying welfare issues, welfare risk factors, and ways to ameliorate them (see Box 16.1 for common welfare issues). There is also a corollary focus on practical support for farmers to translate scientific evidence into delivering benefits on farms, as well as a growing recognition of the importance of farmer innovations in finding and sharing solutions (van Dijk *et al*., 2019). Whilst the farm environment, management, and genetic predispositions all influence welfare, some farm environments are of such poor quality that the welfare potential of such systems is always low, regardless of level of care experienced (Murphy and Legrand, 2023). Confinement and barren housing systems have unequivocally been shown time and again, across sentient species, to result in animal physical and mental suffering and in effect are now 'legacy systems' that animal welfare scholars believe should be rapidly abandoned (see Box 16.2). For example, large European reviews conducted by expert panels of welfare scientists recommend moving away from all cages for laying hens (EFSA AHAW Panel, 2023c), farrowing and gestation crates for sows (EFSA AHAW Panel, 2022), and single animal small housing systems for calves (EFSA AHAW Panel, 2023b), as well as barren, high stocking density housing for pigs (EFSA AHAW Panel, 2022) and broiler chickens (EFSA AHAW Panel, 2023a). Problems created by these methods include a genetic predisposition for poor health and behavior outcomes of broiler chickens (EFSA AHAW Panel, 2023a) and hyperprolificacy of sows, which has led to numbers of piglets in a litter exceeding the number of functional teats (EFSA AHAW Panel, 2022). Global estimates for the number of animals farmed in potentially low-welfare systems are not precise (Ritchie, 2023), but around 70% of chickens farmed for meat (52.6 billion birds/year) have genetic predispositions for high levels of lameness, ascites, and inactivity and are kept in large barren sheds (Compassion in World Farming, 2024), 84% of hens in the world (6.6 billion birds) are kept in battery or furnished cages (Guyonnet, 2022), and almost all pig production in higher income countries (over 1 billion pigs) relies on intensive indoor confinement (Maes *et al*., 2020).

16.3 Principles of a Good Life for Farmed Animals

Sentient animal lives are made up of conscious experiences that give rise to short-term emotions, coalescing into longer-term moods which in turn influence whole-life welfare (Mendl *et al*., 2010). Mostly, overall welfare of an animal is considered a continuum from extremely poor to excellent, although not all components that contribute to this overall welfare have a similar continuum. Animal welfare science has historically been primarily focused on identifying negative experiences of animals and their associated risk factors, enabling welfare improvement through reduction of risk of

Box 16.1. Common sources of suffering in farmed animals

- Physical restriction
- Inability to fulfill basic behavioral needs
- Lack of maternal care or inability to provide maternal care
- Pain due to management procedures, e.g., castration, disbudding, tail-docking
- Social stress, including overcrowding, frequent mixing of animals, or social isolation
- Hunger of animals on restricted diets, especially breeding animals of fast-growing breeds
- Thermal discomfort, including heat stress and cold exposure
- Physical discomfort, including from uncomfortable resting surfaces
- Ill health and/or pain, including 'production diseases'
- Fear and stress during handling and transport
- Pain during the slaughter process, including non-stun slaughter

Box 16.2. 'Legacy systems and practices' that should be abandoned

- Cage systems for egg-laying hens, breeding chickens, rabbits, quail, ducks, and geese
- Gestation crates for sows
- Farrowing crates for sows
- Individual calf pens
- Separation of cows and calves shortly after birth
- Killing of male day-old chicks and calves
- Barren slatted small pens for pigs, cattle, sheep, and other species
- High stocking density, barren environments for fish
- Painful management procedures without adequate anesthesia/analgesia
- Painful slaughter methods

poor welfare (Whay, 2007). More recently there has been an explosion of interest in positive experiences that animals can have and their value to animals (Boissy *et al*., 2007; Yeates and Main, 2008). There are differing views about how best to classify different forms of affect (Mendl *et al*., 2010), with the simple 'positive' versus 'negative' distinction being common, relating just to the pleasantness or otherwise of the feeling, regardless of other relevant elements such as level of associated arousal, and regardless of the cause or outcome of the feeling. Animals will work to achieve positive emotional states and avoid negative states in both experimental and other settings (e.g., Widowski and Duncan, 2000; von Keyserlingk *et al*., 2017). It has been suggested that overall well-being is not simply a lack of negative states, but may predominantly depend upon positive experiences (Seligman and Csikszentmihalyi, 2000). As Yeates and Main (2008) put it, 'what use is there in satisfying an animal's vital needs, if the life the animal then lives is devoid of any enjoyment?'.

16.3.1 Understanding positive experiences of farmed animals

Perhaps the longest tradition of assessing positive experiences of farmed animals lies in behavioral observations, from informal farmer observations of features that may appear analogous to signs of human pleasure, such as half-shut eyes, relaxed postures or playfulness, to more formal recording of behavior in research projects. Building the evidence to support the association of a behavior or body posture with a positive experience has been done in several ways, for example, through evaluating how and when animals will work to perform the behavior (e.g., for dustbathing in hens: Widowski and Duncan, 2000), or understanding associated neurobiology (e.g., for food preference in pigs: Briard *et al*., 2023; see also Chapter 23, this volume). It is proposed that rewarding experiences are made up of three distinct components: wanting (a positive anticipation), liking (the core hedonic experience), and learning (positive associations), with all three not necessarily associated with pleasurable feelings (although 'liking' appears mostly to be experientially pleasurable in humans) (Berridge and Robinson, 2003). Many species show specific behaviors in response to the 'wanting' component, especially increased locomotor activity (e.g., in pigs: Dudink *et al*., 2006; Imfeld-Mueller and Hillmann, 2012) and this is sometimes interpreted as a pleasurable experience in itself (excitement) or used as an indication of a resource that is likely to induce pleasure. Likewise, learning may appear pleasurable in itself (Boissy and Lee, 2014), or may prime the reward system for pleasures in the future.

16.3.2 The value of choice to animals

Providing animals with choice or control over their environment has been advocated as a method to improve animal welfare in various care settings (Spinka, 2019; see Chapter 8, this volume), including for farmed animals (Edgar *et al*., 2013). The perceived benefits may be three-fold: first, that increased choice will result in a greater likelihood of availability of a desirable resource to an animal, especially important when recognizing individual differences in preference (e.g., those shown consistently by individual chickens: Browne *et al*., 2010); second, that an animal may be afforded greater control over its life (autonomy) through the provision of various options; and third, that the act of choosing may in itself be intrinsically desirable.

Indeed, the need to exercise autonomy has been proposed as a biological imperative for survival (Leotti *et al*., 2010).

16.4 'Good Life Frameworks' for Assessing the Positive Welfare Opportunities of Farmed Animals

Given the importance of assessing the welfare of farmed animals to ensure consumers' and citizens' confidence (Blokhuis *et al*., 2003), farm assurance schemes have developed, and often aim to include animal welfare outcomes within their audits (RSPCA, Soil Association and University of Bristol, 2018). However, such outcomes have focused almost exclusively on negative welfare, and it has proved challenging to incorporate positive welfare outcomes into such schemes. The Welfare Quality protocols for pigs, cattle, and chickens incorporate Qualitative Behavioural Assessment (QBA) as their mechanism for assessing welfare (Welfare Quality® Network, 2009a,b,c). Candidate indicators of positive welfare have been reviewed, either specifically (e.g., for vocalizations: Laurijs *et al*., 2021) or across species (Boissy *et al*., 2007) and for specific types of animal, e.g., ruminants (Mattiello *et al*., 2019), cattle (Keeling *et al*., 2021), pigs (Kells, 2022), or fish (Fife-Cook and Franks, 2019).

We have developed 'Good Life Frameworks' for farmed animal species based on the principle of offering meaningful choice of desirable resources to farmed animals (Edgar *et al*., 2013; Rowe and Mullan, 2022; Stokes *et al*., 2022). They were inspired by the UK Farm Animal Welfare Council (FAWC) report outlining how a good life for animals ensures that positive experiences far outweigh negative experiences and goes beyond a 'life worth living' where the balance is only just into the positive (Farm Animal Welfare Council, 2009). We have drawn on the FAWC four good life opportunities of 'comfort', 'pleasure', 'interest', and 'confidence' and added a fifth opportunity of 'healthy life'. Within each opportunity, species-specific resources are identified, and three tiers of additionally positive welfare criteria are provided above UK legislation and industry codes of practice (Welfare +, Welfare ++ and Welfare +++). Importantly, these were evidence-based where possible, and derived from the highest level (Welfare +++) downwards. An accepted premise was that the product that the animal was farmed for would be taken (e.g., eggs, milk) or that animals would be killed if they were raised for meat, but that the highest tier need not be constrained by existing farming practices or economically viable options. The level was set based on the scientific literature: if the evidence suggested that the highest level of welfare would be to provide a resource requiring a radically different form of farming than exists today, the resource was still included. Farmers and other stakeholders helped shape the frameworks through discussion groups and piloting. The frameworks were designed to require minimal time to audit, taking no longer than 20–30 minutes on a farm, and to facilitate this are entirely input/resource based. However, an outcome-based version could be employed, utilizing information from farmers or direct observations of animal use of the resources and/or key positive behaviors. One of the difficulties of some positive behaviors is that they are performed infrequently, such as dustbathing by chickens or play behaviors, and it may become possible for continuous automated monitoring with machine learning to detect certain behaviors of animals, thereby offering a solution to otherwise time-intensive human observations (Neethirajan, 2022).

16.5 A Good Life for Commonly Farmed Terrestrial Animal Species

The following presents the major negative experiences by species. These must be substantially or wholly eliminated in order to ensure a good life, which is further advanced with the addition of positive welfare opportunities outlined below.

16.5.1 Cattle

Major sources of negative experiences that should be avoided in a good life

DAIRY CATTLE

- Pain and sickness from disease, including lameness and mastitis.
- Separation of the cow and calf shortly after birth.
- Hunger, physical restriction, social isolation, and poor health in calves.
- Pain through management procedures conducted with no, or insufficient, anesthesia and analgesia, e.g., disbudding, castration, dehorning, branding.
- Social stress within the herd.

- Stressful handling procedures.
- Fear, distress, and sometimes pain during transport and slaughter.

BEEF CATTLE

- Pain through management procedures conducted with no, or insufficient, anesthesia and analgesia, e.g., disbudding, castration, dehorning, branding.
- Outside living in harsh climatic conditions.
- Confinement fattening systems, especially in small slatted pens.
- Barren outdoor feedlot systems.
- High-concentrate, low-fiber diets of intensive fattening animals leading to high rates of oral stereotypies and rumen acidosis.
- Fear, distress, and sometimes pain during transport and slaughter.

Opportunities for positive experiences (Rowe and Mullan, 2022; Stokes et al., 2022)

COMFORT: BY CHOICE OF PHYSICAL AND THERMAL ENVIRONMENT AND MILKING CHOICES (DAIRY COWS ONLY) This can be achieved through free movement (i.e., no tethering) in an environment with variation in thermal characteristics (i.e., shade and/or shelter and temperature gradient) and also physical properties (especially providing lying comfort) which are lacking in cubicles with inadequate bedding or solid/slatted pens. There appear to be benefits of large, bedded barns over cubicle housing (Campler *et al*., 2018). Automatic milking systems offer increased opportunities for autonomy for cows (Cogato *et al*., 2021) including when combined with grazing (Lessire *et al*., 2020).

PLEASURE: BY PLAY, BREEDING, AND NURTURING EXPERIENCES INCLUDING MAINTENANCE OF THE COW–CALF BOND AND FOOD ENRICHMENT Calves enjoy playing, which can be encouraged by providing sufficient space (at least 20 m^2 per calf (EFSA AHAW Panel, 2023b)), social contact with other calves, and enrichments such as scented hay in nets, rubber teats, or hanging chains (Zhang *et al*., 2021). Adult cattle can also exhibit playful behaviors, for example, when entering new pastures or playing with their calves (Kilgour, 2012). Cows choose to access their calves in a free-choice system (Johnsen *et al*., 2021), and keeping cows and calves together promotes normal, pleasurable (including mediated via oxytocin) cow and calf social behavior (Wagner *et al*., 2015) (Fig. 16.2). In addition, calves not separated from their dam have higher mood (Daros *et al*., 2014), absence of abnormal behaviors (Roth *et al*., 2009), and play more (Waiblinger *et al*., 2020) than those with no cow contact. Weaning stress can be ameliorated by gradual weaning, separating nutritional and social weaning (Taylor *et al*., 2020).



Fig. 16.2. Dairy cows and calves enjoy being kept together and such innovative farms often sell cow–calf contact milk and other dairy products direct to customers from the farm. (Image used under license from Shutterstock.com.)

Cattle naturally eat a wide range of plants and show clear preferences for certain foods, including clover within the pasture (Rutter, 2010; Ginane *et al*., 2011), and work in heifers emphasizes that even preference for food variety is individually variable (Meagher *et al*., 2017).

CONFIDENCE: BY POSITIVE EXPERIENCE WITH STOCK KEEPERS INCLUDING FAMILIAR ROUTINES AND PROCESSES AND BY POSITIVE SOCIAL EXPERIENCES IN THE HERD Cattle have been shown to have complex social lives with long-lasting relationships (Reinhardt *et al*., 1986) and enjoyable social interactions (Laister *et al*., 2011) which can be promoted through maintaining stable social groups and buffering social stress (Hubbard *et al*., 2021; see Chapter 9, this volume). Positive human–animal relationships can have long-term benefits to ameliorate stress and fear (Rault *et al*., 2020) and for cattle involves calm handling and gentle stroking; dairy cattle and calves in particular have been shown to enjoy such interactions (Ellingsen *et al*., 2014; Proctor and Carder, 2015).

INTEREST: IN A POSITIVELY ENRICHED ENVIRONMENT AND PASTURE CHOICES Both adult cattle and calves take interest in a variety of enrichments such

as a mechanical or static brush (McConnachie *et al*., 2018; Zhang *et al*., 2021). Cattle demonstrate a high level of motivation for pasture (von Keyserlingk *et al*., 2017) and when given the choice will choose to spend time at pasture, either for grazing or resting or both, and especially at night, except under unfavorable weather conditions or if driven to access higher energy feed indoors (Charlton *et al*., 2011; Falk *et al*., 2012). Systems that promote choice within pastures and for pasture access are likely to promote welfare.

HEALTHY LIFE: BY MANAGEMENT POLICY FOR POSITIVE HEALTH, POSITIVE GENETIC SELECTION FOR LONG-TERM HEALTH AND WELFARE, AND PROMOTING A NATURAL BODY TYPE Appropriate management by farmers is frequently cited as a requirement to successfully manage welfare issues on farms, including mastitis and lameness of dairy cows (Bell *et al*., 2006) and calf health and welfare (Carulla *et al*., 2023), and includes appropriate breed selection to promote welfare (Ring *et al*., 2019). Health planning is central to that process (Tremetsberger and Winckler, 2015) and may be augmented by benchmarking (Sumner *et al*., 2018).

16.5.2 Sheep

Major sources of negative experiences that should be avoided in a good life

- Pain and sickness from disease, including lameness.
- Pain through management procedures conducted with no, or insufficient, anesthesia and analgesia, e.g., tail-docking, castration.
- Stressful handling procedures.
- Outside living in harsh climatic conditions.
- Fattening/winter housing systems in slatted pens.
- Barren outdoor feedlot systems.
- High-concentrate, low-fiber diets of intensive fattening animals leading to high rates of oral stereotypies and rumen acidosis.
- Fear, distress, and sometimes pain during transport and slaughter.

Opportunities for positive experiences

COMFORT: BY CHOICE OF PHYSICAL AND THERMAL ENVIRONMENT AND MILKING CHOICES (DAIRY SHEEP ONLY) Sheep are frequently reared outdoors in a wide variety of climates, and provision of shade and shelter, as well as dry, comfortable lying areas, will ensure protection from harsh weather (Dwyer, 2009; Masters *et al*., 2023) as well as allow enjoyment of pleasant aspects such as gentle sunshine.

PLEASURE: BY PLAY AND SOCIAL INTERACTIONS AND MAINTENANCE OF THE EWE–LAMB BOND Ewes and lambs form a strong bond within hours of birth (Mora-Medina *et al*., 2016) and preserving that bond promotes positive maternal and offspring experiences that are maintained until weaning (Mora-Medina *et al*., 2015). Lambs reared for meat are typically reared with their dams and may be artificially or naturally weaned, whereas in dairy sheep production ewes and lambs will often be separated early on and the lamb reared by a surrogate or without a ewe, being fed on milk replacer. Artificial weaning methods such as gradual weaning or providing social buffering can reduce weaning stress and have welfare benefits (Freitas-de-Melo *et al*., 2022).

When given the opportunity, lambs will engage in a variety of forms of play, often running and jumping in groups (social and locomotor play) (Fig. 16.3) or exploring objects, and this can be promoted by providing opportunities for play such as space, other lambs, and interesting objects (Chapagain *et al*., 2014; Anderson *et al*., 2015).

CONFIDENCE: BY POSITIVE EXPERIENCE WITH STOCKPERSONS, POSITIVE LEARNING, RESILIENCE, AND SOCIAL EXPERIENCES WITHIN THE FLOCK Sheep are highly sociable and form strong bonds with certain animals within the flock (Ozella *et al*., 2022) whilst also flexibly reforming sub-groups easily (Doyle



Fig. 16.3. Lambs engaging in social locomotor play. (Image used under license from Shutterstock.com.)

et al., 2016). Having demonstrated abilities in a range of spatial and social learning tasks as well as decision-making and reasoning skills, offering opportunities for cognitive enrichment is proposed as a mechanism to enhance positive welfare (Doyle, 2017). Farmed sheep are often moved around the farm and grazing areas for management reasons, and this is most positive when it incorporates positive reinforcement, such as food rewards, and avoids high fear, such as that shown in response to dogs rather than humans (Beausoleil *et al.*, 2005).

INTEREST: BY A POSITIVELY ENRICHED ENVIRONMENT, AND PASTURE AND FOOD CHOICES Many studies have documented the benefits of enriching sheep environments, particularly indoor or feedlot settings, for example with additional space, straw bales, food balls, and hanging hay (e.g., Aguayo-Ulloa *et al.*, 2014). Sheep are grazing animals and have evolved to spend a large proportion of their time eating high-fiber forage plants (Michelena *et al.*, 2006). They eat a wide range of plants and demonstrate clear preferences, and production gains are observed when they are able to select their own diet (Rutter, 2010).

HEALTHY LIFE: BY EFFECTIVE MANAGEMENT OF DAY-TO-DAY HEALTH, AND WELFARE AND POSITIVE GENETIC SELECTION FOR LONG-TERM HEALTH AND WELFARE Good health management is essential for disease prevention in sheep, and embracing human behavior change theories can be a useful tool to maximize the benefits of health planning through understanding the perspectives and barriers for farmers, e.g., for lameness (Clark *et al.*, 2024) and disease management (Boyd-Weetman *et al.*, 2024).

16.5.3 Pigs

Major sources of negative experiences that should be avoided in a good life

- Severe confinement of gestation crates, thwarting all important behaviors.
- Severe confinement of farrowing crates, thwarting nesting and maternal behaviors.
- Prolonged hunger of sows.
- Pain through management procedures conducted with no, or insufficient, anesthesia and analgesia, e.g., tail-docking, castration, tooth reduction.
- Barren, often slatted, pens with no/inadequate manipulable material.
- High levels of injurious behaviors, e.g., tail biting.
- High levels of social stress and fighting when mixed.
- Pain and sickness associated with disease, including infectious diseases.
- Fear, distress, and sometimes pain during transport and slaughter.

Opportunities for positive experiences (Rowe and Mullan, 2022)

COMFORT: BY CHOICE OF PHYSICAL AND THERMAL ENVIRONMENT Pigs in semi-wild settings utilize their environment to maximize their comfort, including finding comfortable places to rest and using wallows to cool down (Stolba and Woodgush, 1989) (Fig. 16.4). It has long been known that bedding offers considerable physical and mental welfare benefits for pigs (EFSA AHAW Panel, 2022) and a range of local materials have been found to be suitable (e.g., Hotzel *et al.*, 2009). Likewise, cooling mechanisms including use of wallows may be pleasurable (Bracke and Spoolder, 2011) and showers, cooling pads, and ventilation systems can be effective on indoor farms (Godyn *et al.*, 2020).

PLEASURE: BY FOOD ENRICHMENT, PLAY, AND BREEDING AND NURTURING EXPERIENCES Wild boar eat a huge variety of plants and some animals (e.g., over 300 species identified for Wild Boar in Europe by Schley and Roper, 2003) and pigs appear to really enjoy many different vegetables, cereals, fruits and nuts, and sweet tastes in general (Roura and Fu, 2017). Young piglets and growing pigs appear to readily enjoy playing when offered opportunities for social, locomotor, and object play (e.g., Steinerová *et al.*, 2024). Sows are highly motivated to build a nest (Vanheukelom *et al.*, 2012) and given the choice will actively nurture their piglets (Stolba and Woodgush, 1989; EFSA AHAW Panel, 2022), providing both with pleasurable experiences.

CONFIDENCE: BY POSITIVE EXPERIENCE WITH STOCKPERSONS AND POSITIVE SOCIAL INTERACTIONS Positive experiences with stockpersons, including calm movements, gentle handling, and active stroking, have shown health, productivity, and behavior benefits for pigs of all ages (Hemsworth *et al.*, 2023). Despite frequent aggression and fighting



Fig. 16.4. Free-range pigs in a woodland that have access to plenty of space, rooting, and foraging opportunities and a wallow. (Image used under license from Shutterstock.com.)

when pigs are mixed in farm settings, this is rare in semi-wild environments (Stolba and Woodgush, 1989). A huge literature has developed to prevent the negative welfare consequences of pig aggression (Peden *et al*., 2018) and some of the proposed measures will also promote positive social interactions though affiliative behaviors, for example, promoting long-lasting social relationships.

INTEREST: BY A POSITIVELY ENRICHED ENVIRONMENT AND ENHANCED LEARNING OPPORTUNITIES Pigs have evolved to root and manipulate their environment in foraging bouts that account for the majority of their active time in semi-wild environments (Stolba and Woodgush, 1989) and the motivation is so strong it is considered a behavioral need (EFSA AHAW Panel, 2022). Pigs from enriched environments show more optimistic states in judgement bias tasks (Ede and Parsons, 2023) and benefit from cognitive enrichment (Zebunke *et al*., 2013). Across a range of outdoor systems, pigs tend to show behavioral and other welfare benefits (Temple *et al*., 2012; Leeb *et al*., 2019).

HEALTHY LIFE: BY EFFECTIVE MANAGEMENT POLICY FOR POSITIVE HEALTH, POSITIVE GENETIC SELECTION FOR LONG-TERM HEALTH, WELFARE, AND NATURAL BODY TYPE Managing pig health and welfare is essential to enable pigs to benefit from positive welfare opportunities afforded them, including through proactive health and welfare planning. The genetic strain of pigs has been shown to influence aggression (Turner *et al*., 2006) and concerted breeding has been proposed as a mechanism to reduce tail biting and hence also the need for docking (D'Eath *et al*., 2014).

16.5.4 Chickens

Major sources of negative experiences that should be avoided in a good life

LAYING HENS

- Severe confinement of battery cages thwarting almost all behaviors.
- Substantial confinement of furnished cages thwarting many behaviors.

- High levels of injurious behaviors, even in some non-confinement or free-range systems, e.g., injurious pecking.
- Pain associated with beak trimming.
- Pain and sickness associated with disease, including bone fractures and infectious diseases.
- Fear, distress, and sometimes pain during transport and slaughter.

CHICKENS REARED FOR MEAT (BROILERS)

- Barren indoor environments with limited foraging/exploration opportunities.
- Genetic predisposition for poor physical health and mobility.
- Prolonged hunger of breeding birds.
- Pain and sickness associated with disease, including lameness and infectious diseases.
- Fear, distress, and sometimes pain during transport and slaughter.

Opportunities for positive experiences (Edgar et al., 2013; Rowe and Mullan, 2022)

COMFORT: BY CHOICE OF PHYSICAL AND THERMAL ENVIRONMENT Wild jungle fowl are found in forests with small clearings and domesticated chickens show preferences for similar environments (Gilani *et al*., 2014) (Fig. 16.5). Where possible chickens choose to perch at height, especially at night (Olsson and Keeling, 2000). Offering choice allows them to exercise their individual, and consistent, preferences for certain elements within their environment (Browne *et al*., 2010).

PLEASURE: BY FOOD ENRICHMENT, PLAY, AND BREEDING AND NURTURING EXPERIENCES Chickens have evolved to eat a wide range of plant and animal foods (Arshad *et al*., 2000) and appear to particularly enjoy foods such as seeds, insects (Bongiorno *et al*., 2024), and fruit. Play, or at least play-like behavior, has been proposed as enjoyable for



Fig. 16.5. Free-range hens with the opportunity to dustbathe, roam in the open or in woodland, and forage extensively. (Image used under license from Shutterstock.com)

chickens and promoted through slower-growing breeds and provision of additional space in broilers (Rayner *et al*., 2020). Similar to mammalian oxytocin, mesotocin helps mediate hen–chick bonding and rearing behavior in chickens (Sinpru *et al*., 2018), and when chicks are reared by a hen they are better prepared for the physical environment and social interactions (Edgar *et al*., 2015). Dark brooders may offer some of the benefits of hen rearing (Riber and Guzman, 2017).

CONFIDENCE: BY POSITIVE EXPERIENCE WITH STOCKPERSONS, POSITIVE SOCIAL INTERACTIONS, AND NESTING CHOICES (LAYING HENS ONLY) Jungle fowl live in small groups of up to 15 birds, consisting of some hens, a dominant male, and a few subordinate males (Garnham and Lovlie, 2018), and when farmed in large groups (often several thousand) chickens adapt by having less antagonistic social structures (Estevez *et al*., 1997). Reducing competition and offering choice of key resources such as nest box site and substrate can promote positive experiences and align with individual bird motivations (Cooper and Appleby, 2003).

INTEREST: BY A POSITIVELY ENRICHED ENVIRONMENT, DUSTBATHING OPPORTUNITIES, AND ENHANCED LEARNING OPPORTUNITIES Chickens are highly motivated to forage, spending large proportions of their day doing so (Mishra *et al*., 2005), even in the presence of abundant food (Lindqvist and Jensen, 2008). Environments that promote varied foraging, for example, safe, well-managed free-range farms, are beneficial for chicken welfare (Campbell *et al*., 2020). A wide variety of other forms of cognitive and sensory enrichments have also been shown to improve welfare of chickens of all types and life stages (Campbell *et al*., 2019). Chickens preen themselves and when given the opportunity are motivated to dustbathe, on average every 2 days (Olsson and Keeling, 2005), and show preferences for particular substrates (Shields *et al*., 2004; de Jong *et al*., 2007).

HEALTHY LIFE: BY EFFECTIVE MANAGEMENT POLICY FOR POSITIVE HEALTH, POSITIVE GENETIC SELECTION FOR LONG-TERM HEALTH, WELFARE, AND NATURAL BODY TYPE As chickens have increasingly been bred for fast growth and efficient meat production their phenotype may limit their ability to experience a good life. Slower-growing broilers have lower mortality, better mobility, increased activity, and greater enrichment use than faster-growing strains (Dixon, 2020; Rayner *et al*., 2020). Equally, genetic predisposition to poor bone quality places highly productive laying hens at greater risk of bone damage (EFSA AHAW Panel, 2023c). Good lives for chickens can be promoted through ensuring that selection of appropriate strains is part of a comprehensive health and welfare plan.

16.6 A Better Life in Intensive Systems

Given the large numbers of animals currently farmed in potentially low-welfare systems, and the reality that this will not change quickly, it seems urgent to consider potential opportunities for providing positive experiences for animals in these environments. Sometimes it is hard to distinguish whether reduction in negative experiences or true positive experiences are elicited by a specific action. For example, many dairy calves are separated from their dam and reared individually on milk replacer, which is fed less frequently and in lower amounts than the calf would consume when provided *ad lib*. These calves appear hungry and have poorer cognitive responses (Gerbert *et al*., 2018; Lecorps *et al*., 2023). However, several issues remain unclear, including: (i) whether providing *ad lib*, or at least higher rates of milk feeding, is solely ameliorating the negative effects of feed restriction or eliciting positive experiences; (ii) whether feeding to satiation could 'compensate' for other deficiencies in the system such as social isolation, physical restriction, and lack of stimulation; and (iii) whether inadequate husbandry impairs the ability of animals to enjoy positive experiences. Nevertheless, the main opportunities for providing positive experiences for animals in restrictive and/or barren systems lie in:

- Providing pleasure through tasty food enrichment (Manteca *et al*., 2008; Ginane *et al*., 2011; Ipema *et al*., 2020).
- Providing other enrichments, including cognitive enrichments (Zebunke *et al*., 2013; Mandel *et al*., 2016; McConnachie *et al*., 2018; Meyer *et al*., 2020).
- Providing positive human interactions (Westerath *et al*., 2014; Proctor and Carder, 2015; Hemsworth *et al*., 2023).
- Providing non-constant access to additional space or enrichments, e.g., a play area (Jensen and Kyhn, 2000; Chapagain *et al*., 2014; Steinerová *et al*., 2024).
- Signaling access to positive experiences to enhance the positive effect, e.g., when providing enrichment

to promote play in pigs (Dudink *et al*., 2006) (although care must be taken to ensure this does not result in frustration; Anderson *et al*., 2020).
- Offering sub-optimal access to desirable resources, e.g., manipulable material for pigs provided in racks rather than on the ground (e.g., Chou *et al*., 2019).
- Reducing stocking density to enable greater expression of positive behaviors (Gilani *et al*., 2014; Rayner *et al*., 2020).
- Ensuring genetic predispositions are sufficient to access positive opportunities, e.g., good mobility of broilers enabling use of perches and available space (Dixon, 2020; EFSA AHAW Panel, 2023a).

16.7 The Future of Farming Animals: Can All Farmed Animals Have a Good Life?

The increases in the number of animals being farmed over recent decades have mostly been in intensive or restrictive systems, therefore increasing overall suffering of animals. Whilst animal protein is still recommended as part of a healthy diet (Willett *et al*., 2019) and overall production is currently sufficient (Berners-Lee *et al*., 2018), it is poorly distributed globally. The United Nations suggest that increasing consumption of livestock products is part of 37% of Asian, 42% of African, and 25% of Latin America/Caribbean national pathways to meet the sustainable development goals of ending hunger and promoting good health and well-being by 2030 (Food and Agriculture Organization of the United Nations, 2023). Correspondingly, the average consumption of protein in more than 90% of countries exceeds the minimum requirements, with a large average over-need consumption of animal protein in North America, Europe, South America, other Organization for Economic Cooperation and Development countries, and China (Ranganathan *et al*., 2016). Citizens consistently report high levels of concern for animals and, all things being equal, the will is there to promote good lives for farmed animals as a basic societal good across diverse cultures around the world (Sinclair *et al*., 2022). As we have already discussed, providing good lives for animals requires space, choice, and investments, and often access to suitable natural environments. It is clear that at current consumption levels there is simply insufficient space and resources to provide good lives for all farmed animals in the world. The first step to reducing animal suffering is for everyone to eat no more than the minimum levels of animal protein suggested for optimal human health. However, it is not yet clear whether that would be enough to ensure that those animals that would remain can lead truly good lives. Nevertheless, there are countless farmers currently providing excellent lives for animals, who are passionate about enshrining animal welfare within their practices and who supply high-quality food for citizens. We can be grateful for these pioneers.

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17 Mental Health Issues in the Horse

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17.1 Introduction

Equids fill a unique niche in their relationship with humans. In many contexts, they are working animals kept for their utility and managed outside the immediate domestic environment; in this situation the mental health challenges facing them may be similar to those facing many farmed or production animals. In other contexts, however, they are close companions with a strong emotional bond extended from their carers; in this situation the mental health challenges facing them may be similar to those facing companion animals. In either context, expectations of their role and potential are critical. Adapting the World Health Organization's (WHO, 2022) definition of mental health, we suggest that, for the horse, mental health can be defined as: a state of well-being in which a horse can *live in a way that does not compromise its potential performance*, is able to *cope* with the inevitable stressors of its management and work so that it can *fulfill an appropriate role*; and for a horse involved in human-based activities this should also incorporate the ability to *willingly participate in goal-based activities*. From this definition, we can identify several potential areas of threat to their mental health, namely:

- Housing and living conditions, which may compromise their potential performance. This includes not only housing that might induce chronic frustration (discussed further in Sections 17.3.1 and 17.5.1), but also produce mental strain from struggling to breathe effectively in an aerial environment heavily contaminated with allergens and fungal spores (Mills and Clarke, 2007).
- Circumstances that unnecessarily reduce their coping capacity, such as certain restrictions to autonomy, including the deprivation of appropriate *ad lib* forage (Sykes *et al*., 2015) and the imposition of meal-feeding practices (discussed in Section 17.2).
- Poor rider–horse communication may not only compromise performance, but also result in the use of aversives, which compromise the horse's mental well-being (McGreevy *et al*., 2009).
- Inappropriate expectations of the role or performance capacity of the individual, including a failure to recognize the effect of chronic pain (Lesimple *et al*., 2013). Indeed, this was ranked number one in a Delphi expert survey of horse welfare priorities (Rioja-Lang *et al*., 2020). This should also include matching a horse to its capabilities, as well as problems arising from poor knowledge and/or anthropomorphization of the needs of the horse by those who care for and ride them.
- Training or activities that can undermine willing participation such as the use of compulsion in the form of restrictive riding gear/tack (von Borstel *et al*., 2009) or punishment (Waran *et al*., 2007), ranked number two in the study of Rioja-Lang *et al*. (2020) mentioned above. From the rider's perspective, rollkur (hyperflexion of the neck) has been associated with potential benefits, including improving horse's strength and responsiveness to the rider (van Oldruitenborgh-Oosterbaan *et al*., 2006). However, it is also associated with greater displays of conflict behaviors (e.g., tail swishing, changes in gait) and fear responses

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(von Borstel *et al*., 2009; Kienapfel *et al*., 2014), suggesting that both the training styles used within different disciplines as well as the demands of the discipline itself need to be considered.

It should be noted that the proposed definition also recognizes that there may be inevitable stressors, and so appropriate preventive measures may be as much about building the capacity of horses to cope with what is necessary as they are about avoidance of certain unnecessary activities. Central to this is a solid scientific understanding of not only what horses are capable of, but also their limitations. Even when they may be able to cope, the effort required may come at some mental health cost. We therefore begin this chapter by considering the issues of coping and adaptation in relation to the cost they may impose, before reviewing specific types of challenges that should be of concern and how they might be addressed. We draw on the available scientific literature, but in places this may be lacking. In these cases, we try to guide the reader on the basis of logical argument built on a compassionate interest in horses, giving the horse the benefit of the doubt, rather than arguing, as some do, that the absence of scientific evidence means that all positions have equal merit, or that the majority/popular view is necessarily the best view. Both of the latter positions have historically resulted in considerable suffering for horses.

17.2 Coping, Adaptation, and Mental Health

Coping implies that an animal can make the necessary changes to adapt and if a horse cannot cope, then it is clear that there is a problem. However, simply being seen to cope is not sufficient for good welfare or mental health. The effort required to adapt comes at a cost, and if this cannot be sustained then there is cause for concern. It is not just the nature of the challenge but also the individual's evaluation of its ability to cope with that challenge (secondary appraisal, *sensu* Lazarus (1966)) that is an important component of the resulting emotional response (Folkman, 1984). Secondary appraisal is a general psychobiological process that may vary in complexity and insight depending on the cognitive capacity of the species or individual concerned (see Chapter 14, this volume). Unlike primary appraisal, which involves assessment of the type of challenge faced by an individual, secondary appraisal involves a reflection by the individual on the options available to them to adapt to the perceived challenge and a prediction of the likelihood that this will succeed. An inability to identify an appropriate response to the challenge or a prediction that the effort needed is beyond the capacity of the individual in either the short term (e.g., response of excessive magnitude required, or response not possible due to current environmental constraints) or longer term (e.g., response required for longer than the animal predicts it can sustain) is likely to result in distress. Inspired by Fraser *et al*. (1997), we elaborate three different types of circumstance that may lead to mental health issues in horses:

1. Evolutionarily natural challenges: The nature (if not the specific form) of these stressors aligns closely with the type of challenges that have shaped the species-typical behavior of the horse, and so the responses that follow retain a clear functional purpose. For example, being able to respond appropriately to the posturing of another results in individual herd rank and helps to reduce the longer-term risk of harm from antagonistic interactions. Included in this class of challenges are circumstances that may be unique to the domestic situation, but which have the general emotional qualities of natural processes that can be deployed to facilitate coping (e.g., habituation to vehicle traffic).

2. Unmet evolutionary expectations: There are some physiological and behavioral tendencies that have arisen through evolution which are no longer advantageous in the domestic environment. The brain is geared towards making decisions about how to divide the available time between competing activities to survive and maximize fitness. However, in the domestic setting the opportunity for these activities often occupies only a proportion of the time available, meaning the animal is faced with the problem of how to fill the available time. The default state, if the animal is safe and secure in its basic biological needs, is to explore and learn about the physical and social environment, especially the discovery of sources of unexpected positive reinforcement. Accordingly, opportunities to engage in these activities are important and an enriching environment is not a luxury but an essential prerequisite for good mental health (Meagher *et al*., 2017). We suggest that a range of problems, including 'box-walking', can arise from this tendency for natural inquisitiveness combined with a restricted environment.

3. Novel domestic challenges: These are specific challenges that are unique to how domestic horses have been kept and for which there has been no selective pressure for adaptation. For example, horses have evolved to trickle feed on forage to obtain their nutritional requirements, but in the stabled environment the nutrient needs may be met with concentrates and without the need for grazing/foraging behaviors. However, the individual may still be motivated to perform associated actions. For example, horses may be intrinsically motivated to perform grazing/foraging behaviors, which if not met may result in problems including gastric ulceration (since acid production in the stomach is not largely regulated by food intake, as it is in humans (Alexander, 1966)), which presumably causes mental suffering. Indeed, there are many problems associated with preventing horses from achieving naturally occurring behavioral tendencies associated with specific goals. This includes preventing them from interacting with other horses that they can see by confining them to individual housing in the form of stalls, or making them work in an outline/posture/way that they may not be physically mature enough to sustain. In these circumstances the individual must use its evolutionary rules of thumb to try to solve the problem but may not be successful and consistent failure can be expected to result in problems with mental well-being. Another area of growing concern affecting many captive individuals is the disturbance of natural sleep patterns (Greening and McBride, 2022), which increases the risk of a range of physical and psychological disturbances, including increased pain sensitivity (Kourbanova *et al*., 2022). In horses, factors like the size of stall (Raabymagle and Ladewig, 2006), type of bedding, and lighting conditions (Greening *et al*., 2021) may each affect recumbency and thus the ability to undertake deep REM sleep.

Before elucidating further on the above circumstances of concern, it is worth emphasizing an important distinction between how we use the terms 'maladaptive' and 'malfunctional' in relation to coping strategies as it has important implications for both mental health and the nature of any additional interventions aimed at helping the animal.

A captive animal has many, relatively hard-wired, behavioral tendencies that follow the evolutionary rules of thumb that helped its ancestors to successfully adapt in the wild (i.e., which are functional from an evolutionary perspective). These rules will be applied to events in a domestic setting even if they do not help the animal cope, because it cannot easily change such hard-wired processes. If this type of situation arises, where the rules the animal follows do not help it adapt, both the underlying strategy and associated behavior may be considered maladaptive. However, the underlying processes are still functional from an evolutionary perspective, and so we would argue that the related behavior should not be considered malfunctional (Mills, 2003). In this situation, as the animal struggles to adapt in the face of unresolved challenges, both mental health and welfare may be compromised. Simply suppressing such behaviors without addressing the underlying mechanism may not only fail to improve the animal's mental well-being but actively compromise it. Only if relevant psychological states are addressed appropriately is mental health improved. In a natural setting, animals typically have a lot of autonomy, whereas this is often reduced in captivity by the associated boundaries associated with keeping the animal in a particular place at a particular time (see Chapter 8, this volume). Evolution has resulted largely in the development of strategies that deal with immediate rather than prolonged threats to well-being. Therefore, it is not surprising that another common type of threat to horse mental health comes not from the quality of the challenge, but rather its prolonged nature. This can result in organizational changes in brain microarchitecture (such as changes in neuronal sensitivity), which may be adaptive in the natural setting but not in the domestic setting. We would argue that these too are, evolutionarily speaking, adaptive changes and not pathological (malfunctional) processes, even if they result in bizarre or even harmful responses.

In a limited number of contexts, such as certain diseases where the brain is damaged by a specific physical pathology, coping may fail due to the organic lesion limiting normal regulatory processes (e.g., loss of neuronal function). This may result in the normal evolutionary rules of thumb not being followed. In this situation the behavior and related processes may be considered both malfunctional and maladaptive.

Treatments focused on improving mental health should aim to restore adaptation and facilitate coping within acceptable limits. In contrast to the medical perspective of human psychiatry, we argue

that few of the mental health issues affecting horses should be thought of as diseases or disorders (see Chapter 14, this volume). This difference in perspective should not be used to imply that the problems faced are any less important, only that the role of medicine (or veterinary medicine) is perhaps somewhat different to how it may sometimes be portrayed.

An example outside of mental health may help to illustrate this subtle but important difference between maladaptive versus malfunctioning processes. If a horse develops diarrhea because the gut is hyper-peristaltic and reduces the normal transit time to eject an irritant, then the gut is still operating in a functional way, even if the horse becomes dehydrated for a while as a result. The gut is not diseased as such. However, if the lining of the gut is so damaged that it is unable to absorb water and diarrhea results, then this has arisen as a result of a malfunction of the gut. In both cases the horse has the signs of diarrhea, but in only one is there a pathology of the gut. A similar argument can be made for mental states resulting in discomfort.

17.3 Evolutionarily Natural Challenges Impacting on Mental Health

17.3.1 Fears, frustrations, and anxieties

Fears are natural responses to perceived threats, and frustrations are natural responses to perceived limits to autonomy, including unmet expectations. By contrast, anxieties are states of uncertainty that may relate to either of these negative perceptions, or states involving motivational conflict (see below). These states are not exclusive and often co-occur.

The adaptive response to a fear-eliciting stimulus is for the individual to protect itself, preferably by taking flight (for which the horse is well adapted), but self-defense may be necessary if flight is not possible (in which case fear and frustration are now present). A horse may also freeze in fear, especially if there is no clear escape from the situation. This may help to avoid attention from a threat like a predator and conserve resources until escape becomes either necessary or possible, or the event passes.

By contrast, when anxious, the horse can be expected to engage in responses directed towards gathering more information to reduce the uncertainty of the situation. This often takes the form of behavioral inhibition (not to be confused with the complete immobility of fear) where the eyes, ears, and nose are used to discover more about the situation. Thus, the horse may snort, flick its ears, or move its head around to focus on various aspects of the environment.

When a horse cannot execute a desired behavior or its expectations are not met, it will become uncertain about what it should do about a situation. In this case frustration occurs. The animal's indecision may relate to motivational conflict, three forms of which are generally recognized:

- **Approach–avoidance conflict**: when an animal is uncertain about the potential risks associated with approaching something that is of interest (in which case both fear and frustration are present). Horses are naturally quite cautious when approaching new stimuli, even if benign. The consequences will determine the outcome, and the use of punishment at this time will likely have the opposite to the desired effect as a negative association is then established.
- **Avoidance–avoidance conflict**: when an animal can only escape from one threat by facing another threat (in which case more intense fear accompanies the frustration). For example, when a horse is anxious about going forward, but the rider tries to coerce it with the use of aversives to move on, or if the use of aids is inconsistent (e.g., kicking whilst pulling the reins). In this situation the horse cannot predict what is required to avoid the application of an aversive. Here, the relationship with the rider may be critical so the horse has a secure base to provide support.
- **Approach–approach conflict**: when the animal is uncertain which stimulus of interest it should approach first (in this case, the frustration does not feature fear). The risks to mental health from this may be less than when aversives are involved and this provides another reason why positive rather than negative reinforcement should be used in training. Indeed, this approach to training is associated with fewer behavioral problems and enhanced ridden performance (Warren-Smith *et al*., 2007).

In these conflict situations, the animal typically engages in ambivalent behavior rather than behavioral inhibition (possibly alongside increased sensory activity). We suggest that other displacement behaviors may also occur at this time. These take the form of simple acts that may appear functionally

unrelated to resolving the problem, but their expression may be important as they may serve to reduce the arousal arising from the failure to consummate the goal of the conflicting behaviors (Scopa *et al*., 2018). In the horse, common displacement behaviors seen in such situations include foot stamping, tail swishing, headshaking, the sudden 'snatching' of grass, and possibly flehmen (lip curling) (Górecka-Bruzda *et al*., 2015). Any of these conflicts may be misunderstood and misrepresented by horse-people as 'stubbornness' on the part of the horse and used to justify the use of physical punishments, which can turn a minor conflict into an active avoidance (e.g., in the form of shying), which may result in a vicious cycle of handler punishment and more major mental health issues as the supportive bond with its primary carer breaks down. Through classical conditioning, this may result in problems with tacking up, as these are preludes to the problems that occur under saddle. In other situations, these behavioral elements may constitute what are commonly referred to as 'calming signals' (Draaisma, 2017) and have communicative value, indicating that the animal is conflicted. The interplay between fear, frustration, and other emotional states makes defining facial expressions of emotion challenging, but is an area of growing research interest (e.g., Ricci-Bonot and Mills, 2023; Tomberg *et al*., 2023; Phelipon *et al*., 2024), with the potential of Artificial Intelligence (AI) allowing future automation of the process (Feighelstein *et al*., 2023). Appropriate response to these signals involves allowing adaptation and avoiding escalation of the situation, while failure to recognize or read these signs can result in further distress. Thus, poor rider understanding of natural horse behavior and the inappropriate use of aversives are major sources of equine mental health concern. Riders should be educated that many undesirable behaviors need to be understood, not ignored or punished.

Different species have inherent predispositions to the type of stimuli that they find aversive (unconditioned fears), and horses are naturally neophobic (Leiner and Fendt, 2011). This may include stimuli associated with predation or harm, such as sudden changes in movement or any circumstance that potentially limits flight or the ability to detect such circumstances. Accordingly, horses may naturally avoid confined or dark spaces (especially if moving from a brightly lit area) or any action that may restrict their locomotion (foot or more general body restraint). Experience can shape emotional responses in both a positive and negative way. If an anxious horse is punished for hesitation when anxious, such as when loading into a trailer (a stimulus set that horses can be expected to naturally avoid – see Fig. 17.1), this will exacerbate the mental challenge. Likewise, fear may develop to novel or even benign stimuli through an association with punishment or pain (conditioned fears). This includes handlers whom the horse learns to associate with the use of aversives. By the same measure, many simple fears can be resolved by associating them with positive experiences. In this regard, giving the horse time to resolve any conflict is as important as ensuring that there is a clear reward available for responding as we wish. These counterconditioning exercises are typically combined with desensitization, in which the fear-evoking stimulus is presented according to an intensity gradient which seeks to avoid an intense avoidance response (e.g., Gough, 1997).

For a herd animal, social transmission of fear reactions may be expected to occur between individuals (Nicol, 1995), so fear responses may arise even if an individual perceives no direct threat. However, the tendency for such emotional contagion may also be used to good effect to help reduce fear responses, with younger animals exhibiting a reduced response to a potentially anxiogenic stimulus in the presence of less reactive older ones (Rørvang and Christensen, 2018; see also Chapter 9, this volume).

Rewards may also be used to help motivational conflicts by clearly highlighting the preferable response. In the case of avoidance–avoidance conflict, this may focus on reducing the perceived aversiveness of one of the options outside of the problem situation so that conflict does not arise in future.

Aspects relating to rider positioning/style include use of the bit, rein tension, and consistency. Misuse of the bit has been associated with behavioral signs of discomfort as well as physical damage (Cook, 2003). When pressure from a bit, applied through rein tension, is not appropriately released or 'softened', horses often display conflict behaviors, fear, and general body tension (Visser *et al*., 2009; Christensen *et al*., 2011). Horses are usually trained to associate changes in pressure with a behavioral response (e.g., increase pressure on the mouth to slow, increased pressure on their sides to move forwards); removing the pressure (e.g., releasing rein contact) acts as a negative reinforcer, increas-



Fig. 17.1. A typical horse box with common features that horses may find aversive. For example, the horse has to step up onto the ramp, which may be an action naturally avoided. The ramp is at an angle and so the lower joints of the limb may need to hyperextend, which may be uncomfortable. The black surface will also naturally be avoided and because it may be a surface associated with vibrations underfoot. It must also be recognized that the horse box is a very novel-looking, and potentially smelling, enclosed environment associated with isolation in a dead-end space, all of which are features that horses will naturally avoid. This is further exacerbated by high-contrast features, making the transition from inside to outside very strong. Additionally, the surface may be slippery and not provide solid grip. Failure to appreciate and address effectively how these features affect a horse can lead an owner to use punishment on the horse who hesitates or refuses to enter, which will add a further learned negative association to the box, resulting in horses who may become traumatized at the prospect of loading or traveling. (Author's own image.)

ing the likelihood the response will occur again (McGreevy, 2007). If the pressure is not consistently reduced sometimes the horse will not be reinforced for displaying the rider-desired behavior, resulting in confusion for the horse, which may lead to unwanted 'evasive' behaviors.

Further misuse of the bit is seen in the delivery of inconsistent communication between the rider's

hand and leg, i.e., kicking and pulling, or 'crank and yank', as it is referred to. This response is seen in riders across the disciplines (McLean, 2003) and again is likely to result in a confused horse that shows evasive, fearful, frustration or 'learned helplessness' type behaviors.

In the wild state it would be unusual for fear, anxiety, and frustration-related problems not to be resolved relatively quickly by these actions, but that does not mean that they are not of concern. As mentioned previously, if the stimuli are particularly intense, frequent, or enduring, they may threaten the animal's mental health even if the immediate situation is resolved, as the animal may adapt by being more vigilant of danger, which may take its toll over time as resources are diverted from other activities to maintain a heightened state of arousal (Forkman *et al*., 2007; Leiner and Fendt, 2011). If the responses do not result in successful adaptation in terms of eliminating the stressor, then there may be other, less natural, consequences; because this is not the natural outcome, these are considered in Section 17.5 on novel domestic challenges.

17.3.2 Loss of social support and separation anxiety

Social support offers physical and psychological protection when faced with stressful events and is associated with feelings of subjective well-being and thriving, and its absence with specific mental health problems (see also Chapter 9, this volume). For a highly social species such as the horse, it is likely that social support is critical for normal healthy mental functioning, owing to the evolutionary pressure not to become an isolated individual who would be easy prey. In many parts of the world some horses are kept in social isolation, deprived of the benefits of conspecific or heterospecific social contact, with an increase in the risk of a range of health and behavior problems (Pierard *et al*., 2019). Even worse, perhaps, the social contact that some horses receive may be primarily with an inconsistent human, which may exacerbate the situation.

Separation anxiety is the normal response of a dependant to prolonged separation from its carer (attachment figure) (Bowlby, 1973), and clearly occurs in foals when weaned (Henry *et al*., 2020). While it may be associated with fear, anxiety, and frustration, remarkably little is known about this condition specifically in the horse, although successful treatment has been described in the form of target training an incompatible behavior at separation (Rybová *et al*., 2022). In dogs, there is growing attention paid to the role of frustration in different behavioral forms of the condition (de Assis *et al*., 2020). From an affective neuroscience perspective (Panksepp, 1998), separation anxiety is not just frustration or anxiety at being alone, but involves an aversion to the absence/loss of a specific attachment figure, which results in a panic-like response (from an evolutionary perspective the loss of one's mother is a life or death situation for a mammalian infant). Social buffering (the phenomenon whereby social relationships reduce the impact of negative events) clearly occurs in horses (Ricci-Bonot *et al*., 2021, 2023), but the extent to which they form specific attachment bonds that affect their sense of safety is less clear. A mechanistically similar emotional response based on the loss of opiate reinforcement can occur when individuals experience grief at the permanent loss of a close associate, and there are anecdotal reports of grief occurring in horses (Mendonça *et al*., 2020). Horses are a highly social species, and we speculate, on the basis of clinical behavioral observations, that this probably means that similar bonds may have the potential to form with both humans who take on a care-giving role as well as conspecifics. Although there is a lack of academic research on both separation anxiety and grief in horses, it has been noted anecdotally that separation anxiety may be more common when the relationship with the handler is inconsistent, such as when intermittent punishment is used in training (McLean and McLean, 2008). This is in line with the human literature on attachment problems that indicates these problems are more common when there is an insecure form of attachment rather than through over-attachment, which is commonly considered in relation to other species. Recent research (Górecka-Bruzda *et al*., 2022) indicates that mares may be more socially dependent than geldings, but whether this translates to an increased risk of separation-related problems remains unknown, although the authors are involved in ongoing research into both separation anxiety and grief in horses, which may be published in the near future.

17.3.3 Pain

A review of chronic pain is outside the scope of this chapter, but it is important to appreciate that it is

common in horses (Landman *et al*., 2004; Fonseca *et al*., 2006) and often goes unrecognized by owners (Lesimple *et al*., 2013). As with humans, chronic pain, and especially back pain, is often associated with a range of mental health issues including depression (Fureix *et al*., 2012), reduced sleep (which may exacerbate the situation), and increased aggressivity including towards humans (Fureix *et al*., 2010), as well as more subtle signs such as reduced attention to the environment (Rochais *et al*., 2016). If these remain unrecognized, they may result in inappropriate 'punishing' behavior by the owner towards the horse. The use of an aversive to correct the perceived 'problem' can result in further mental health issues associated with anxiety, and so on, as described in Section 17.3.1 above. Behavioral indicators of chronic pain may not be very reliable, but increasing attention is being paid to the potential value of distinctive facial expressions (e.g., Dalla Costa *et al*., 2014; De Grauw and Van Loon, 2016), which may facilitate automated recognition (Hummel *et al*., 2020; Andersen *et al*., 2021; Lencioni *et al*., 2021).

17.4 Unmet Evolutionary Expectations Impacting on Mental Health

There are several potential challenges arising from the evolutionary mismatch between the biases created in the equine brain to aid survival in their natural habitat and the domestic environment of many horses (genome lag; Fraser *et al*., 1997). These typically arise from the well-intentioned but sometimes inappropriate care provided by owners to ensure the animals' basic needs are met.

17.4.1 Boredom

Boredom may be defined as a negative affective state associated with the interpretation of one's environment as lacking interest (i.e., potential sources of unexpected positive reinforcement), because it is highly predictable and controllable (Fureix and Meagher, 2015; Burn, 2017). It does not necessarily imply that there is a lack of stimulation, but that the stimulation which is available is perceived as irrelevant (Burn, 2017).

In the absence of appropriate environmental interest, horses may engage in exploratory tasks that may be problematic, such as wood chewing and repetitive walking. With time the behavior becomes more predictable and so it may become simplified (Fentress and Gadbois, 2001), a process that appears to be facilitated by dopaminergic activity in striatal structures within the brain (Cools, 1992). This may lead to repetitive simplified behaviors such as box-walking, wood-chewing, and possibly some other behaviors, which are often (and we suggest erroneously) referred to as compulsive disorders or stereotypies, since they are not necessarily associated with either a specific anxiety or frustration (see Section 17.5 for a discussion of these issues).

Owners often misunderstand the reason for repetitive behaviors and blame the horse, as implied by the commonly used term 'vice' to describe them, and this may then be used to justify attempts at resolution based either on suppression or aversion (Hothersall and Casey, 2012) (e.g., muzzles, or the use of shock collars; Houpt, 2018), which may have their own mental health implications. However, these problems should be alleviated by appropriate environmental enrichment, which may take the form of a more visually complex physical environment (Cooper *et al*., 2000) or an increase in compatible social contact (Yarnell *et al*., 2015), both of which may provide variable positive reinforcement for the horse. Increased paddock size has been shown to reduce the amount of time spent standing passively and increase foraging activity (Jørgensen and Bøe, 2007) and while access to a paddock is clearly enriching (Ruet *et al*., 2020), it may increase problems when the horse returns to a stall. The simple provision of a diet of varied forage in the stall may in itself be enriching (Goodwin *et al*., 2002; Thorne *et al*., 2005). The role of stable toys is less straightforward, as while they may increase the diversity of activity, their effects may be varied if careful consideration is not given to their psychological effects (Jørgensen *et al*., 2011); for example, they may cause specific frustrations that increase problem behavior in a proportion of individuals (Henderson and Waran, 2001).

17.5 Novel Domestic Challenges Impacting on Mental Health

Whereas in the previous section we considered problems that may arise in the domestic situation as a result of evolutionary tendencies not being fulfilled, there are some specific novel challenges associated with the domestic environment for which it should not be expected that horses have evolved adaptive coping strategies. As a result, the

horse's behavior may appear 'stupid' or 'stubborn' to those who do not appreciate that they are governed by the evolutionary rules of thumb that evolved in their wild ancestors and there has not been selection in captivity for adaptation to these traits. Of particular note here are the consequences of insoluble problems for the horse, inconsistent communication by the rider towards the horse, and the absence of social support often found in the domestic environment.

17.5.1 Insoluble tasks

Insoluble tasks faced by the horse, in which that horse is the sole agent involved (i.e., no involvement of humans or other horses), are quite common. For example, the horse kept in a stable, where it can see other horses but not interact with them, will likely be motivated to try to approach them but is prevented from doing so by the stable door. The horse's brain has not evolved simply to accept this situation and so this can lead to chronic frustration of locomotion directed towards exiting the stable, and this may lead to repetitive weaving (Mills, 2005). Horses are commonly relieved of this frustration on an occasional basis by being turned out, and this might explain why the problem is easily resolved by enrichments that may simply distract the horse from the specific frustration, such as the provision of a stable mirror (McAfee *et al*., 2002; Mills and Davenport, 2002). However, not all domestic frustrations are transient; some, like crib-biting, appear to be typically more persistent. Crib-biting is associated with changes in dopaminergic sensitivity (McBride and Hemmings, 2005; Wickens and Heleski, 2010), which are not apparent in weaving horses (Lethbridge *et al*., 2007). It is important not to overgeneralize results relating to one repetitive behavior to another. Current neurophysiological evidence suggests that the repetitive behavior associated with cribbing, but not weaving, is more like the stereotypies described in human mental health conditions such as schizophrenia, hyperactivity disorder, and autism, or those induced with dopaminergic agents in the laboratory (Jongkees and Colzato, 2016). The exact etiology of this change remains uncertain, but a high level of concentrate feeding is a consistent finding (Wickens and Heleski, 2010), and changes in the intestinal, but not gastric, microbiome may occur (Arias-Esquivel *et al*., 2024). It is unclear whether this is of causal importance or simply a correlate of the condition. The role of the microbiome on animal mental health is rapidly becoming an important research focus (see Chapter 4, this volume).

17.5.2 Unresolved conflicts associated with equitation

Some insoluble conflicts for the domestic horse arise as a result of inconsistent communication between riders and their horses and inappropriate training methods (Merkies and Franzin, 2021). Consequently, the environment may become unpredictable at this time and the horse loses the control over its environment that it might expect (McLean and McGreevy, 2010) with no clear way to avoid an aversive interaction. This is the contingency required for the development of learned helplessness/depression-like conditions (Overmier and Seligman, 1967). Such behavior was first speculated to occur in horses in the 1980s (Ödberg, 1987) and has received some attention since (Hall *et al*., 2008; Fureix *et al*., 2015; McLean and Christensen, 2017). Alternatively, seemingly undesirable behaviors, which may be seen as expressions of non-compliance by the rider, such as bucking, shying, and issues with tacking up, may be expressed as the horse tries to avoid the context leading to the uncontrollable punishment. There is also some evidence to suggest that the type of work the horse undertakes may also affect its mental health. Disciplines that require high amounts of rider control and obedience (classical equitation, eventing, or dressage) are associated with a greater risk of problematic behaviors (including repetitive behaviors) than horses ridden Western style (Normando *et al*., 2011) or other disciplines in which the rider has looser contact through the bit with the horse's mouth (McGreevy *et al*., 1995; Hausberger *et al*., 2009).

Whereas depression in humans is assessed through clinical enquiry, often supplemented by psychometric assessment, assessing depression in horses is subject to greater methodological challenges. Nonetheless, identifying proxies of this mental health issue is important (MacLellan *et al*., 2021). States involving profound inactivity and low responsiveness to external stimuli (i.e., appearing withdrawn) have been linked to depressive states in horses (Swann, 2006; Burn *et al*., 2010; Fureix *et al*., 2012). Horses who have been identified as having impaired welfare and being in pain often show reduced responsiveness to the environment

(Pritchard *et al*., 2005; Hausberger *et al*., 2016; Burn, 2017). Such 'withdrawn' states are commonly defined through a stationary, atypical, flat-necked posture, wide-open, unblinking eyes, fixed gaze, and backwards-pointing ears (Fureix *et al*., 2012). As well as low behavioral reactivity to stimuli, depressive-like states in horses have also been associated with differences in attention. Non-withdrawn horses show greater reactions to novel auditory stimuli, and these reactions are displayed for a longer period of time, than behaviorally depressed horses, who show less reaction and greater consistency in this response over time (Rochais *et al*., 2016). Additionally, depressed horses have been reported as showing reduced food consumption and reduced latency to consume food (Fureix *et al*., 2015) as well as anhedonia (a loss of pleasure), as assessed through reduced consumption of sucrose, compared to horses that displayed non-withdrawn behaviors (Fureix *et al*., 2015). Taken together, these findings suggest that it is reasonable to refer to psychological as well as behavioral depression in horses. Failure to recognize this sort of mental health problem is likely to exacerbate the situation. For some owners, 'withdrawn' behaviors may be desirable, making the horse easier to handle and seemingly more compliant with the demands of their environment, but for others, the horse may be seen as stubborn as performance expectations are not met. Either way, this is a cause for concern, especially if this state is misinterpreted as a positive psychological state, such as feeling calm and content. Important ancillary signs that may help to differentiate this are wider signs of anxiety (Fureix *et al*., 2012) and reduced attentional processing (Rochais *et al*., 2016), which may be most evident from poor learning and performance (Hall *et al*., 2008). It is therefore important that owners are educated on behaviors indicative of depressive-like states in horses.

Adaptive behavior and reduced stress in the face of challenges require an ability to make adaptive decisions by predicting the likelihood of future success based upon previous experience. The inability to accurately predict outcomes increases arousal and creates distress (Weiss, 1972; Shihata *et al*., 2016) even if it does not lead to learned helplessness. Within the human health literature intolerance of uncertainty has been related to psychopathologies, particularly obsessive compulsive disorders (OCD) (e.g., Laposa *et al*., 2015) and generalized anxiety disorder (GAD) (e.g., Norton *et al*., 2005). Inconsistency may result in the expectation that uncertainty, ambiguity, newness, and change are potentially dangerous (Grenier *et al*., 2005; Buhr and Dugas, 2009). When being ridden, horses can often depend on the rider's actions rather than their words to predict what is required, and so signaling consistency including the use of aids, such as the leg and seat, is paramount. Sometimes signals are conflicting, e.g., the rider urges the horse forward with the leg but keeps restraining it through the mouth bit (McGreevy and McLean, 2005); at other times signals and aids may be simply applied unsystematically (Hockenhull and Creighton, 2013). In either case, the consequence is a loss of control to which the horse is unable to find a solution. It is natural for a horse to resist such confusion and frustration, but this may be seen as disobedience and result in inappropriate attempts at punishment or more technical solutions, which are likely to exacerbate the situation if the fundamental signaling consistency issue is not addressed. In this regard it is interesting to note that Hockenhull and Creighton (2012) found that ridden-horse behavior problems were more likely when more technical aids were used, although the causal nature of the relationship cannot be established.

17.5.3 Cognitive dysfunction and associated problems

Finally, it is worth noting that in many industrialized nations the horse population is, like the human one, an aging one, with an increased potential for dementia-like problems. While Alzheimer's-like conditions have been identified in other companion species such as the dog (Azkona *et al*., 2009) and cat (Gunn-Moore *et al*., 2007), less attention has been paid to the horse. Our own unpublished work suggests that older horses may show some of the spatial learning deficits commonly seen in dogs with this condition (Milgram *et al*., 1994), but whether or not there is a similar pathological correlate is unknown. Nonetheless, older horses are also prone to Cushing's disease (McCue, 2002) and the increased cortisol production associated with this condition, like Alzheimer's, is likely to increase the risk of anxiety-related problems, which are of concern. There is therefore not only a need to monitor the physical health of older horses and address related issues, but also to carefully consider their secondary psychological effects.

17.6 Conclusions

The horse occupies a unique position among domestic species when it comes to their mental health, potentially suffering from issues relating to close association with often well-meaning individuals who may fail to take the horse's perspective on things, as well as the stresses associated with expectations of performance. In modern equitation many individuals want rapid results and can fail to consider the horse's perspective; however, to obtain a safe and ethically correct training environment, the mental state of the horse is an essential consideration (Hendriksen *et al*., 2011). Not only rider impatience but also rider inconsistency is a particular problem (Hemsworth *et al*., 2015); it would be advantageous if riders first learned more about horse ethology and communicating with their horse through training them from the ground and learning some equitation skills, such as balance and seat, leg, and hand independence on horse simulators. In this way, they might reduce the risk of sending confusing signals to the horse. Furthermore, the increasing use of automated equipment and software to track rider's position and body movements, as well as rein tension (McGreevy, 2007), means it is now possible to provide feedback to riders on the clarity of their signaling and appropriate use of pressure-release. Horses are not deliberately disobedient or stubborn, and it is essential that riders reappraise any such perspective on a horse's behavior and come to appreciate more fully the horse's world view (umwelt). In this way, the unique partnership between humans and horses can be enjoyed and the mental well-being of both enhanced as a result.

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18 Behavioral Health and Mental Well-being of Sheltered Animals

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18.1 Background

Behavior problems are thought to drive the relinquishment and returns of pets to shelters (Sulonen *et al*., 2024). For example, a national survey found respondents were more likely to relinquish to a shelter versus rehome to a friend if the animal had behavior concerns (Weiss *et al*., 2015). Relinquishing owners can also be unreliable (Powell *et al*., 2021a) and may underestimate behavior concerns. All of this seems to suggest psychological problems abound in shelter populations. However, human issues, such as health problems or housing, are equally or more important drivers of relinquishment than behavior concerns (Jensen *et al*., 2020). A recent review found problem behaviors in relinquished dogs were not strikingly different from those of pets retained in the home (Patronek *et al*., 2022). Further, most animals enter shelters as strays with only about one-third surrendered by an owner (Count, 2024).

Even prior to the COVID-19 pandemic, there was a sense that length of stay (LOS) – how long the animal spends in the facility from intake to release – was increasing as shelter populations shifted toward high-needs animals that require medical or behavioral interventions prior to making them available for adoption (Cussen *et al*., 2022). However, an animal's LOS is influenced by many factors besides behavior or medical needs (Marston and Bennett, 2003), from shelter location (Kay *et al*., 2018) to visitor biases (Cohen *et al*., 2020). Pandemic-related population reductions were reportedly followed by post-lockdown relinquishments (Carroll *et al*., 2022, 2024); however, data from multiple sources suggested otherwise. A large-scale national survey found most pets remained in their homes (Hoffman *et al*., 2021). Regardless, there is no doubt that shelters are currently experiencing an acute and widespread surplus that is straining capacity for care, driving up rates of euthanasia, and increasing LOS (Count, 2024).

18.2 Assessing Animal Welfare in the Shelter

The typical shelter environment is not designed to provide for the mental well-being of animals long term. Captivity exposes animals to a wide array of stressors, including loud noises, smells, restricted movement, and forced proximity to human and conspecifics, coupled with the inability to interact directly, etc. (Morgan and Tromborg, 2007). The effects of chronic stress are cumulative (Mills *et al*., 2014), meaning welfare impacts are compounded over the duration of an animal's shelter stay. Understanding behavior, stress indicators, and risk factors remain critically important areas for shelter-based research (Horecka and Neal, 2022), yet identifying the stressors most relevant to animal welfare in the shelter is challenging. Most research compares some type of management change, e.g., space allowance, single or group housing, human interaction, etc., to see how it impacts animals' behavior (Taylor and Mills, 2007). However, results to date for behavioral, physiological, and

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immunological outcomes of shelter-based research are variable and, at times, contradictory (Polgár *et al*., 2019). Specific 'welfare-indicators' can be difficult to interpret (Hennessy, 2013), as they can be influenced by arousal as well as valence (Flint *et al*., 2024). Variability in estimations of prevalence across behavioral indicators and estimation methods (Normando *et al*., 2019) further complicates interpretation. Understanding the relationship between behavioral indicators and animals' affective states is, of course, critical for interpretation (Kremer *et al*., 2020). Yet, indicators may be used without any validation or explicit interpretation of their meaning for welfare (De Winkel *et al*., 2024). Validation is especially limited for more recent indicators of positive welfare (Lawrence *et al*., 2019). Furthermore, random variability between facilities can also explain more of the behavior results than any of the wide range of management factors under study (Kiddie and Collins, 2015), possibly because of small sample sizes (Pongrácz and Camerlink, 2023) or a restricted number of observation points in shelter research. From a practical perspective, shelter managers should be cautious about assuming welfare benefits will apply in their facility and should monitor animals following management changes.

Monitoring welfare requires standardized assessment approaches. Yet, such approaches are yet to be agreed upon or widely adopted across shelters (Lamon *et al*., 2021). The Five Domains Model has grown in popularity and scope (Mellor *et al*., 2020; Chapter 24, this volume), but suffers from fundamental issues related to transparency and subjectivity (Hampton *et al*., 2023). Applied monitoring generally involves assessing behavioral changes, and changes across multiple indicators must be synthesized and translated into an interpretation of overall welfare (Cussen and DiGangi, 2022). Whole animal approaches, e.g., qualitative behavioral assessments (QBA) or subjective ratings of quality of life (Reid *et al*., 2024), may prove useful for capturing welfare. To date, most welfare assessments focus on acute snapshots rather than longitudinal changes over time (Lamon *et al*., 2021), which are critical for monitoring welfare of individuals across longer shelter stays (Cussen *et al*., 2022). Mental well-being monitoring should be included in basic animal care used to calculate shelter's capacity for care (e.g., Koret Shelter Medicine Program, 2024) as this is a fundamental need to protect animal welfare in the shelter.

18.3 Shelter Environment and Welfare

The response to environmental stressors, i.e., the 'psychological environment', (Taylor and Mills, 2007), is influenced by dogs' previous life experiences (Tiira, 2019). Dogs with a history of adverse social or thermal experiences, for example, were less negatively impacted by individual housing in indoor kennels (Hubrecht *et al*., 1992). Owner-surrendered dogs may be more distressed due to the loss of a stable attachment figure (Tuber *et al*., 1999). They showed a significant increase in physiological stress indicators over the 6 weeks after entering a shelter (van der Laan *et al*., 2022), whereas strays showed evidence of habituation (Hiby *et al*., 2006). Owner-surrendered dogs did not show a positive physiological response to interaction with unfamiliar humans in the shelter, whereas stray dogs showed an acute decrease in cortisol (Willen *et al*., 2017), possibly due to life history impacts on attachment formation (Thielke and Udell, 2019). So, perception of and response to the environment likely differs between dogs with varied histories or personalities (see Section 18.4).

Restricted movement of mammals is known to be a powerful stressor linked with stereotypical or repetitive behaviors (Latham and Mason, 2010). Studies on exercise in kennel-housed dogs do not consistently find that exercise per se is enriching (Cafazzo *et al*., 2014; Jongman *et al*., 2018), but conclusive evidence is limited because exercise is usually confounded with increased space, social enrichment, etc. (e.g., Cafazzo *et al*., 2014). The effect of exercise on shelter dog behavior is usually framed within the paradigm of increasing adoptability by promoting desirable behavior. Because of that perspective, studies focus on short-term changes in behaviors related to kennel presence (Protopopova *et al*., 2018) as opposed to determining if exercise can improve the mental well-being of the animal directly. Exercise is known to reduce stress in dogs generally and it is negatively correlated with fear and anxiety, even within phobic/anxious populations (Tiira and Lohi, 2015). Therefore, allowing individuals the control to self-regulate exercise could promote mental and physical health (see Section 18.6).

Noise is another known stressor in the shelter environment. It interferes with dogs' ability to rest and sleep (Hoffman *et al*., 2019), elicits a physiological stress response (Beerda *et al*., 1997), and is related to poor post-operative recovery rates in human medical patients (Fullagar *et al*., 2015). Dogs in shelters are frequently exposed to noise levels over 100 dB (Coppola *et al*., 2006a), a level that led to hearing loss in shelter dogs (Scheifele *et al*., 2012). Ideally, new construction projects should design noise-dampening elements into the shelter plans (Coppola *et al*., 2006a), but pragmatic approaches are needed for existing facilities. Since much of the noise is created by the barking of the dogs themselves, decreasing arousal is a high priority in shelters. Human traffic increases barking in the shelter (Carrero and Bennett, 2025); limiting visitor access can significantly lower noise levels and promote resting (Hewison *et al*., 2014). Many shelters now use 'quiet times' where all staff and volunteers must be off the floor for a period during the day. However, human interaction has benefits, so balancing restful periods against social enrichment is important. Many shelters also use some version of 'drive-by treats' which pairs human presence with the provisioning of a high-value food reward; this can be effective in reducing vocalizations (Zurlinden *et al*., 2022). However, the effect is strongly linked to human compliance, which is low even with signage, and the total reduction in noise is modest (e.g., reduction from ~102dB to ~100dB; Carrero and Bennett, 2025), and results across studies are sparse and mixed (Shnookal *et al*., 2024). Making modifications to housing to provide or prevent visual access to conspecifics is also common in an attempt to reduce arousal and barking, also with mixed results. Images of moving conspecifics reduced vocalizations in kenneled dogs, though the effect was largest on the first day (Graham *et al*., 2005). More recently, a study removed visual barriers (commonly employed by shelters to decrease arousal) and found dogs vocalized somewhat less, not more; the authors suggested visual contact reduced frustration (Martin *et al*., 2023). An alternative approach is to remove the animals themselves from the stressful shelter environment. Specifically, short-term outings and overnight visits have been found to have beneficial impacts on behavioral and physiological welfare indicators, including resting behavior (Gunter *et al*., 2023). While fostering has benefits, programs can be difficult to scale up (Powell *et al*., 2021b) – especially in under-resourced shelters (Gunter *et al*., 2022) – and challenging to maintain (Reese *et al*., 2022). Therefore, programs using short-term reprieves from shelter stress may be more feasible than long-term fosters if the lower commitment results in higher community participation.

Providing social enrichment through human interaction buffers dogs from shelter stress (Hennessy *et al*., 2020; Chapter 9, this volume). Even opportunities for passive proximity to humans outside the home kennel decreased vocalizations and panting as compared to control dogs that were removed from their kennels but did not have human interaction (Shiverdecker *et al*., 2012). Relatively short sessions can be as effective as interactions twice as long (Willen *et al*., 2017). Dogs seem to prefer to interact with familiar people (Pullen *et al*., 2013) yet also appear to benefit from contact with unknown people (Coppola *et al*., 2006b). One study found that areas of dogs' brains associated with reward were activated by smelling the scent of a familiar – but not an unfamiliar – human (Berns *et al*., 2015). Incorporating scents specific to humans familiar to the dog into olfactory enrichment may be a novel way to extend the benefit of social enrichment after the dog returns to the kennel, but this has yet to be studied. There is some evidence, too, that the beneficial effects of human interaction are short lived (Willen *et al*., 2017) and influenced by the dog's history (Pullen *et al*., 2013). Because length of interactions varies between studies, there is no rule of thumb for how best to set up human interaction. Maximizing time spent with the dog may increase welfare and provides an opportunity to gather information about that animal's temperament (Coppola *et al*., 2006b).

Social enrichment through interaction with conspecifics is another powerful way to offset the stress of the shelter environment. Providing dogs opportunities for social interaction with compatible conspecifics through pair housing is known to reduce stress (Grigg *et al*., 2017). Another way to provide social enrichment is playgroups. They are variable in their complexity – e.g., dyads versus group play – and formality – volunteer versus behavior staff, information collected during playgroup, etc. – depending on resources and shelter population. The unifying idea is that interacting with other dogs is a highly effective tool for reducing the effects of shelter stress. Anecdotal reports support the benefits of using playgroups (Dogs Playing for Life, 2023), but the effects on in-kennel

behavior outside the play-yard are yet to be systematically studied. Still, conspecific social buffering against stress is well established in dogs in the home (Tiira, 2019) and the shelter (Hennessy *et al*., 2020) and can even serve to catalyze behavior modification for severely undersocialized or fearful dogs (Collins *et al*., 2022), making it a powerful tool to promote mental well-being in the shelter.

18.4 Reward Sensitization, Anhedonia, and Helplessness

High-arousal behavior is likely maintained, at least partially, by a conditioned emotional response to the appearance of people and other stimuli associated with high-value reinforcers such as time outside of the kennel, human interaction, food delivery, etc. (e.g., Protopopova *et al*., 2018). To a point, increasing anticipatory behaviors can indicate a positive subjective state, because the animal has an expectancy of obtaining an impending reward and is not suffering from anhedonia (Spruijt *et al*., 2001; Van der Harst and Spruijt, 2007). Above a certain point, however, excess anticipatory behavior may appear almost manic, and may indicate a sensitization to reward (Bassett and Buchanan-Smith, 2007). Reward sensitization can occur when the environment offers few rewards such that any reward becomes highly salient and the animal is neurologically primed to have a large emotional response to it (Spruijt *et al*., 2001). Responding can then become reinforced via the gambling effect, to the point of pathology. The *degree* of the anticipatory response – and its change over time – could be a potential metric of affective state in shelter dogs (e.g., Van der Harst and Spruijt, 2007).

The flipside to reward sensitization is the loss of neurological or behavioral responsiveness to environmental rewards. This phenomenon is called 'anhedonia', or a loss of enjoyment in previously enjoyed activities or rewards. Outside of the laboratory, anhedonia can be difficult to distinguish from relaxed resting if relying only on behavioral measures (Kremer *et al*., 2020) unless within-individual changes are monitored over time (Cussen *et al*., 2022). For example, dogs suffering from a depressive-like state probably spend the majority of their time lying at the back of their kennel, much the same as would a dog that has adjusted to the shelter environment and is lying down to relax (Wells *et al*., 2002). The inability to avoid aversive physical or social stimuli is likely a major in-shelter stressor with a devastating effect on psychological well-being. Dogs that could perform a behavior to avoid an aversive event (shock) learned to do so, whereas those lacking behavioral control over the shock could not learn to do so later – even when avoidance was possible – a phenomenon called 'learned helplessness' (Seligman, 1972). Further, dogs that were able to turn off an electric shock showed a significantly lower increase in cortisol compared to dogs that had no control over a shock *of the same intensity* (Dess *et al*., 1983; see Chapter 8, this volume, for more on the sense of control in animals). Importantly, the behavioral impacts of learned helplessness were long lasting (Seligman and Groves, 1970).

One approach to distinguish between these states uses subjective assessments such as QBA. Here, observers freely describe the behavior of an animal from a video clip. QBA generally finds high agreement between people of varying familiarity or expertise level for a given species (Wemelsfelder *et al*., 2001). The rationale behind QBA is that animals manifest their internal subjective states through qualitative changes to their behavior – e.g., not if they sit but *how* they are sitting, etc., what Wemelsfelder and colleagues called the 'whole animal' approach (Wemelsfelder *et al*., 2001). QBA was developed for farm animals but has since been applied to assessing emotional expressions in dogs (Walker *et al*., 2010). Multiple studies have subsequently demonstrated the inter-rater reliability of QBA as a means of describing dogs' outward manifestation of affect in shelter environments (Walker *et al*., 2016; Arena *et al*., 2017; but see Arena *et al*., 2019). The need for complex statistical analyses and training, however, may limit the widespread use of QBA in shelters.

The takeaway is that chronic environmental stress profoundly impacts animals and can cause changes to the structure and function of animals' brains (Maier and Seligman, 2016). Behaviorally, this manifests in many ways, including as an increasing responsivity to pleasurable stimuli (reward sensitization) *or the converse*, a decrease in responsivity (anhedonia). An important component of these opposing processes is change over time, underscoring the importance of longitudinal monitoring of within-individual changes in the shelter to assess the welfare of an individual animal (Cussen *et al*., 2022).

18.5 Personality, Coping Styles, and Consistent Individual Differences

How animals respond to stress is mediated by multiple factors including genetics and previous

experience (Southwick and Charney, 2012). Two concepts related to consistent individual differences are coping styles and personality. Both of these related concepts seek to explain variability between animals of the same species in their behavioral responses to a given situation or stimulus; both are directly relevant to shelters because they have implications for resiliency to stress, disease susceptibility, and overall fitness (Laskowski *et al*., 2022).

Coping styles emphasize the relationship between observed behavioral tendency and the underlying physiological mechanisms. Two commonly used classifications are 'proactive' and 'reactive' coping styles (Koolhaas *et al*., 1999). Proactive individuals are less behaviorally flexible, more impulsive, and more easily frustrated than reactive individuals, which renders them less able to deal with changing environments (Coppens *et al*., 2010; Koolhaas and Van Reenen, 2016). Animals also vary in the amplitude of their response (stress reactivity or emotionality) (Koolhaas and Van Reenen, 2016). One study found categorical differences in the strength of kenneled dogs' physiological response (i.e., stress reactivity) to a stress challenge test (Denham *et al*., 2014). Dogs in the 'high' group showed significantly more repetitive behaviors and they were *the only* individuals to show repetitive behaviors in the absence of environmental triggers such as food preparation or humans walking in front of their kennels (Denham *et al*., 2014). Some speculate a 'proactive' coping style may be related to aggressiveness while a 'reactive' coping style may be related to fearfulness (Horváth *et al*., 2007). Another study found a link between coping styles in stray dogs and disease development in-shelter (Corsetti *et al*., 2018). These studies underscore the link between consistent individual differences and functional outcomes.

Comparative personality is also interested in consistent individual differences (Gosling, 2001) but differs conceptually from coping styles (Uher, 2011). Recent years have seen a large expansion of research focused specifically on dog personality (Jones and Gosling, 2005). This includes the familiar Canine Behavioral Assessment & Research Questionnaire (C-BARQ), the less ubiquitous but extensively validated Dog Personality Questionnaire (DPQ) (Jones, 2008), and the more recent Vienna Dog Personality Test (VIDOPET) (Turcsán *et al*., 2018). Similarly, there was a proliferation of scales to describe specific traits (rather than personality structure) in domestic dogs. These include the Dog Impulsivity Assessment Scale (DIAS) (Wright *et al*., 2011), the Canine Frustration Questionnaire (CFQ) (McPeake *et al*., 2019), the Lincoln Canine Adaptability Resilience Scale (L-CARS) (Mackay *et al*., 2023), sensory processing sensitivity (Bräm Dubé *et al*., 2020), etc. Unlike aggregate scales, behavior assessments are generally not repeated, but rather provide a snapshot of behavior at the time of the test and, therefore, do not account for within-individual variation in behavior (Dingemanse and Wright, 2020). Currently, shelter-based assessments tend to lack rigor (Rayment *et al*., 2015) and are not terribly predictive of future behavior (e.g., Shabelansky *et al*., 2015), though there are exceptions (Clay *et al*., 2020; Reid *et al*., 2022). Longitudinal behavior assessments based on repeated observations over a month's time were better able to explain variability within and between dogs in a shelter than were stand-alone behavior assessments (Goold and Newberry, 2017). Evidence suggests that personality traits are correlated with behavior concerns in pet dogs (Salonen *et al*., 2022), possibly because they are linked to inter-individual differences in set point for core affective states (Svartberg, 2022).

Therefore, understanding shelter animal personality would increase the likelihood of targeting interventions to best support their welfare. Consider, for example, frustration tolerance, identified as a personality trait in dogs (Turcsán *et al*., 2018). Dogs in shelters repeatedly see and hear other dogs and humans and may be motivated to engage in appetitive behavior to seek out interaction, but due to the physical restrictions of the kennel environment they may be unable to reach the consummatory phase of behavior, e.g., interaction with a person or a conspecific, which can lead to frustration (Taylor and Mills, 2007). Repeated frustration of goal-directed behavior causes excitation of the 'rage' system, which is associated with aggressive behavior in animals (Panksepp, 1998). Whether or not this mechanism underpins the development of barrier aggression or reactivity in shelter dogs is not known, though frustration behavior in dogs includes activity, displacement behavior, and vocalizations (Jakovcevic *et al*., 2013).

Some individuals are more negatively impacted by the thwarting of goal-directed behavior in the shelter than others, which may be underpinned by the stable trait related to frustration tolerance (McPeake *et al*., 2019). Importantly, many in-shelter interventions focus on inhibiting arousal-related

behavior (Shnookal *et al*., 2024), Inhibition is, essentially, the flip side of impulsivity; it is sometimes called 'impulse control' (Wright *et al*., 2011) though they may not be synonymous. It involves refraining from or terminating a likely or preferred behavior that is not effective, or not as effective as an alternative response (Brucks *et al*., 2017). Training impulse control makes intuitive sense as a way to, for example, reduce jumping or barking. It may inadvertently, however, exacerbate behavior stemming from frustration rather than impulsivity (Cussen and Reid, 2023). Understanding the relative contribution of impulsivity versus frustration tolerance and how they relate to each other (Brucks *et al*., 2017) and to excessive arousal in the shelter would facilitate tailored, effective interventions that would minimize negative affect and reduce LOS.

However, the familiarity necessary for aggregate ratings (Epstein, 1979) appears to limit their utility as a means of quickly classifying animals entering the shelter. Rather, it may prove necessary to develop easy to administer tests that are predictive of future behavior, as is commonly done for coping styles (Bolhuis *et al*., 2004). Some work has happened in this direction. Shelter dogs in Italy were assigned to 'shy' or 'bold' coping styles using relatively simple novel object, T-maze, and novel environment assessments. A blood sample was taken on admission and 30 days later. Dogs classified as 'bold' were reported to be less susceptible to disease compared to dogs classified as 'shy' on intake (Corsetti *et al*., 2018). Brady and colleagues developed a simple behavioral test for impulsivity, with the goal of phenotyping relatively unknown dogs, which they reported correlated with DIAS aggregate ratings (Brady *et al*., 2018). However, a later attempt to replicate their work found no such correlation (Stevens *et al*., 2022). Indeed, a recent systematic review found little evidence of a relationship between different tests purported to measure impulsivity within or across studies (Barela *et al*., 2024). This suggests simple assays may be challenging to develop. On the other hand, we recently piloted the use of the DIAS and CFQ by shelter staff working with dogs exhibiting high arousal behavior (Cambrelen *et al*., 2023). In this study, the staff reported the surveys were easy to complete, and the dogs scored significantly higher compared to reported values for pet dogs. This may indicate tools published for assessing owned dog personality traits can be used by shelter staff to better understand their populations.

Behavioral phenotyping is critical for understanding and supporting shelter populations (Cussen and Reid, 2024). An approach where simple, validated assessments classify dogs on intake would allow tailored psychological management – e.g., high or low novelty, quiet or active area, etc. – to best prevent mental suffering and behavioral deterioration during their time in the shelter.

18.6 Recommendations

18.6.1 Agency, or 'behavioral engineering' revisited

Providing some level of choice over the captive environment accounts for individual differences, provides agency, and improves animal welfare, even in systems geared to standardized husbandry and housing (Špinka, 2019; reviewed in Chapter 8, this volume).

Agency, or the ability to effectually make choices and act on the environment, is postulated to be a biological imperative across species (Englund and Cronin, 2023). Indeed, choice itself is rewarding even when it leads to the same ultimate outcome, i.e., the *perception* of control (Leotti *et al*., 2010). Environmental enrichment should, therefore, always increase the animals' level of control over their captive environment (Westlund, 2014). This can be done via preference testing (Hou, 2023) or training programs, but those approaches can be time and labor intensive (Reid and Rehner-Fleurant, 2022). Alternatively, 'behavioral engineering' approaches that increase animals' degree of control without reference to naturalness can be employed (Markowitz, 1982). This approach addresses the overarching biological imperative to act on a responsive environment; it does not attempt to 'naturalize' time budgets (Fraser, 2009).

Naturalizing time budgets has led to a focus on terminal behaviors (e.g., eating) as opposed to the psychological imperatives – agency, problem solving – underpinning the goal-directed behaviors (Meehan and Mench, 2007). For example, food enrichments in animal shelters are given to promote relaxed chewing and licking (and thus, also decreased arousal and barking) without considering appetitive behaviors. How 'enriching' such items are to the animals, i.e., their biological relevance and their influence on satiating underlying motivations (Newberry, 1995), is rarely assessed in shelter programs due to time constraints. A recent pilot study assessing behavioral change after enrichment found

that food-stuffed toys had little to no effect on relaxation or 'stress' behaviors, while conspecific play had the largest effect (Hunt *et al*., 2022). On the other hand, learning how to successfully act on the environment is associated with positive affect in dogs (termed the 'Eureka effect'), whereas noncontingent reinforcement promotes frustration (McGowan *et al*., 2014). An alternative approach to free food treats may be to feed the animals' daily ration in a way such that they must act on the environment to obtain it and can decide how or when to do so. The tendency of animals to work to obtain food even when the same type of food is freely available, called 'contrafreeloading', is well documented across a wide range of species. Contrafreeloading appears strongly related to food acquisition (i.e., appetitive foraging behavior), and preference for contrafreeloading is stronger when the value of the food reinforcer is higher (Osborne, 1977).

Research on contrafreeloading did not include domestic dogs until 2024. Rothkoff and colleagues reported domestic dogs were *willing to* contrafreeload, but did not appear to *prefer* working for food (Rothkoff *et al*., 2024). Notably, however, the value of the food was not unusually high, preference was determined by first choice location rather than total duration of feeding at each location, and the participants were owned pet dogs (and, therefore, likely well fed and reasonably well enriched) (Rothkoff *et al*., 2024). For dogs in shelters, opportunities to contrafreeload could afford agency and provide more enrichment value than a food treat given in addition to a freely available ration, even if they do not prefer to contrafreeload. More work is needed in this area as it has a high potential for improving welfare in shelter without staff/labor-intensive interventions.

While typically tied to foraging, increased choice and agency can also be created by allowing the animals to manipulate their micro-environment in some way. Markowitz (1982) empowered captive animals to control the light and music in their enclosures. Training a dog to operate an on–off switch is a trivial task that could be applied to a speaker in the kennel. They could then select whether, for example, to listen to classical music, white noise, some other type of music, or nothing. Given that dogs habituate quickly to auditory enrichment and genre of music is known to influence its effect on behavior (Bowman *et al*., 2017), providing choice may maximize the impact of auditory enrichment by allowing individuals to select the music they hear.

Agency – or lack thereof – may be the most directly relevant aspect of the shelter environment as concerns mental well-being. A sustained absence of control, in conjunction with forced proximity to unpredictably available rewards or aversive stimuli, can lead to extreme frustration or apathy (Brando and Buchanan-Smith, 2018). The longer animals spend in the shelter, the more likely they will display behavior that is indicative of poor mental well-being (Cussen *et al*., 2022). However, when animals learn they have control over enduring aversive stimuli, they are protected against the deleterious behavioral and physiological effects of chronic stress (Maier and Seligman, 2016; reviewed in Chapter 8, this volume).

18.6.2 Predictability

Predictability is another important aspect of the psychological environment. For a given reinforcer, animals prefer a signaled (i.e., predictable) reinforcer more than the *same* reinforcer given to them without a signal (McGowan *et al*., 2014). They also show conditioned place preferences for areas associated with predictable reinforcement compared to areas associated with unpredictable reinforcement (Osborne, 1977). Further, predictable aversive stimuli reduced the amplitude of animals' physiological stress response compared to the *same* but unpredicted stimulus (Gliner, 1972; reviewed in Chapter 8, this volume). Dess *et al*. (1983) reported a somewhat different relationship between predictability and stress in dogs with no difference in physiological responsiveness to an unpredictable versus predictable aversive stimulus. But, importantly, when tested later in a novel environment, dogs with a history of unpredictable shock were sensitized to an aversive stimulus in the novel environment, resulting in significantly larger cortisol responses (Dess *et al*., 1983). Therefore, it seems clear that predictability ameliorates the physiological response to unpleasant experiences on some timescale. Furthermore, predictability reduces frustration (McGowan *et al*., 2014), making it a powerful tool for decreasing arousal.

Simple predictive cues preceding normal operations, especially for temporally variable events such as opportunities for social interaction, walks, etc., could have a profound impact on shelter animals. Logically, predictive cues could increase arousal through anticipation of access to reinforcers, but they should also decrease arousal at other times

when opportunities for reward are not signaled. Currently, animals make associations between humans or facility noises and rewards (e.g., Denham *et al*., 2014; Protopopova *et al*., 2018), but as predictive cues they have a high rate of non-reinforcement, e.g., human presence may have nothing to do with a specific dog or activity at that specific time. Learning theory suggests variable schedules of reinforcement maintain responding in the absence of reward through the gambling effect (Reid, 1996). Encouraging associations with cues only present during the target activity (feeding, walk time, etc.) may, then, reduce overall arousal and frustration in shelter animals. At present, this has yet to be evaluated in shelters.

An environment that provides animals the opportunity to both predict future events and control them when they occur is important for mental well-being. This may be challenging in animal shelters but need not be impossible. It remains a vitally important and critically understudied area.

18.7 Conclusion

Animal shelters are tasked with providing care for large numbers of animals. The psychological environment is a critical component of that care. Individual differences in factors such as life experiences, genetics, and personality result in animals that are more or less able to cope with the shelter environment. Animals' behavior, their response to stress, and their mental well-being are inherently individualistic.

Assessing within-individual changes in behavior over time is necessary to provide for the welfare of individual animals and to assess the efficacy of shelter-based behavioral interventions. An infinite number of operational procedures in shelters is not possible, nor are they necessary to ensure mental well-being. Behavioral observations on intake or shortly thereafter could be used to assign individual animals to one of a finite number of psychological risk groups: e.g., resilient, fearful, high arousal, etc. Management protocols specific to risk category could then streamline the use of shelter resources and decrease behavioral deterioration of animals with longer LOS. This approach would also allow for more refined intervention impact assessments, because population-level assessments can miss meaningful differences in behavioral responses between risk categories.

Especially because many aspects of the shelter environment are irreducibly stressful – e.g., noises, smells, physical restriction, etc. – meeting the biological imperative for the perception of control will allow animals to better cope with unavoidable shelter stressors, regardless of behavioral phenotype. With thoughtful planning, predictability and control can be built-in to existing operations. Providing social support via access to conspecifics and human interaction also protects against the deleterious effects of chronic stress via social buffering (reviewed in Chapter 9, this volume). To integrate mental well-being into the shelter capacity for care, staff must plan for and accommodate consistent individual differences between animals, support the biological imperative for control, and facilitate access to social buffers that offset the chronic stress of the shelter environment.

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19 From Fish to Mice to Monkeys in Research: Challenges and Opportunities for Mental Well-being

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19.1 Introduction

Mouse, monkey, zebrafish, pig: what makes an animal a *laboratory animal* is not species, but the setting in which the animal lives, and the uses to which the animal is put. Animals in medical research are subject to a range of diseases, pains, and stresses that scientists induce so that they can model similar states in humans.

In this chapter, we focus mainly on animals in medical research, though their use in laboratories is broader than that. Many, especially the smaller species such as rats, mice, and zebrafish, may be seen only a few minutes a day by their human caregivers. Most laboratory animals are kept in confinement for all or most of their lives. Many research projects include intensive handling and restraint to administer test substances or to collect tissues and data. Housing varies, from groups of nearly identical mice in rooms housing thousands of animals, to singly caged monkeys or pigs, to large outdoor corrals for primates or hoof stock.

The laboratory often raises conflicts between animal welfare and human priorities. What is best for the animals might cost money or require added human labor. For example, animals on farms, in zoos, or in laboratories may be housed in small, easy-to-clean cages, prioritizing cost and efficiency over what may be truly best for the animals.

In the laboratory, while finances constrain some welfare advances, the most important conflict can be between the animals' welfare and the need for high-quality, reliable scientific data for the experiments. A serious challenge to animal welfare is that scientists may avoid various treatments and refinements that could improve animals' mental lives for fear that they will weaken the quality of their science, whether by introducing excess variability in their study populations or in other ways changing the animals' bodies and behaviors and how they perform as experimental subjects.

The simplest animal experimental design tests a hypothesis by comparing two groups of animals. To test the hypothesis that Drug A can be effective against bone cancer, the scientists may implant bone cancer cells to two groups of mice, give the experimental group the drug and the controls a placebo, and then measure outcomes such as tumor size, how quickly they spread to the lungs, how much the bone cancer causes pain, or whether the tumors regress entirely. Similarly, a scientist might explore whether a particular gene affects brain development or function, whether the microorganisms in the gut affect diabetes, or whether the animals' housing temperature affects immune function. In these simplest paradigms, researchers want the groups to differ in a single way – the drug, the gene, the microbiome, the housing temperature – and

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they want everything else constant between the two groups. If mice who receive Drug A have lower rates of bone cancer metastasis, the scientists will only credit the drug if they believe they have held constant the housing, the food, the handling, the lighting, the social interactions, the various forms of stress, the other drugs the animals receive, and various enrichments and novelty in their environments. Scientists generally want low variability within each of the two groups, so that differences between the experimental and control groups stand out clearly. It is that search for low within-group variability that drives scientists' concern about adding any possible complicating or confounding factors, including welfare enhancements of various sorts, to the experiments. This leads to tight control over every aspect of animal housing and *care*, as well as experimental manipulations and animal *use*.

19.2 Regulatory and Historical Context

In the United States, two federal laws cover laboratory animal care and use. The Animal Welfare Act (AWA), first passed in 1966, limits its coverage to warm-blooded animals, with the curious exclusion of laboratory-bred mice and rats who comprise the vast majority of laboratory mammals.

The Health Research Extension Act of 1985 is the AWA's companion law. It requires National Institutes of Health (NIH) oversight of all vertebrate animals in research, based on compliance with the *Guide for the Care and Use of Laboratory Animals* (the *Guide*), though only if the work receives federal research funding (Institute for Laboratory Animal Research, 2011). Animals not covered under these laws, such as mice in private industry or in undergraduate classrooms, may be covered by state laws or voluntary accreditation. However, their care and use may have no external oversight at all.

Two British scientists, William Russell and Rex Burch, developed a widely used framework for improving laboratory animal welfare (Russell and Burch, 1959). In their seminal work, they describe a system for categorizing the sources of pain, distress, and suffering. Suffering can be the result of how scientists house and care for research animals, or a result of how they use them in experiments, or both (for more on suffering, see Chapter 11, this volume). Animal suffering in laboratories can be either *direct* or *contingent*. Animals experience direct suffering when their suffering is the subject of study. For instance, a researcher investigating the neurobiology of pain may need to first induce pain; prevention or alleviation of that pain would invalidate the study. Contingent suffering is a side effect of the animal's environment or experimental use. For example, a researcher investigating the effects of canine parvovirus may create nausea by infecting the animal, and housing the animal alone to prevent infection to others may create contingent suffering of isolation stress.

Russell and Burch also proposed their framework for reducing suffering, the 'Three Rs' of Replacement, Reduction, and Refinement alternatives. *Replacement* is precisely that: replacing sentient animals with nonsentient cells, computer simulations, or even human clinical data. *Reduction* comprises the various ways an experiment might use fewer animals. *Refinement* is the suite of activities that can improve humane treatment when animals must be used. Most of our coverage in this chapter pertains to various refinements of animal housing and animal use.

Suffering is not purely pain nor exclusively physical, and regulations have increasingly and incrementally focused explicit attention on the mental health of laboratory animals. But this was not always the case. The USDA once feared that *anxiety* was a 'psychiatric term that is only applicable to humans', while distress is 'more descriptive of the physical visible state of the animal' (Carbone, 2004). Then Congress amended the AWA in 1985 with a provision for environments that enhance the psychological well-being of zoo and laboratory animals, though only for nonhuman primates.

The *Guide* has gradually expanded its focus on the mental health and well-being of animals in laboratories through its eight editions. It now sets some general standards for behavioral management and for enrichment. It sets a default expectation that social animals should be housed with compatible conspecifics (Institute for Laboratory Animal Research, 2011). For the most part, however, welfare standards in the *Guide* and the AWA are quite general, and left to individual research institutions, acting through their institutional animal care and use committee (IACUC) and their veterinarians, to develop their own specific policies and procedures.

19.3 Animal Welfare and Animal Research Data: How One Influences the Other

At first this seems paradoxical: most biomedical animal research requires healthy, normal, comfortable,

unstressed animals. The researcher wants her animal groups to differ solely by whether they are receiving the placebo or the test cancer drug. She wants them to be eating normally, not stressed by rough handling or painful injections. Their cage should be comfortable, not too cold or hot or stuffy or brightly lit. If they live in groups, the groups should be compatible, no fear of bullying, no fights, and no painful infected fight wounds. If the drug makes the animals too sick or in too much pain to eat, she is introducing unwanted variability in nutritional status. If cancer rates then differ, does she credit the drug, or chalk it up to how much the animals ate? Has she wasted animal lives on an inconclusive experiment?

Russell and Burch used the term *psychosomiasis* to describe the very real interaction between physical and mental health, a mind–body interaction that informs this chapter (see also Chapter 3, this volume; however, in general, modern writers avoid this term and its modern connotations). Significant mental and emotional stressors can lead not just to distress and poor mental well-being in animals, but also to physical consequences. Severe stress may lead to illness, that may in turn add to the animals' mental suffering. Stress may also have less dramatic effects on the animal's body, altering immune function, for example, but not to the degree that the animal actually feels ill.

Scientists may evaluate any suggestions laboratory animal professionals or IACUCs make to improve the animals' welfare through the lens of their concern over outcomes in physical function and the quality of their data. However, knowledgeable animal researchers understand that changes in an animal's emotional or affective state can affect how the animal's body functions, even if they do not know the specific physical effects of specific changes in animals' mental state.

While some welfare improvements raise concerns about the quality and variability of the effects on data, animal welfare improvements may instead lead to better science. For example, the less stressed the animal is, the more normal many aspects of the animal's biology and the more reliable the studies of that animal may be. Unfortunately, there are times when welfare improvements can work against the goals of the experiment. For example, mice on a lung cancer study might feel more comfortable with supplemental oxygen therapy, but if that changes how the cancer cells respond to drugs, the small improvement in animal welfare may render the experiment useless.

Regulations recognize that refinements such as pain medicines and tranquilizers might have a confounding effect on data. The AWA requires annual reports of animal use, with a special focus on animals who experience significant unalleviated pain or distress, when scientists are concerned that use of anesthetics, analgesics, or tranquilizers would adversely affect research procedures, outcomes, or interpretation. Missing from regulations and guidelines is a clear discussion of how unalleviated pain and distress can also affect data outcomes. Pain and stress can affect immune function, social interaction, cancer biology, food consumption, sleep, and other functions, all of which can affect research data. As scientists and IACUCs review whether pain medications and other refinements might disrupt data outcomes, they need to also consider the effects of unalleviated distress and pain.

There are but a small number of model-specific side-by-side comparisons of data outcomes when welfare enhancements are used (pain medications, stable compatible group housing, enrichments) compared to when they are not. These would be the gold standard to help scientists make determinations, and they may sometimes show that welfare refinements affect data in some cases but not in others. When they do, the size of the effect is important; a significant improvement in animal well-being that only minimally affects data outcomes might be worth adopting.

Scientists frequently report quite limited details about the housing, pain management, enrichment, or other refinements in their animals' lives, making it difficult to establish a standard practice in their field (Würbel, 2007a; Carbone and Austin, 2016). For example, a scientist who believes her peers are not treating pain in a cancer study will believe she cannot use pain medications herself, fearing that pain medications will invalidate her data or make it unpublishable. In reality, it may be the case that her peers simply omit such details from their papers, believing them to be tangential to the data they are presenting. Fuller reporting of animal-welfare measures as part of scientists' Materials and Methods sections of their publication has the potential to both universalize a standard of care for animals, and improve better research reproducibility (Kilkenny *et al*., 2010).

As with pain, so is the case with other refinements. Scientists may fear that environmental

enrichments such as large complex cages, dietary novelty, social interactions, and opportunities to explore will introduce too much variability in their study populations and will skew their experimental data. And, in truth, animals in such environments may develop differently and behave differently from animals in barren solitary cages. Scientists must consider whether such effects would invalidate their studies, have no strong effect, or possibly improve them (Würbel, 2007b; Li *et al*., 2013). Scientists must remember that for many well-designed, well-controlled experiments, differing data outcomes are not necessarily 'truer' – scientists who worry that environmental enrichment, pain medications, or other refinements 'affect' animal data may be overlooking the effects of isolation, boredom, pain, lack of thermoregulatory options, and lack of control over one's life.

19.4 Stress, Distress, and Laboratory Animals

Stress is a generalized response to events, environments, and bodily processes that have the potential to change an animal's health, safety, or physiological equilibrium (homeostasis). Animals respond to stressors behaviorally, physiologically, or through a combination of the two. For example, animals may respond to cold stress behaviorally by building a nest, huddling with other animals, and fluffing up their fur or feathers (known as piloerection). Physiologically, they may shiver or activate their brown fat and generate body heat. Thus, behavior and physiology combine to bring the animal to thermal homeostasis.

Stress is a welfare matter when it rises in severity and/or duration to the level of true emotional distress (for more on distress, see Chapter 11, this volume). Stress can also affect research outcomes, as stressed animals may have profound differences in their biology compared to non-stressed animals. Researchers should bear in mind that even small stressors can affect biology, including behavior, immune function, and metabolism. Minimizing stressors and timing research procedures around stressful events may lead to better data outcomes.

Some stressors pose minimal risk to animals' well-being and short-term transient stress is inevitable. Even something as seemingly minor as a cage change can induce changes in behavior and activate the classic 'stress response' via the hypothalamic–pituitary–adrenal (HPA) axis. Animals can, however, effectively cope behaviorally if they are provided the agency to explore the environment, mark it as they deem necessary, and build their nests.

However, stressors can lead to emotional distress in animals if the stressors are great enough and beyond the animals' ability to adjust and cope. The animal laboratory potentially poses many limitations on animals' ability to cope. For example, if a cage contains insufficient nesting material, a mouse cannot build a nest for security, territory, and thermoregulatory needs. Genetically manipulated mice may lack the physical, physiological, or behavioral capacities to cope with some stressors; for example, piloerection is not a physical option for a nude mouse in a cold cage with no fur to fluff up for insulation.

Confronted by multiple serious stressors, animals will prioritize their coping mechanisms and preserve some functions at the expense of others, partitioning their finite physiological resources. Though first described as the 'fight or flight response', this prioritization of functions is not restricted to confrontations with predators or with bellicose cage-mates. Mice in a cold environment with insufficient nesting material may shunt their resources toward thermoregulation, depressing their immune function and cancer protections. This may decrease their value in some cancer studies, as well as decrease their well-being.

Scientists need to be aware of these stressors, remove the ones they can, limit their duration, and provide the animals with biologically relevant resources to help them cope. A researcher may also choose to accept the effects of stressors, and fold that information into their study. This can most easily be accomplished by incorporating them into the experimental design (Richter *et al*., 2009); this has the added advantage that the investigator need not identify all stressors, but rather ensure that they impact all study animals equally. These methods of design may include statistical blocking factors, Latin square designs, housing treatment and control animals in the same cages, and balancing for housing location.

19.5 Opportunities and Considerations for the Improvement of Well-being in Laboratory Animals

With these general principles in mind, we next focus on some specific welfare challenges, chosen

because of how common they are, how serious they are, or both. This is by no means an exhaustive list of all well-being challenges and opportunities in the laboratory. The 'Five Freedoms' that the UK's Brambell Report (Brambell, 1965) listed for farm animals in the 1960s also serves as a useful organizing framework for laboratory animals:

1. Freedom from hunger or thirst.
2. Freedom from discomfort.
3. Freedom from pain, injury or disease.
4. Freedom to express (most) normal behavior by providing sufficient space, proper facilities, and company of the animal's own kind.
5. Freedom from fear and distress.

As described in Chapter 24 of this volume and in Mellor *et al*. (2020), however, the more complex and nuanced framework of the 'Five Domains' has been recently favored by animal welfare scientists over the 'Five Freedoms', especially in the context of clinical applications, because it acknowledges the critical role of human–animal interactions in the animal's overall perceived experience.

Most research animals are caged or confined in some way. Important considerations of their confined environment include temperature, light, complexity of the cage, noise, food, and water. The social environment must meet the species' and individual's needs for access to compatible animals but also protection from incompatible animals. Many animals want a place to hide and escape from potential predators and aggressors and a way to watch, smell, and listen to the world around them.

Beyond review of their housing, we must consider some aspects of the experiments the animals undergo. Pain, contingent or direct, is a crucial factor for laboratory animal well-being. Many welfare concerns straddle the categories of animal housing (or *care*) and research manipulations (or *use*). Human caregivers and researchers are an important part of an animal's world, both for their daily lives and for how people handle them for experiments. Often, research requirements, such as a need to easily restrain animals for examinations, drug administrations, or sample collections, drive particular choices to house animals in smaller cages or in solitary housing.

Researchers have an ethical and regulatory obligation to seek ways to minimize animal suffering. We recommend a 'birth-to-death inventory' of all of the welfare points of concern during an animal's life in the laboratory, along with all the refinements, analgesics, early euthanasia endpoints and strategies appropriate for each one. The range of welfare challenges in the animal laboratory require that scientists customize these checklists for their own research program. Table 19.1 illustrates some representative birth-to-death welfare inventories for some common animal research models.

For most of this discussion, we focus primarily on mice and monkeys. Monkeys present challenges through their size, social complexity, and cognitive–emotional sophistication, as well as the public concerns for the ethical use of primates in research. Mice are numerically the most important research mammals, are used in a wide array of research programs, and their biology is well-characterized. Laboratory mice face welfare challenges in their wide range of genetically encoded deficits and diseases. Whether through selective breeding of animals with spontaneous mutations or through genetic engineering, mice may be genetically prone to conditions like high anxiety, decreased tolerance to pain, or susceptibility to a wide range of immunologic, neoplastic, neurologic, respiratory, and other diseases. They are harbingers of emerging welfare challenges for other species, too. As new technologies make genetic manipulation of other species easier, we can look ahead to primates in laboratories with genetic predisposition to depression, autism, and other diseases; to ferrets with debilitating cystic fibrosis; and to other genetically modified animals developed to model human diseases.

19.5.1 The physical environment

A modern mouse vivarium is a highly efficient operation with numerous challenges to animal well-being. Vivarium design reflects several factors, including cost and labor efficiencies, as well as the drive to eliminate infections from the mouse colony, and to prevent their spread should they occur. The increasingly standard mouse cage is a sterilized plastic box with sterilized food, water, and bedding, as well as HEPA-filtered sterile air supply. Its size conforms to minimum recommendations in the *Guide* without 'wasting' space to oversized cages. For monkeys or other larger animals, the plastic may instead be metal, and standards of sterility lower, but their cages similarly present challenges. The physical environment includes the cage, tank or pen, food, water, air, light, sounds, smells, and

Table 19.1. Birth-to-death welfare inventory for three exemplar experiments, highlighting potential welfare points of concerns with alternatives to consider.

Model	Welfare points of concern	Possible alternatives for improved welfare
Cancer studies in rodents	Genotyping – tissue collection	Saliva or hair as DNA source Analgesics for tail or toe clipping
	Surgery to place tumor cells	Subcutaneous injection of tumor cells Analgesia for surgeries
	Large tumors that interfere with mobility	Earlier euthanasia endpoints Place tumors where they will not interfere with animals' movement
	Ulcerated tumors – infections	Earlier euthanasia endpoints Topical treatments; analgesics
	Chemotherapy drugs: pain, nausea	Nursing care, with soft palatable food and fluid sources Monitoring for earlier endpoints
	Lung metastasis – dyspnea	Oxygen-enriched cages Euthanize all of cohort when the first animal presents with dyspnea Set endpoints based on noninvasive imaging rather than clinical presentation
	Bone metastasis – pain, mobility	Analgesics Easy access food/water
	Euthanasia – handling/restraint and dyspnea	Avoid carbon dioxide and injectable drugs as euthanasia agents
Capture-and-Release Field Studies: small mammals	Capture distress	Minimize time in captivity Minimize handling
	Invasive marking methods (e.g., toe amputation)	Dyes for short-term marking Analgesics for physical methods
	Effects of ID methods on fitness	Potential invasiveness of collars
	Anesthesia in field	Short-acting/reversible anesthetics Confine animals until recovered enough for safe climbing, swimming, etc.
	Hypothermia/hyperthermia in live traps	Provide sufficient nesting material and food/fluid in traps Frequent trap checks
Neurologic recording from single brain cells: rodents or nonhuman primates	Food, water restriction as behavioral motivators	Rewards that are sweeter, more nutritious or more positive valence than plain water Acclimation to the restriction regimen
	Rigid restraint during recording	Flexible tethers for cables Implanted telemetry
	Surgery to place brain implants for neural recording	Anesthesia/analgesia Non-acrylic implant fixation (e.g., titanium implants and screws)
	Social isolation, single housing	Social housing for implanted animals

items in the enclosure, such as bedding, perches, shelter, and nest boxes. All can affect animal well-being and all can affect animals' biology as research subjects. Here we discuss air temperature, noise, and light to illustrate the range of concerns for well-being and research that the physical environment presents.

Temperature

Homeothermic animals (those who can regulate their own internal temperatures even as external temperature varies) have a thermoneutral zone (TNZ), the range of temperatures in which they can maintain their body temperature without having to increase their metabolism. Just as humans put on a sweater or crawl under a blanket, a mouse in a cool environment below his TNZ will fluff his fur and build a nest or huddle with cage-mates. Their discomfort at cooler temperatures drives them to perform these behaviors; conditions that thwart these behaviors, such as housing mice in a cool ambient temperature without mates or nesting material, will decrease their well-being. Especially in under-resourced cages, solitary mice with their high surface-to-volume ratio are expending a great deal of energy on maintaining their body temperature. When

mice are not cold-challenged they may breed better, and also have more normal immune function and physiology (Gaskill *et al*., 2013a,b; Kokolus *et al*., 2013).

Cold mice may therefore be welfare-challenged, and may also be biologically abnormal as experimental subjects, though a cage can also be too warm for mouse health and comfort. Laboratory mice live in the same ambient temperature throughout their active and resting periods, though their temperature preferences may vary throughout the day. Mouse cages are usually not large enough to allow for warmer and cooler areas where the animals can choose to spend time through their day's cycle. Behavioral thermoregulation is more feasible for warming an animal in a cold cage than cooling an animal in a warm cage. For these various reasons, the *Guide* and others recommend slightly cooler ambient temperatures, which best fit mice during their nocturnal active period, with sufficient resources (like nesting material) for the animals' freedom to alleviate temperature discomfort.

Noise and vibration

Noise and vibration are abundant in animal facilities, though humans do not always perceive them. Hearing ranges in animals are highly species-dependent; while Japanese macaques hear more or less what humans do, mice likely cannot hear us speaking, and we certainly hear very few of their vocalizations (Heffner and Heffner, 2007). Sensitivity to vibration also varies with species, with rodents thought to be some of the most sensitive; however, fish also respond to vibration.

Rodents communicate at least partially in ultrasound at frequencies too high for humans to detect unaided. There may be distressing levels of ultrasound and lower frequency noise in the laboratory environment that animals hear but that humans do not hear and may not even realize are present (Reynolds *et al*., 2010). Animals chronically exposed to ultrasound may develop physiological and behavioral changes, including seizures and auditory damage (Sales *et al*., 1988). Loud, unpredictable noises can startle and stress animals. Common procedures, such as cleaning hard steel or plastic cages, and common equipment, such as the blowers in ventilated racks of mouse cages, can produce distressing levels of noise and vibrations, with effects on the animals' well-being and on their biological functions. Periodic audits of excessive noise and vibration, especially those humans cannot hear, are necessary and require specialized equipment.

Light

Light's impact on animal health and well-being can come from intensity or from photoperiod. Light can also affect how animals serve as research subjects.

Bright lights are aversive to many species, and rodents will work to avoid brightly lit chambers (La-Vu *et al*., 2020). Some species, such as caged primates, may benefit from brighter lighting than humans or rodents would prefer. Albino rodents are susceptible to retinal damage from lights that humans perceive as normal intensity (Bellhorn, 1980). This may affect their behavior as experimental subjects; for example, they could score poorly on maze tasks that rely on following visual cues, not because they are losing cognitive function, but because they cannot perceive visual cues. Decreased vision is not necessarily a welfare problem for these animals, as they live in small, predictable predator-free environments, and rely as much on hearing and olfaction as they do on sight.

Photoperiod is also quite important for animal health, well-being, and normal biology. Various studies have demonstrated that disruption of diurnal cycles can lead to altered metabolism, behavior, reproduction, and other effects in animals (Karatsoreos *et al*., 2011; Walton *et al*., 2011).

As with noise, human caregivers may not notice perturbations of room lighting without a specific effort to look for them. Light meters can reveal light intensity and should include checking the levels on the top shelves, just below the ceiling lights. Timers can maintain a standard 12:12 hour light:dark cycle in a room, but staff need to explicitly check periodically that the lights are, in fact, going off at night. Graduate students can be semi-nocturnal, and may want to turn on lights for experiments during what should be the animals' dark phase, with significant effects on the animals' circadian rhythms. Dim, red lights can improve on this, but do not entirely eliminate stimulation of the rodent retina and associated ganglia (Hattar *et al*., 2002).

19.5.2 The social environment

The Brambell Report called for, 'Freedom to express (most) normal behavior by providing…company of the animal's own kind.' The *Guide* recommends, 'Social animals should be housed in stable pairs or groups of compatible individuals unless they must be housed alone for experimental reasons or

because of social incompatibility.' Social housing is the first item in the USDA's suggestions for meeting the AWA's requirements for the psychological well-being of nonhuman primates. Social housing in compatible groups is therefore the default expectation for housing laboratory animals (see Chapter 9 this volume.)

Despite the regulatory presumption for compatible social housing, many laboratory animals do, in fact, live alone in their cages. Others, though housed together, may live in a socially incompatible group. This incompatibility can be difficult to detect during a brief vivarium walkthrough; knowledgeable staff and a deliberate effort to evaluate suitability can help identify animals that should be separated prior to injury or severe distress.

Under natural conditions, animal packs, troops, herds, harems, and warrens cover enough territory that individual adult animals are neither totally solitary nor side-by-side 24 hours a day. Most laboratory animals live indoors in cages that are too small for them to alter their proximity to others throughout the day, choosing close contact and affiliation some of the time, avoiding agonistic conflict at others.

Common laboratory species – rodents, primates, dogs, cats, pigs, rabbits – range in how social they are under natural conditions. Within a species, an individual's interest in social contact with conspecifics may reflect that individual's history, age, physiological status, and sex, and also depends on various features of the physical environment as well as who the candidate conspecifics for sociality are.

Given the range of species, we focus here on mice and monkeys to explore the challenge of deciding what is best for them in the caged environment. We review common reasons scientists might prefer singly caged animals. Economics and efficiency do play a role, leading institutions to choose smaller, simpler, easily cleaned cages while also keeping costs down by housing multiple animals per cage.

Mice and rats live in dynamic shifting groups, and their social preferences depend in part on how they were reared and what resources their environment offers (Olsson and Westlund, 2007). Caged rodents often seek social interaction; for example, female rats show greater motivation for access to conspecifics than for any other resource (Patterson-Kane *et al*., 2002) and male mice show a preference for sleeping in close proximity to a familiar male (Van Loo *et al*., 2003). Teasing out the main motivator can be difficult – do they want warmth? companionship? – though that information can help tailor environments to best suit animal needs and preferences.

Depriving rodents of desired social contact can decrease their well-being. Social isolation can be a stressor, resulting in increased corticosterone and neurobehavioral alterations (Olsson and Westlund, 2007). Social isolation during development is linked to increased anxiety-like behaviors, increased fear behavior and reduced social contact later in life (Lukkes *et al*., 2009; Ros-Simo and Valverde, 2012). Solitary animals in a multi-animal room are not truly solitary if they can hear and smell and see their conspecifics; in the vivarium, however, individually ventilated cages block most of this cage-to-cage social knowledge.

Aggression is common in rodents under common conditions, with mice usually more aggressive than rats, males more aggressive than females, all influenced by differences related to strain and an individual's history (Gaskill *et al*., 2017, Olsson and Westlund, 2007). Wild mice live in territories inhabited by only one adult male, several females, and their offspring. Therefore, male mice do not naturally share territories and resident males are highly intolerant of intruders (Kappel *et al*., 2017) and can be 'despotic territory-holders' (Latham and Mason, 2004). It is not possible at this point to firmly conclude if male mice have a better quality of life when housed alone (with added nesting material for thermoregulation) or in a same-sex group as it is highly context-dependent and varies depending on strain, age, social status, and husbandry practices (Kappel *et al*., 2017). Subordinate animals and high-ranking individuals experience life in an enclosed space differently, and where dominant individuals might prefer a group setting in which they rule the hierarchy, subordinate animals might actually fare better in a solitary cage.

Thus, rodents choose to be together (sometimes), are stressed by solitary confinement (sometimes), and may fight when they are together (sometimes). If co-housing is on balance the better option for animal welfare, and coincidentally, for economic efficiency, the challenge then is finding ways to maximize success in co-housing. Strategies include finding optimal group sizes for the strain and sex (three per cage is a common recommendation), maintaining stable groups, and transferring enough scent-marked nesting material at cage change so that pheromones associated with a stable hierarchy continue (Van Loo *et al*., 2003; Olsson and Westlund, 2007).

Macaques, such as Rhesus monkeys, are the most numerous nonhuman primates (NHPs) in laboratories. They live in large male–female groups with hierarchies, which are more easily accommodated in large corrals (common at the large primate centers) than in smaller cages. Socially housed macaques display more affiliative interactions, more play and locomotor behaviors, and fewer abnormal, stereotypic, and self-injurious behaviors than singly housed monkeys (Baker *et al.*, 2012; Hannibal *et al.,* 2016). In a restricted environment, enforced co-housing can lead not just to distress, but to outright fighting and even in corral housing animals may lose fingers and tails to aggressors.

As with mice, if monkey housing cannot accommodate a large male–female group with its shifting dynamics, affiliative moves, and defense retreats, strategies are needed to house smaller numbers, typically just pairs, compatibly. A common strategy for establishing compatible macaque pairs requires extended familiarization of the animals to allow them to establish a dominance relationship, progressing from visual-only contact to limited touch via a 'grooming bar' panel of slats between two cages to supervised full contact. The available choices of potential social partners in a small laboratory will be limited (Baker *et al.*, 2014). If full-time unsupervised co-housing is not successful, singly caged animals in a room will still have visual and auditory social contact, establishing a stable hierarchy without ever actually touching each other. Caregivers can supplement this with grooming bar 'protected contact' (Baker *et al.*, 2014; Hannibal *et al.*, 2016).

No social housing program can succeed if it undermines the needs of the research project. Given the complexity of socially housing mice and monkeys, and the violent consequences of doing it wrong, researchers have several reasons to prefer singly caging their animals. They may fear that increasing social interaction will introduce greater variability in their research subjects, especially if an unstable hierarchy creates added stress to subordinate animals. Group-caged animals often live in an unstable, shifting social milieu, as a group of five mice goes down to four and three and two as animals are removed for analysis. In fact, this shifting social environment can be both a welfare and a research-consistency concern. The researchers may believe that single caging better standardizes their subjects' biology. Research animals may have assorted 'implants' and foreign bodies (e.g., attachments to the skull that allow for brain recording, suture from a recent surgery, etc.) and researchers need to ensure that cage-mates leave these items intact. Group-caged animals in infectious disease research could cross-transmit infections in an uncontrolled way.

Along with the welfare obligation to give animals the freedom to express normal social behavior, scientists should realize that the stress of social isolation also may impact data outcomes. They should work with their veterinarian, IACUC, and behavior specialists to plan the best course for the particular experiment, and then publish social milieu as a relevant factor, just as they do their animals' genetics, the pH of reagents, research manipulations, and other salient components of their Materials and Methods.

19.5.3 Human–animal interactions in the laboratory

Laboratory animals cannot avoid contact with people, both their daily caregivers and the researchers performing experiments. Whether these interactions increase or decrease the animals' welfare varies with the species, with the animal's history of human interaction, and with the specific procedure and the manner in which is it is performed.

Thoroughly domesticated species such as dogs, cats, and pigs may find human contact comforting, assuming they were socialized correctly. Mice, rats, and monkeys frequently find humans threatening, though they can be acclimated to human contact. Whereas dogs or pigs may readily learn in the laboratory to follow their human caregiver, present a limb for blood collection, and climb on the scale for their weekly weigh-in, most mice, rats, and monkeys are not taught to interact this way. They may be caught and lifted for a cage change, restrained for an injection, and, in the case of primates, may be sedated even for simple procedures such as blood collection or physical examination.

Forced restraint and handling can scare and stress animals. Some methods are better than others. A busy caregiver will not train all his mice to jump into his hand for cage-changing, but he can use gentler methods for picking them up than by the tail, which causes anxiety (Gouveia and Hurst, 2013). Scooping or cupping the animals into the hand or coaxing them into a small tube to lift them results in more voluntary interactions and less stress (Hurst and West, 2010). Rats habituate to human

handling and respond well to tickling, a playful handling method that strengthens human–animal interaction, one which caregivers enjoy as well, thereby decreasing a stressful experience for both humans and animals (LaFollette *et al*., 2017).

Gentle handling and close contact may be dangerous for highly immune-compromised animals or for animals infected for microbiology studies. Risks of human–animal and animal–human cross-infection may require a more hands-off approach. Macaque monkeys can be large and aggressive, and are natural carriers of viruses that can infect people. Direct contact is dangerous, so people may use various squeeze-back cages to restrain animals to inject a sedative, or fit them with collars and train them to cooperate with a restraint pole hooked to the collar. Positive reinforcement training can replace coercion with cooperation (Fig. 19.1). As in zoos, monkeys in laboratories can also learn to approach people to present a limb for blood collection or for injection (Perlman *et al*., 2012; Kemp *et al*., 2017).

Animals are not capable of true informed consent as human research volunteers must be. They may understand what injections are as a momentary procedure, but not the *reason* they are being injected. True informed consent would require knowledge of the present procedure and its consequences – short term and/or long term. While positive reinforcement training can lead to their cooperation with the short-term procedure, going beyond this training, at least in the case of Great Apes, scientists can strive to obtain *assent* (Institute of Medicine and National Research Council, 2011; Fenton, 2014). Assent in this case refers to allowing the animals to choose to do what they've been trained to do, or to terminate an interaction-in-progress (i.e., to *dis*sent).

19.5.4 Pain and laboratory animals

Pain is a physical and emotional state that profoundly affects animals' mental health and well-being. The physical aspects of pain, or *nociception*, are a welfare concern when they lead to emotional distress in animals. Not all nociception is severe enough to cause suffering, and humans and animals may willingly submit to pain in pursuit of some valued goal. On the other hand, nociceptive input (e.g., electric shocks) may end, but the suffering may continue as animals remember the pain or anticipate (with fear) its possible return.

Pain is more of a concern with animal *use* in experiments than in animal care and housing.



Fig. 19.1. A cynomolgus macaque (*Macaca fascicularis*) trained through positive reinforcement to present a limb for injections and for blood collection. (Photo courtesy of Melanie Graham, used with permission.)

While scientists may induce pain in order to study it, more commonly pain is a contingent side-effect of other research programs. Surgery is a common cause of acute pain in laboratory animals, while advanced cancers, some inflammatory conditions, some toxicity testing, and many other models can cause chronic animal pain.

Current regulations and guidelines consider pain, along with distress, as the focus of concern, and set a threshold, 'more than minor or momentary', above which a scientist must pay special attention to the effects of what she is doing to animals. She must consult a veterinarian on pain management and consider alternative methods and refinements to reduce the pain. Of course, lesser pains can also matter to the animals, and though below the level of regulatory concern, scientists can brainstorm ways to avoid causing even small pains. For example, rather than daily injection of some test drug, they may formulate it into an oral version and administer it in the animals' diet.

Pain diagnosis in all animals is challenging, including in laboratory animals. They cannot tell us in a shared language precisely how they are feeling, nor is there one single simple physical or behavioral test of pain. Laboratory personnel need to be trained to recognize and watch for the nonverbal signs of pain. Decreases in normal behaviors (e.g., grooming, feeding, nest-building, social interaction) and increases in abnormal behaviors (e.g., twitching, grimacing, hiding) may indicate pain; however, these signs may not be noticed even when pain is present. A particular challenge is that so many near-identical small animals typically get but a few minutes of human observation per day, often during their typically inactive period, and thus subtle signs of mild-to-moderate pain are easily missed. Good pain management relies on good pain diagnosis, and good pain diagnosis is a vexing challenge.

Armed with appropriate knowledge of the model and its pain potential, scientists should consider ways to: (i) prevent the pain; (ii) treat the pain; and, finally, (iii) alleviate the pain. Prevention includes efforts to find alternative, less invasive methods. Veterinarians can advise on analgesic drugs and nursing care to treat animals' pain. Every research protocol must include humane or intervention endpoints, which will ensure that the study is ended (typically through euthanasia) when animal suffering reaches pre-defined criteria such as weight loss, decreased mobility, or other disease-specific signs of advanced pain or illness.

As noted above, IACUCs have the authority to approve (or disapprove) studies in which scientists plan to withhold pain medications for painful conditions. Pain, and the analgesic drugs used to treat it, both can have powerful effects on the animals' biology and both can influence research outcomes. Pain and pain medications can affect immune function, food consumption, sleep patterns, and a host of bodily functions, and scientists and IACUCs must consider both before too-readily approving projects with significant unalleviated pain (National Research Council, 2008, 2009; Carbone, 2011; Carbone and Austin, 2016).

19.5.5 Environmental enrichment

Following decades of efforts to improve the lives of captive animals, the AWA gave the term 'environmental enrichment' (EE) its legal status in 1985, though only for nonhuman primates. The AWA amendment stated that zoos and laboratories must have a 'plan for environment enhancement adequate to promote the psychological well-being of nonhuman primates'. The plan must address the social environment, but also environmental enrichment, adding 'means of expressing noninjurious species-typical activities' to the animals' enclosures (Carbone, 2004). Welfare scientists study enrichment strategies not just for primates but for other species, too (see Hubrecht, 1993; Newberry, 1995; Olsson and Dahlborn, 2002; Würbel and Garner, 2007; Baumans *et al*., 2010; Collymore *et al*., 2015; Coleman and Novak, 2017).

Defining environmental enrichment: What's in a name?

The term *environmental enrichment* has different meanings in different contexts, thus leading to its inconsistent use in the scientific and welfare literature (Newberry, 1995). Scientists may study EE and non-enriched environments to model human developmental neurology. Those studies give the animals cognitive, motor, and sensory stimulation at levels that greatly exceed standard housing, but also exceed the degree of EE used in vivaria as an animal welfare tool (see van Praag *et al*., 2000; Alwis and Rajan, 2014).

Enrichment is a problematic word to the extent that it implies going beyond some sort of default standard in which an animal lives alone in a barren cage. It can sound like it is a little extra that people might choose to provide, whereas the bare 'standard'

cage is in reality 'controlled deprivation' and should not be standard or default at all (Burghardt, 1996). The term can also challenge IACUCs, when neurobiologists read the literature on EE as a research variable that affects neural development and fear that anything beyond a bare solitary cage is enrichment that will skew their experimental outcomes (see Baumans *et al.*, 2010; Toth *et al.*, 2011; André *et al.*, 2018; Bailoo *et al.*, 2018). Clear definitions can lead the way to a compromise situation in which animals are neither over-stimulated nor living in impoverished environments.

Modern EE goes beyond putting a toy or a novel food in the cage on the hunch that animals might like it. Effective EE must be biologically relevant. EE improves animals' well-being by allowing them the opportunity to perform natural behaviors and to have enhanced control over their environment as a way to better cope with the stresses of captivity and confinement (Mason *et al.*, 2007; see also Chapter 8, this volume).

Würbel and Garner (2007) devised a three-level classification scheme for EE including 'pseudo-enrichments', 'conditionally beneficial enrichments', and 'beneficial enrichments'. This classification scheme covers biological relevance, welfare benefits, detriments, and consequences. For example, marbles in the mouse cage are a 'pseudo-enrichment' that animals interact with, not for play, but to remove them to the extent possible by burying. Shelters are conditionally beneficial – in some circumstances, they provide an outlet for natural behavior; however, in cases where shelters elicit aggression, they can be detrimental. Nesting material tends to provide high EE value with little downside to the animals.

EE is biologically relevant when it meets important needs or desires of the animals, a determination that requires rigorous examination. Nesting material allows a natural behavior that gives mice a place to hide and helps them stay comfortably warm (Gaskill *et al.*, 2013a,b). Predictions of a particular enrichment's value require testing and continuing refinement, involving ongoing questions such as: When are shelters valuable, versus a cause of aggression? *How* can social enrichment meet animals' needs without promoting fighting and social stress? Are puzzle feeders a useful way to simulate foraging behavior, or are they too frustrating, too boringly simple to solve, or a place for monkeys to entrap their fingers?

Even tested, biologically relevant EE strategies present some challenges. Nesting material may clog drains. Devices cost money, take time to maintain, take space in the enclosure, must be safe if eaten, and must be monkey-proof to avoid injuries. An effective EE program must take into account both animal and human needs, and strike a balance between them.

19.6 Conclusion

Efforts to maintain mental health and well-being in animals face challenges common to other settings: the available space, resources, and human knowledge to develop the best possible outcomes for the situation. Beyond that, scientists should know that enriched, physically and mentally healthy animals are biologically different from isolated, stressed, painful animals, and experimental data will differ when studying healthy versus stressed subjects. Scientists may successfully justify restricting their animals' welfare in various ways for some compelling experiments, but that does not mean that animals sitting alone in a barren cage, or animals without effective pain medications, are necessarily the 'truer' model of whatever human condition scientists are studying. Responsible stewardship of laboratory animals requires an informed inventory of welfare challenges for every study and every situation, and careful review of refinements and alternatives before any decision to proceed with an option that compromises welfare.

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20 Psychological Well-being of Animals in Zoos and Aquariums

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When it comes to maintaining mental health, or psychological well-being, zoo and aquarium animal populations are unique in a number of important ways. These populations tend to be relatively small, and many species have not been intensively studied in the wild, resulting in a lack of basic biological knowledge about them. In contrast to most other animals in human care, zoo and aquarium animals are 'wild' rather than domesticated, meaning that they have not been intentionally bred to favor traits compatible with captivity and human management. Certainly, genetic selection must exist in the zoo environment and it may result in small changes that favor survival and reproduction in zoos, but most zoo-held species have not been separated from their natural habitat for many generations and breeding programs exist to maintain genetic diversity and minimize directional selection (reviewed by Hutchins and Wiese, 1991; Maple, 1992).

The number of different 'wild' species that are cared for in zoos and aquariums results in tremendous variation in ability to adapt to and cope with captive environments and represents a significant challenge for animal managers. Some species may come from similar environments and climates as the host institution, whereas others come from radically different ones. Some species have small home ranges and some have large ones. Some species are shy by nature and others are bold. Some species are highly social and others more solitary. Indeed, Mason (2015) has pointed out that this variation could be a powerful comparative tool in identifying the factors that predispose a species to adapt well to captivity and has shown, for example, that species with larger home ranges in the wild tend to spend more time engaged in stereotypic behavior in zoos than those with small home ranges (Clubb and Mason, 2007).

Modern accredited zoos and aquariums have evolved to become organizations centered on animal well-being and conservation. This evolution is reflected in standards put in place by regional accrediting organizations like the Association of Zoos and Aquariums (AZA), the Zoological Association of Australasia (ZAA), and the European Association of Zoos and Aquariums (EAZA). The World Association of Zoos and Aquariums, although not an accrediting body, now requires members to have robust animal welfare programs in place. These changes have placed an emphasis on welfare science and continuous improvement in animal care practices. As the science of zoo and aquarium animal welfare advances, more measures of psychological well-being are being adopted, environmental enrichment techniques have become an everyday part of husbandry, and welfare assessment and real-time monitoring tools are being developed.

20.1 Challenges Particular to Zoo Animals

Zoological environments have challenges to well-being that other contexts may lack. There are many

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sources of aversive stimulation (stressors) that are known to elicit protective behavioral and/or physiological responses in animals. Many are ultimately associated with space restriction and confinement that limit an animal's ability to escape what is fear-inducing or prevent the ability to adapt to it. Some examples are noise, excessive heat or cold, overcrowding, social group instability, and the actions of caretakers (reviewed in Carlstead and Shepherdson, 2000; Morgan and Tromborg, 2007). Hediger (1964) describes situations in which captive animals injured themselves or failed to breed because of the inability to escape from caretakers or visitors. Persistent uncertainty about the actions of caretakers or veterinarians may contribute to the stressfulness of some captive situations if the animals have no reliable predictive cues (Bassett and Buchanan-Smith, 2007; Thines *et al*., 2007). Other stressors may be unique to zoos, specifically, olfactory and auditory cues from predators (Buchanan-Smith *et al*., 1993; Carlstead *et al*., 1993; Wielebnowski, 2003), events (Bastian *et al*., 2020; Fanning *et al*., 2020; Harley *et al*., 2022), and construction (Cociu *et al*., 1974; Powell *et al*., 2006; Jakob-Hoff *et al*., 2019; Williams *et al*., 2021c). Beyond space restrictions, the complexity of the environment has also been examined to understand the connection with animal well-being (for example, see de Azevedo *et al*., 2023).

Lack of mental or cognitive stimulation, analogous perhaps to boredom in humans, is often presumed to be a problem for captive exotic animals and has been well documented (Špinka and Wemelsfelder, 2011). Animals in the wild are constantly faced with cognitive challenges. They have to remember the location of important resources that may change through time, and they have to problem-solve to find and gain access to the resources that they need. Predators have to outsmart their prey, and prey animals have to avoid predators. Individuals representing a rapidly growing list of species use tools to get what they want (Seed and Byrne, 2010). Information important to survival surrounds wild animals and finding and interpreting this information correctly can determine the difference between life and death. The importance of information seeking and strategies for providing opportunities to meet this need have long been recognized (e.g., Shepherdson *et al*., 1993) and, as we shall see, there are many ways in which zoo environments can be enriched to provide meaningful opportunities for information seeking. However, Meehan and Mench (2007) mount a spirited argument in favor of not just providing information-rich environments, but of specifically providing animals with biologically appropriate challenges, the solving of which results in strong positive affect and associated well-being.

There is one potential stressor that is common to zoos, aquariums, and wild animal parks, and very uncommon or rare in other animal contexts: the presence of visitors. There is evidence that visitor presence, activity, density, and viewing position causes changes in the behavior of zoo-housed mammals (reviewed by Davey, 2007). The 'visitor effect' has been associated with a number of changes suggestive of stress, including increased vigilance, closer social spacing, reductions in affiliative behavior, and increases in aggression (Glatston *et al*., 1984; Hosey and Druck, 1987; Chamove *et al*., 1988; Thompson, 1989). Numerous species-specific studies have elucidated on the effect of visitor presence, density, and behavior on animal behavior and stress, including rhinos (Carlstead *et al*., 1999; Carlstead and Brown, 2005), Indian blackbuck (Rajagopal *et al*., 2011), spider monkeys (Davis *et al*., 2005), Mexican wolves (Pifarré *et al*., 2012), clouded leopards (Wielebnowski *et al*., 2002), black-capped capuchins (Sherwen *et al*., 2015), little penguins (Chiew *et al*., 2021), and fish (Boyle *et al*., 2020). Sometimes, however, studies of visitor effects on zoo animals bear out that the visiting public has no effect (neutral) on animals, or is even enriching (Davey, 2007). The most negative effects of visitors have been found amongst animals with poor baseline welfare combined with high levels of stereotypic locomotion, intragroup aggression, and self-injurious behavior (Farrand, 2007). The global COVID-19 pandemic in 2020 necessitated the closure of zoological institutions, resulting in the opportunity to assess the impact of visitor absence and presence. Similar to research prior to the pandemic, there were mixed results across a variety of species. Gorillas at a North American zoo showed mixed behavioral changes (Miller *et al*., 2021c), as did meerkats (Williams *et al*., 2021b). The meerkats did use more of their space during closure to visitors. Changes in space use were also seen in other species during closures, including increased time spent near public viewing areas in Grevy's zebras (Williams *et al*., 2021a). Although reptiles are understudied in terms of zoo animal welfare, several studies reported interesting findings related to closures, such as increased time

spent visible in tokay geckos (Carter *et al*., 2021) and species-specific responses (Hamilton *et al*., 2022). For some species, like African penguins (Williams *et al*., 2021b) and greater flamingos (Kidd *et al*., 2022), no significant changes were noted. The currently available body of research underscores the different impacts visitors may have on different species and the need to continue to explore how to maximize positive outcomes, as suggested by Sherwen and Hemsworth (2019). This includes examination of the impact of visitor–animal interaction programs, to better understand how they contribute to the well-being of the animals involved.

20.2 Abnormal Behaviors in Zoo Animals

The abnormal ways that many animals behave while confined in zoos were largely accepted by managers and the visiting public before the early to mid-20th century. One of the first of a new breed of zoo biologists was past director of the Zurich Zoological Garden, Heini Hediger (see obituary by Maple, 1992). He was one of the first to acknowledge, study, and write about abnormal behaviors and the importance of psychological or mental health in zoo animals, and suggested solutions based on their natural history. Hediger (1950) wrote that, 'Clearly one of the most urgent problems in the biology of zoological gardens arises from the lack of occupation of the captive animal.' Hediger's strategy was to apply his understanding of the biology, behavior, and motivation of a species in the wild to 'see' the zoo environment through their eyes. Hediger was particularly interested in studying stereotyped motor reactions in captive animals, work that was continued by Meyer-Holzapfel (1968) and published, amongst other places, in M.W. Fox's (1968) seminal publication *Abnormal Behavior in Animals*. Meyer-Holzapfel spent many years studying abnormal behavior in zoo animals, observing the development and form of mostly locomotor stereotypies in a variety of species, and was one of the first to document the progression through time of some stereotypies from stimulus dependent to 'fixated by habit'. The significance of stereotypic behavior as a potential indicator of stress has been confirmed many times since (e.g., Mason *et al*., 2007; Shepherdson *et al*., 2013; Kroshko *et al*., 2016). Other abnormal behaviors observed in zoos include self-mutilation (Pizzutto *et al*., 2015), regurgitation and re-ingestion (Gould and Bres, 1986), coprophagy (Akers and Schildkraut, 1985), and excessive aggression (Erwin *et al*., 1976). Much work has gone into studying and ameliorating abnormal behaviors, including the development of tools and frameworks (for example, see Bacon, 2018).

20.3 Positive Affective States and Well-being

Animal welfare scientists have become interested in positive emotions and psychological well-being, placing an emphasis on what increases thriving as opposed to reduces suffering. Boissy *et al*. (2007) and Yeates and Main (2008) have proposed a change in focus to a broader perspective of welfare measures that increases the emphasis on positive experiences. For example, they encourage assessment of behavioral indicators of contentment, such as play and exploration, self-grooming and maintenance behaviors, and affiliative relationships between animals as well as between animals and their caretakers (Boissy *et al*., 2007; Hemsworth, 2007).

Globally, zoo and aquarium industry organizations (e.g., AZA, EAZA, British and Irish Association of Zoos and Aquariums (BIAZA), World Association of Zoos and Aquariums (WAZA)) have adopted frameworks for assessing and ensuring zoo animal welfare. All of these frameworks encompass physical and mental health components, including positive and negative experiences such that one can say, in principle, that there is a wide consensus of the importance of mental health for zoo animal welfare. There is, therefore, an emerging recognition in the zoo and aquarium industry of the importance of considering the experiences of individual animals and promoting positive subjective affective states; the absence of suffering due to pain, fear, or anxiety alone is not enough to ensure good welfare (Whitham and Wielebnowski, 2013). In fact, some scientists argue that positive experiences may offset the impact of negative experiences (Spruijt *et al*., 2001; Duncan, 2006; Van der Harst and Spruijt, 2007; Yeates, 2011). A number of frameworks have been developed to capture more fully the emphasis on positive experiences, including the Five Domains Model (Mellor, 2017; Chapter 24, this volume) and the Five Opportunities to Thrive (Greggor *et al*., 2018), and to guide assessment practices.

Measures of positive affective states potentially can be determined from responses to signaled events (anticipation) (Watters, 2014), cognitive tests that assess optimism about future events (such as cognitive bias tests, Keen *et al*., 2014), and even pleasure-associated vocalizations (e.g., Panksepp and Watt, 2011) and facial expressions (for reviews see Whitham and Wielebnowski, 2013 and Chapter 23, this volume). Boissy and Lee (2014) discuss investigation of affective states in animals using cognitive approaches, such as tests of judgment bias, which have been developed for a variety of species (Boissy and Lee, 2014; Bethell, 2015; Chapter 23, this volume). Basically, these methods observe how an animal judges the presentation of an ambiguous stimulus cue after having been trained to distinguish presentations of the same stimulus under conditions in which it is unambiguously rewarding or aversive. The interpretation of reactions to ambiguous cues is considered to reflect whether the animal's emotional state is optimistic or pessimistic. In 2018, Clegg (2018) published a thorough review of the potential applications of cognitive bias testing in zoological settings. The first application of a cognitive bias test to aquarium-housed mammals – bottlenose dolphins – linked the affiliative behavior of synchronous swimming to optimistic judgment of ambiguous cues in a spatial location bias test (Clegg *et al*., 2017). A study of tufted capuchins (*Cebus apella*) at a research animal center revealed a positive correlation between levels of stereotypic behavior and a pessimistic judgment bias (Pomerantz *et al*., 2012).

Studies on anticipatory behavior in expectation of predictable events have revealed links with animals' affective states (Van der Harst and Spruijt, 2007). Anticipatory behavior is expressed as an increase in activity in response to a signaled reward such as food or enrichment and demonstrates the perceived importance of a given reward to the animal. Watters (2014) suggests that zoo animal behaviorists should pay attention to anticipatory behavior, and this technique has been used to study motivation and related affective state of aquarium-housed cetaceans (Clegg and Delfour, 2018).

20.4 The Importance of Keeper–Animal Relationships for Psychological Well-being

The relationships between animal care staff and animals are beginning to be a fruitful research approach to understanding animal emotions and psychological well-being. Whitham and Wielebnowski (2013) state that 'it is vital to recognize that animal keepers are a central element of each zoo animal's environment, and that the quality of a given keeper-animal relationship may influence an individual's well-being'. Furthermore, interactions between keepers and animals can be a major source of positive experiences and emotions, in effect becoming a form of environmental enrichment for animals (Claxton, 2011). On a regular basis, individual zookeepers feed, clean, groom, shift, exercise, monitor health, train, and provide enrichment to their animals. Developing a positive keeper–animal relationship (KAR) requires becoming familiar with the communication signals and patterns of the animal towards the keeper and of the keeper towards the animal – from the animal's perspective – and responding appropriately.

There is a growing body of research on the characteristics of positive KARs in zoos. Mellen's (1991) study of 20 small felid species at eight US zoos was the first to report that 'keepers who spent a great deal of time with each cat, soliciting contact and talking to the cat', had significantly better reproductive success among their cats. Wielebnowski *et al*. (2002) found that, among 72 clouded leopards, stress, as assessed by fecal corticoids, was lower if keepers spent relatively more time around the animals and higher if there was a greater number of keepers working with the animals. The authors suggested that this apparent contradiction may be a function of the quality of the KARs, in that 'many facilities with higher numbers of keepers also rotate them more frequently, so the overall time spent with individual animals is likely to be reduced'. A colony of captive common marmosets increased play and grooming activities after a program of daily 20-minute, positive interactions with caretakers was added to their husbandry routine (Manciocco *et al*., 2009). Keepers anecdotally report the emotional benefits of a caretaker just sitting quietly near an animal. Spending more time around animals could function as 'safety signals', i.e., a learned cue that predicts the nonoccurrence of an aversive event. Safety signals are potent inhibitors of fear and stress responses (Christianson *et al*., 2012) and are thought to be disrupted in people suffering from PTSD (Lohr *et al*., 2007). Keepers' activities are often signals to animals that something is imminent that will affect them, be it feeding, cleaning, shifting, separation from conspecifics,

etc., so periods of inactive co-presence of a keeper provide a direct safety signal that nothing will happen for a period of time. Hence, this provides the animal an opportunity to visually inspect the keeper, approach in their own time, and relax in keeper presence.

Animals may have varying needs for predictable behavior from keepers, and unpredictable actions may cause stress (Bassett and Buchanan-Smith, 2007; see also Chapter 8, this volume). Carlstead (2009) explored KARs among 82 keepers working with four different species: black rhinoceros, cheetah, maned wolf, and great hornbill. She found that the animal's affinity to the keeper (approaching spontaneously and allowing touching, etc.), was modulated by environmental factors that affect keeper predictability such as keeper visibility to the animal, the frequency and timing of feeding, and whether the keeper enters the enclosure space or not. Rimpley and Buchanan-Smith (2013) have shown that making keeper entries into indoor brown capuchin enclosures more predictable and less startling by providing a reliable entry signal (always knocking on the door before entry) reduces anxiety-related behaviors.

To avoid negative interactions and poor relationships with zoo animals, keepers should be aware of and avoid fear-evoking behaviors. For example, at 32 zoos, keepers were videotaped calling to maned wolves and cheetahs from the visitor area, an unusual location for the keeper to solicit interaction. Both species responded with aggressive behaviors more often to keepers that performed a high amount of locomotion when calling, and they approached keepers less often if the keeper made nonverbal noises (clapping, banging on fence) (Carlstead, 2009). When caretakers spent additional time engaging in positive interactions with chimpanzees, such as playing, grooming, feeding treats, and talking, the animals performed higher levels of allogrooming, exhibited fewer abnormal behaviors, and were less reactive (Baker, 2004). Unstructured affiliative interactions between 12 zookeepers and two resident groups of zoo-housed chimpanzees and two groups of gorillas were associated with the animals exhibiting fewer self-directed and abnormal behaviors (Chelluri *et al*., 2013). However, after interactions with keepers, agonism in the groups increased, leading the authors to suggest that managers should consider practices that minimize the degree to which zookeepers insert themselves in the social environment of great apes.

An important aspect of 'true relationships' is that interactions have reciprocal effects on both partners, which may include benefits to the well-being of each (Hemsworth, 2003; Clegg and Delfour, 2018). Zoo animals and keepers may form mutual bonds that may reflect a psychological need for emotional rewards on both sides of the bond. In surveys of zoo staff working with various species, zookeepers reported having a bond with a zoo animal (Hosey and Melfi, 2012; Birke *et al*., 2019). Furthermore, the benefits to keepers of bonding were reported to be of two sorts: *Operational* benefits, which enabled better, easier, or more efficient management of the animals, and *Affective* benefits, which included general enjoyment of the relationship and emotional rewards (Hosey and Melfi, 2012). An epidemiological analysis of keeper–elephant relationships in North American zoos (Carlstead *et al*., 2019) revealed that bonds between keeper and elephant are associated with welfare benefits for both. In light of research in occupational medicine demonstrating a strong relationship between job satisfaction and both mental and physical health of workers (Faragher *et al*., 2005), keepers likely experience multiple benefits from having a bond with a zoo animal.

20.5 Tools for Enhancing Psychological Well-being: Positive Reinforcement Training

The application of positive reinforcement training (PRT) for zoo animals originated in the 1990s and has grown as an enrichment and management technique ever since (Laule, 2003). Described as 'occupational therapy' by Hediger (1950), the benefits of this technique to animals and to husbandry and veterinary management have proven to be numerous. This includes providing animals with more choice and control, which is an important aspect of well-being (Allard and Bashaw, 2019; Chapter 8, this volume). With PRT, animals are reinforced with pleasurable rewards for performing a behavioral response asked for by a trainer. The technique relies on voluntary cooperation by the animal and the animal is not food deprived (Laule, 2003). PRT is welfare-enhancing because it provides animals the opportunity to work for food rewards, achieve greater choice and control over daily events, and experience mental stimulation. Also, by using a properly applied PRT training technique called 'cooperative feeding' with socially housed animals,

introductions can be enhanced, dominance-related problems mitigated, aggression reduced, and affiliative interactions increased (Laule, 2003). Clegg *et al.* (2019) found that willingness to participate in PRT is a potential indicator of welfare in bottlenose dolphins. As is the case with any factor that can influence the well-being of animals, assessment of these practices is essential (Brando and Norman, 2023).

Few studies have been undertaken to examine the long-lasting impact that PRT has on zoo animals' daily lives. Shyne and Block (2010) examined the effects of PRT on African wild dogs in a zoo and found reductions in stereotypic pacing behaviors following training sessions. PRT training of chimpanzees decreased abnormal and stress-related behaviors and increased prosocial affiliative behaviors (Pomerantz and Terkel, 2009). Among polar bears at 20 zoos, Shepherdson *et al.* (2013) found that bears receiving PRT had lower levels of stereotypy and lower fecal corticoid concentrations. Ring-tailed lemurs demonstrated higher levels of affiliative behaviors and lower levels of aggressive behaviors following PRT sessions when compared to a baseline period when no training was offered (Spiezio *et al.*, 2017). Evidence suggests that PRT training alters the animal's relationship with the keeper and removes at least one important stressor associated with the keeper's actions that might have been causing anxiety-related behaviors prior to training; examples of such stressors include unpredictability, uncertainty, confusion, need for a safety signal, or even lack of attention. Training provides a stimulating human–animal interface (Reinhardt, 1992; Claxton, 2011). Once training begins, communication with the keeper is improved and stress-related behavior declines.

Studies to establish the impact of PRT on KARs are increasing. Savastano *et al.* (2003) reported positive changes in keeper–animal rapport among callitrichid primates as a result of PRT, including a reduction in keeper-directed aggression and avoidance. Ward and Melfi (2013) reported shorter latencies to approach keepers and reductions in time to perform novel behaviors after PRT in black rhino, zebra, and Sulawesi macaques, concluding that PRT can decrease fear of humans and contribute to positive KARs. In a later paper, Ward and Melfi (2015) demonstrated that each keeper–animal dyad is unique and animals respond differentially to each keeper's 'stockmanship style', which consists of two factors: *attitudes towards animals* and *knowledge and experience of animals*. Therefore, PRT is not only an enriching cognitive challenge for the animal, it is a means of communicating directly with the keeper in a common language.

20.6 Tools for Enhancing Psychological Well-being: Environmental Enrichment

Environmental enrichment has during the past three decades become *de facto* the primary tool for addressing psychological well-being in zoo and aquarium animals. Compared to other animal contexts, enrichment in a zoo context is permitted to be much more boundless and creative to the extent that zoos perhaps lead the field of enrichment in terms of innovation. However, theory development, formal experimentation, and reporting in the literature may be more restricted than for animals in labs and on farms due to the diversity of species kept in zoos, the wide variety of enrichment ideas, and limited number of subjects in a given zoo. Nevertheless, enrichment methods and successes are widely shared among zoos via scientific publications, newsletters, websites, and workshops.

Many different interpretations of the term 'environmental enrichment' exist today and other names have been used to describe this process. The following definition is commonly accepted by the zoo community and the AZA:

> Environmental enrichment is a process for improving or enhancing zoo animal environments and care within the context of their inhabitant's behavioral biology and natural history. It is a dynamic process in which changes to structures and husbandry practices are made with the goal of increasing behavioral choices available to animals and drawing out their species-appropriate behaviors and abilities, thus enhancing animal welfare.
>
> (Shepherdson, 2003)

In the 1960s, Desmond Morris, then curator of mammals at the London Zoo, like Hediger took a strong interest in zoo animal behavior and described what we would now call an enrichment device that carried fish around the seal pool before releasing them to the chasing seals (Morris, 1960). More recently, in the 1970s and 1980s, publications arising from experiments conducted by Hal Markowitz and co-workers at what is now the Oregon Zoo in Portland, Oregon, USA, were influential in raising the level of interest in environmental enrichment in zoos (Markowitz, 1982). Markowitz pioneered and

popularized the use of machines that required animals to perform complex behavioral tasks in order to obtain a food reward. These ideas were critiqued and built upon by people such as Hutchins *et al.* (1984) and Maple (1990). They emphasized the importance of providing naturalistic habitats for animals, which allow them to perform many of the behaviors that would be seen in the wild. Since the 1990s the interest in enrichment, as evidenced by scientific papers, zoo conference programs, and advertised positions, has steadily climbed.

Environmental enrichment encompasses activities in zoos and aquariums that generally proceed with one or more of the following benefits to animals, most of which follow from the challenges discussed already:

- Increasing environmental novelty, change, and complexity to allow animals to establish meaningful interactions with their surroundings, diversify their behavior, and mediate social interactions. More complex environments contain information that is of importance to animals and encourage exploratory behavior (e.g., Shepherdson *et al.*, 1993).
- Presenting cognitive challenges such as problem solving, learning new tasks, and participating in training sessions (e.g., Meehan and Mench, 2007).
- Meeting specific behavioral needs, such as a need for shelter/hiding, foraging, or a substrate to dig in, to encourage the expression of species-appropriate behavior (e.g., Kastelein and Wiepkema, 1989).
- Giving animals choice, control, or 'behavioral contingency'. The goal is to establish in the enrichment program a situation in which the animal achieves its needs through its own behavioral interactions with the environment (Quirke and O'Riordan, 2011).
- Stimulating and mediating social interaction by providing social groupings of appropriate sex ratio, age classes, genetic relatedness, and experience (Meehan *et al.*, 2016a).
- Modulating optimal levels of stress (Wielebnowski, 2003) and reducing abnormal behaviors such as stereotypic behavior (e.g., Swaisgood and Shepherdson, 2005).
- Promoting and maintaining positive KARs (Carlstead, 2009).

A heavy emphasis is placed on the importance of providing enrichment that is appropriate to the specific biology of the species under consideration. Biologically appropriate complexity can be increased in many ways, for example, by adding substrates such as dirt, litter, mulch, vegetation, or trees. These substrates increase the 'information content' of the environment and can elicit foraging and exploratory behavior by concealing food, smells, and naturally occurring insects or other wildlife. Barriers and landscaping can provide privacy, promote territorial behavior, provide escape routes, and interrupt sight lines, thus improving social interactions. Toys and novel objects elicit exploration and creative play. Climbing structures allow more efficient use of space and provide shade and temperature gradients for choice of microclimate. They can also provide hiding places from conspecifics, zoo visitors, and keepers. Cognitive challenges, such as mechanical apparatuses, puzzle feeders, or computer interaction with visitors, put captive animals in a position in which they can learn to actively control and explore some aspects of their environment. Various feeding devices and practices such as carcass and whole fruit feeding allow animals to acquire and process food in diverse, versatile, and more natural ways (Carlstead and Seidensticker, 1991; McPhee, 2002). More recently, the potential of training, not just as a management tool but as cognitive enrichment for captive animals, has begun to be realized (Westlund, 2014; Fernandez, 2022).

Enrichment programs should begin with a thorough understanding of the behavioral biology of the species, from which behavioral goals can be determined. Goals should be well-planned to ensure that enrichment is available throughout the 24-hour period, and that there is an ample amount of enrichment items and variety of activities to enhance the well-being of each animal within an enclosure. The effectiveness of enrichment should be evaluated on a regular basis to ensure that items and activities offered do indeed meet the animals' behavioral goals (Mellen and Sevenich MacPhee, 2001). Typical measurable behavioral goals include reducing abnormal behavior, increasing feeding behavior, exploration, the range and diversity of natural behaviors, species-specific behavior, space use, and activity. The SPIDER model, which entails the six steps of Setting Goals, Planning, Implementing, Documenting, Evaluating, and Readjusting, has been widely used in enrichment programs (Mellen and Sevenich MacPhee, 2001).

20.7 Assessing Well-being

The well-being of animals living in zoological institutions is increasingly being systematically assessed as part of regular management practices. This is a requirement by most accrediting organizations and reflects both a common understanding that animal well-being is a key tenet of modern zoos and aquariums as well as greater support and resources for animal welfare science within these institutions. Welfare assessment tools are being developed and shared amongst institutions and programs to better enable data collection, such as Welfare Trak (Whitham and Wielebnowski, 2013) and Zoo Monitor (Lincoln Park Zoo, n.d.).

Each animal experiences their life uniquely, and thus welfare assessments must be able to evaluate at the level of the individual. This ensures that opportunities for improvement can be tailored appropriately, and this type of monitoring helps us understand the role of individual differences in the response of zoo and aquarium animals to our attempts to improve their welfare. However, welfare indicators need to be validated, which requires more extensive study. Multi-institutional studies in which comparisons are made of larger numbers of animals across various environments and management practices constitute a productive approach (Wielebnowski *et al*., 2002). For example, an early study of stereotypy in zoo-housed bear species found that variations in cage size and topography were associated with levels of stereotypic pacing (Van Keulen-Kromhout, 1978). The causal factors of abnormal behaviors such as stereotypy have been investigated multi-institutionally in giraffes (Bashaw *et al*., 2001), polar bears (Shepherdson *et al*., 2013), Indian leopards (Mallapur and Chellam, 2002), and elephants in the UK (Harris *et al*., 2008). The use of non-invasive techniques for analyzing glucocorticoid hormones in feces and urine has led to multi-institutional investigations of stress in clouded leopards (Wielebnowski *et al*., 2002), African rhinoceros species (Carlstead and Brown, 2005), and polar bears (Shepherdson *et al*., 2013). However, even though multiple zoos participated in all of these studies, they were conducted with relatively small sample sizes and limited investigation of a wide range of factors potentially impacting welfare.

Increasingly, zoo scientists are using epidemiological methods to guide improvements in animal care and well-being. A good example is a large-scale study of almost the entire North American population of 255 Asian and African elephants at 68 AZA-accredited zoos (Carlstead *et al*., 2013; see Meehan *et al*., 2016b, for an overview of the results). The study identified 22 unique environmental variables that have significant associations with one or more welfare indicators (body condition, foot and joint health, walking rates and recumbence, stereotypy, ovarian cycling, hyperprolactinemia, serum and fecal glucocorticoids, and clinical health). In broad terms, the study provides support that good elephant welfare in zoos is promoted by elephants spending more time in larger, stable social groupings that include both juvenile and adult elephants, reducing time spent in isolation, and experiencing frequent and diverse enrichment. In contrast, there were few associations between welfare measures and the amount of space that elephants experience. Some of the most important results of the study concerned the impact of human-controlled management factors. The variety and frequency of enrichment provisioning, the use of alternative feeding methods (e.g., hanging or hiding food), staff-directed walking exercise, time spent interacting with staff, unpredictable feeding schedules, and positive attitudes of keepers all had well-being-promoting impacts on the welfare measures assessed in the study (Brown *et al*., 2016; Greco *et al*., 2016; Holdgate *et al*., 2016a,b; Morfeld *et al*., 2016; Carlstead *et al*., 2019).

A similarly scaled study of cetacean welfare included data from 43 facilities housing common bottlenose dolphins, Indo-Pacific bottlenose dolphins, beluga whales, and Pacific white-sided dolphins. An overview of the study goals and findings is available in the 2021 publication by Lauderdale *et al*. (2021). In bottlenose dolphins (common and Indo-Pacific), several management practices and habitat characteristics were related to welfare indicators. Positive relationships were seen between behavioral diversity and the number of habitats accessible to the animals, the predictability of training schedules, as well as more flexible social management (Miller *et al*., 2021a). Another of the publications resulting from this study noted that the type and timing of enrichment may have greater impact on social behaviors than size of habitat (Miller *et al*., 2021b). As was the case in the elephant study, the results of this multi-institutional project reinforce the importance of management practices as factors related to animal well-being in zoos and aquariums.

20.8 Conclusion

Zoo and aquarium animals face unique challenges, but animal welfare is increasingly an integral component of the zoo and aquarium ethos, and considerable resources are already devoted to monitoring and maximizing the welfare of animals in zoological institutions. Improvements in our biological understanding of psychological well-being in zoos and other captive circumstances will continue to benefit zoo animals, as will technologies and protocols that improve the monitoring and tracking of welfare.

There is increasing recognition that the quality of interactions and relationships between zoo animals and their caretakers plays an important role in the welfare of animals, as has long been the case for agricultural animals (Hemsworth, 2003). The keeper–animal relationship is an emerging area of study in zoo animal welfare science that promises to deliver increased knowledge of the psychological requirements of animals. Zookeepers are positioned on a daily basis to monitor, interact with, react to, reassure, and provide care for animals; continued study of these ongoing, reciprocal relationships promises to ensure that all animals will have the opportunity to thrive in zoos.

Enrichment provides an effective and proven tool for addressing many of the challenges of the zoo environment (Swaisgood and Shepherdson, 2006) and will continue to increase in effectiveness as it is applied in an institution-wide, programmatic fashion with appropriately dedicated resources. The development of innovative ways to enhance captive environments will provide zoo and aquarium animals with more choices and improved agency. Further investment in animal welfare science within the zoological field will support the well-being of individual animals and enhance the mission of zoos and aquariums.

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21 Mental Health Issues in Captive Psittacine Birds

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Mental states in birds involve a wide range of cognitive abilities and emotions. Due to the popularity of psittacine birds as pets, there is a need for understanding and further scientific study of their emotional needs. Psittacine birds do not have the extensive history of domestication that many other species that are kept as pets, such as dogs and cats, have experienced.

Emotional well-being in pet birds is affected by additional unique challenges. Many psittacine species have the capacity to live as long as humans, requiring a lifelong commitment on the part of their caregivers. Unlike dogs and cats in the United States, most pet birds remain reproductively intact, which creates behavioral challenges, especially at puberty and during breeding seasons when new behaviors appear. The intelligence of psittacine birds has been documented in numerous studies and illustrates the importance of providing intellectual challenges for these highly intelligent species (Pepperberg, 1987, 1994; Cussen, 2017).

Understanding the behavioral and emotional needs of psittacine birds has important applications. For example, we can improve the conditions for birds kept in captivity and provide for the expression of species-typical behaviors. We can reduce the incidence of behavior problems in pet birds, such as screaming, repetitive behaviors, feather-damaging behaviors, self-trauma, and aggression. Boredom and social deprivation are examples of the negative influences on birds' mental well-being. Inadequate attention to birds' mental health is an important welfare issue as it can lead to emotional suffering and poor quality of life.

A better understanding of the emotional requirements of psittacine birds could enhance the success of captive breeding programs for endangered psittacine species. Parrots possess the largest number of threatened species of any avian family. There are at least 90 psittacine species at risk for extinction (Collar and Juniper, 1992). The *Psittacidae* family contains more threatened species than would be expected by chance, with an increased extinction risk with increasing body size and deceasing fecundity (Bennett and Owens, 1997). Threats include habitat destruction, live bird trade, introduced species (cats and rats), persecution, hunting for food, and fluctuations in environmental conditions.

This chapter discusses the importance of mental health and well-being in captive psittacine birds, with practical recommendations for bird caregivers to maximize the mental wellness of birds in their care.

21.1 Species Diversity

The large variety of psittacine species presents an important limitation to generalizing about their behavioral needs and mental health. There are three families within the order Psittaciformes: *Psittacidae*, *Cacatuidae*, and *Loriidae*. The family *Psittacidae* is the largest, including approximately 280 species of parrots, macaws, parakeets, rosellas, and lovebirds. The family *Cacatuidae* includes more than 20 species of cockatoos and a single species of cockatiel. *Loriidae* includes more than 50 species of lories and lorikeets (Forshaw, 1989).

Psittacine birds exhibit considerable range in appearance, with wide variations in size (from 10 g to >1500 g), structure (crested or non-crested), and coloration. Some species are sexually dimorphic. Some are primarily arboreal (yellow-winged

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Amazon, *Amazona aestiva xanthopteryx*), while others are terrestrial foragers (budgerigar, *Melopsittacus undulatus*).

Psittacine birds occupy diverse habitats, living anywhere from tropical rainforest to dry savannah. Tropical and subtropical lowland forested areas offer the most species diversity. Psittacine birds are neither sedentary nor migratory, but mobile within a geographical area. Many travel substantial distances between roosting and feeding sites.

Social behavior varies among the different species as well. Some appear to be solitary (kakapo, *Strigops habroptilus*), while most species are highly social. With so much variation in habitat and life history, recommendations for maintaining emotional health would need to be specific for the species and individuals involved. Available research on the behavior of gray parrots (*Psittacus erithacus*) in the wild suggests that providing appropriately enriched captive environments may be challenging. Considerations include accommodating high degrees of sociability, long-term breeding pair bonds, stable flock membership, and opportunities for flight and foraging (Greenwell and Montrose, 2017).

21.2 Mental States and Experiences of Birds

It is important to recognize both positive and negative mental states in birds. Unfortunately, there are very few published ethograms for psittacine birds. Studies are needed that illustrate the meanings of various postures and actions of captive birds so that caregivers can more accurately assess mental and physical well-being. Fear or anxiety in captive birds is generally associated with increased vocalizations, defensive postures (such as crouching or flight intention movements), avoidance, frantic behaviors, displacement behaviors (such as preening), aggression, or escape attempts. Anxiety can also suppress normal behaviors, manifesting as freezing behavior or lack of interaction with the environment.

Exotic pet species may be more susceptible to the detrimental effects of chronic stress in captivity due to their lack of selection for tolerance to novelty and humans (Clayton and Tynes, 2015). In a study evaluating neophobia, or latency to approach a novel object, Mettke-Hofmann *et al*. (2002) found that the natural ecology of the species influences neophobia. Sixty-one parrot species with different habitat preferences were studied in aviaries. The species with the shortest latency to approach and longest duration of exploration were species inhabiting complex habitats and species that fed on seasonal foods (nectar, fruit, and nuts). The species with the longest latency and shortest duration of exploration were seed eaters. This study documents behavioral differences in captive species based on their natural habitats that must be considered when providing ideal captive environments.

In clinical situations, caregivers often report fearful behaviors with no known etiology. Fears can develop as a result of classical conditioning, in which the bird forms an association between the owner and an aversive event. This situation has been reported in a case study of a Goffin's cockatoo (*Cacatua goffini*) that developed a persistent fear response toward its owner following an episode of fear-evoking construction noises (Seibert *et al*., 2001).

21.3 Importance of Social Interactions

The importance of providing some forms of social companionship must be considered for captive birds. Psittacine birds often form flocks. The benefits of flock membership include improved defense against predators, increased competitive ability, increased feeding efficiency, and access to mates (Wilson, 1975).

Feeding together in organized flocks may be advantageous to the individual, who is able to benefit from the collective knowledge of the group. By following the flock, an individual has a better chance of locating adequate amounts of food when resources are unpredictable. Small foraging groups are better able than individual birds to exclude competitors from feeding sites. There is some evidence that birds with more limited fasting ability, or smaller birds, are more likely to flock than larger birds (Gill, 1995).

Indefensible areas also promote flocking behavior in birds. There is increased security in a large group, with individuals nearest the center of the flock having the least chance of becoming the victim of a predator. Flocking improves the efficiency of predator detection, allowing the individual more time for other activities. Alarm calling is common within flocks and serves to alert other members of the group to possible danger. South and Pruett-Jones (2000) studied feral flocks of Monk parakeets in a natural environment. The birds formed foraging groups of 2 to 31 birds (mean <10). Individual vigilance declined with increasing flock size, indicating that the flock serves an important function for predator detection.

The number of birds in the flock appears to be very important to the breeding success of large macaw species. Only a portion of the flock will be engaged in breeding activity during any one season, with the non-breeding birds appearing to form a buffer zone of territorial defense (Harrison, 1994).

21.4 Pair Bonding

Pair bonding has been defined as a mutually beneficial relationship between sexually mature female and male birds (Doane and Qualkinbush, 1994). Wilson (1975) defines pair bonding as a close and long-lasting association between a male and a female, serving the primary function of cooperative rearing of young. Pairs are characterized by allopreening, courtship feeding (also called allofeeding), pair participation in agonistic encounters, and close spatial associations (Levinson, 1980).

Allopreening has been cited as the most important behavior for maintenance of social bonds. Close spatial associations are also evidence of a bond. Among bonded pairs of canary-winged parakeets (*Brotogeris v. versicolurus*), mates maintained very close proximity and were usually touching (Arrowood, 1988). Many psittacine species maintain pair bonds throughout the year.

In captive environments, many birds do not have the opportunity to form close social bonds with conspecifics. In other situations, incompatibility can increase stress in social pairings between birds. Captive environments should provide some opportunities for the expression of social behaviors and the maintenance of healthy social relationships with humans or other birds.

Meehan *et al.* (2003a) evaluated the influence of isosexual pairing of orange-winged Amazon parrots (*Amazona amazonica*) on the development of abnormal behaviors. Paired parrots used inanimate enrichment devices more than singly housed cohorts. Paired parrots also spent less time screaming, less time preening, and were more active. Parrots housed in pairs did not develop stereotypic behaviors, were less fearful of human handlers, and had reduced latency to approach a novel object. This study demonstrates the potential importance of social bonds between non-reproductive pairs of birds (Fig. 21.1).



Fig. 21.1. Isosexual pairing between two female cockatoos of different species. (Author's own image.)

21.5 Predictable Environments

The general daily activities (feeding, maintenance, and roosting behaviors) of flocks of orange-fronted parakeets (Hardy, 1965) and white-fronted Amazons (Levinson, 1980) were highly predictable. Two activity peaks were commonly observed, one in the early morning and one in the late afternoon. During the periods of high activity, the birds engaged in feeding, agonistic behaviors, increased mobility, and increased vocalizations.

Pet birds are often exposed to unpredictable environments. Feedings, photoperiods, baths, attention, exercise, and social interactions are often provided based on the varying schedules of the caregivers. This unnatural state of affairs does not allow the bird to develop a sense of control or the skills for coping with stress and challenges. Bassett and Buchanan-Smith (2007) have discussed the adverse effects of unpredictability on the mental well-being of animals (see also Chapter 8, this volume).

21.6 Developmental Factors

Many psittacine offspring have relatively long infancies. Weaning may require up to a year in some species, increasing the requirements for

parental care (Doane and Qualkinbush, 1994). The detrimental effects of early maternal deprivation on neural development and adult functioning are well-documented in primate species (Ruppenthal *et al.,* 1976; Suomi *et al.,* 1976).

Captive psittacine breeding programs have historically involved removal of the newly hatched birds from their parents and hand weaning by humans, due to the belief that this practice produces better quality pet birds. However, the rearing of baby birds by human surrogates may not be sufficient for the development of healthy adult coping skills and stress responses. The justifications for the practice of hand weaning are beginning to be questioned and alternatives considered.

Aengus and Millam (1999) studied the effects of neonatal handling of parent-raised orange-winged Amazon parrots (*Amazona amazonica*). One group was handled daily for 10–30 minutes from day 10 to fledging. The control group was handled only to obtain their weights. There were significant differences in tameness between these groups, documenting that tameness toward humans is possible for parent-raised birds that are exposed to human handling. Sensitive periods for socialization to humans need to be determined.

Long-term behavior effects of rearing method (wild-caught, parent-raised in captivity, or hand-weaned) have been investigated in gray parrots (*Psittacus erithacus*) using questionnaire data collected from owners of adult birds (Schmid *et al.*, 2006). Hand-raised parrots showed more problematic behaviors, and feeding method used to hand-raise chicks also affected adult behavior. Hand-weaned parrots demonstrated significantly more selectivity toward particular humans and more aggression than parent-raised birds. Chicks that were hand-fed by tube-feeding were more aggressive and less healthy as adults than chicks that were fed with syringes or spoons. Wild-caught parrots engaged in more feather-damaging behavior. Chicks that spent more time in the nest with their parents were less likely to develop stereotypies compared to chicks removed from the nest before 5 weeks of age.

There may be effective interventions for individuals that were deprived of maternal care. Bredy *et al.* (2003) evaluated the effects of environmental enrichment in rats that were deprived of early maternal care and found that peripubertal enrichment did compensate for some of the effects of early maternal deprivation. Francis *et al.* (2002) also found that environmental enrichment helped to compensate for the negative effects of postnatal maternal separation.

21.7 Foraging Opportunities

Foraging activities (locating, selecting, manipulating, and consuming food) occupy the majority of a wild parrot's active daylight hours. Wild psittacine flocks generally maintain separate foraging and roosting sites. Levinson (1980) observed separate roosting and feeding areas in white-fronted Amazon parrots (*Amazona albifrons*). In their observations of sulfur-crested cockatoos (*Cacatua galerita*), Lindenmayer *et al.* (1996) noted that the birds traveled considerable distances between roosting sites and areas where foraging occurred. Orange-fronted parakeets (*Aratinga canicularis*) in natural habitats maintained separate roosting and feeding sites 1 mile apart (Hardy, 1965).

Pet birds are often fed commercially prepared diets on a free-choice feeding schedule, drastically reducing the amount of time spent in feeding behaviors. Captive, singly housed, orange-winged Amazon parrots spent only 30–72 minutes per day engaging in feeding behavior when offered free-choice pellets (Meehan *et al.*, 2003b). Meal feeding has been suggested to simulate natural feeding behavior more closely (Fig. 21.2). In addition, captive birds may prefer foraging devices that require them to perform work for food (Coulton *et al.*, 1997).

Opportunities to forage have been shown to reduce feather-picking behavior in Amazon parrots



Fig. 21.2. Macaws receiving meal feeding on a schedule. (Author's own image.)

(Meehan *et al.*, 2003b). Foraging enrichments required the subjects to manipulate objects with openings, chew through barriers for food, sort through inedible materials, and open containers. In addition to preventing the development of feather-damaging behaviors in the enriched group, the same enrichments were used to reverse the development of feather-damaging behaviors in control birds. In this study, the foraging enrichments were used more than physical enrichments, which provided perching, swinging, and climbing opportunities. A preference for larger pellets has been demonstrated in Amazon parrots (*Amazona amazonica*) (Rozek *et al.*, 2010). Over-sized pellets formulated to be approximately 20–30 times larger than regular pellets were strongly preferred over regular-sized pellets.

In a study of captive grey parrots (*Psittacus erithacus*) that were trained to use specific enrichment devices, it was demonstrated that more complex foraging enrichments were the most effective at approximating natural foraging time budgets of wild birds (Beekmans *et al.*, 2023). Enrichments that addressed both appetitive activities (traveling, searching, exploring, selecting) and consummatory activities (extraction and manipulation of food items) were the most successful.

21.8 Photoperiod, Lighting, and Sleep Deprivation

Sleep deprivation can have detrimental effects on the mental health of captive birds. Most psittacine species are diurnal prey species, with an acute sense of vision and hearing. These characteristics present avian caregivers with the challenge of providing for an adequate amount of uninterrupted rest for the birds in their care. Wilson (1999) has discussed sleep requirements for pet birds. It is generally accepted that natural photoperiod variation is ideal for the mental and physical health of pet birds. A two-cage system, including a sleeping cage in a quiet room, provides pet birds with a quiet secluded sleeping area. However, pet birds are often housed in common areas of the home and covered when the caregivers retire for the evening, or at dusk. Given the level of vigilance and reactivity that is characteristic of prey species, it is highly unlikely that the birds receive adequate sleep in these environments. In addition to the stress associated with sleep deprivation, exposure to lengthy photoperiods (increased daylight or artificial light) can increase the incidence of undesirable reproductive behaviors.

In addition to the proper amount of light, the type of lighting can also affect a bird's sensory experience. The type of artificial lighting is important. The flickering of fluorescent light bulbs may be detectable to some avian species. LED lights are recommended (Rupley and Simone-Freilicher, 2015). There is evidence that birds' perceptive abilities extend into the ultraviolet range (Bennett and Cuthill, 1994; Hausmann *et al.*, 2003). Hausmann *et al.* (2003) found that 68% of psittacine birds surveyed have fluorescent plumage. A bird housed in a room with windows that block natural ultraviolet light has a more limited sensory experience than one that is exposed to full-spectrum or natural lighting. Housing birds strictly indoors without adequate UVB light exposure may contribute to feather-damaging behavior (West *et al.*, 2018).

21.9 Consequences of Poor Mental Health

Emotional suffering and poor quality of life are evidenced by the prevalence of behavior problems in pet birds and the reduction or absence of species-typical behaviors. Abnormal behaviors include feather-damaging behavior, barbering and self-mutilation, screaming, aggression and biting, misdirected sexual behaviors, and phobias (Davis, 1991).

21.9.1 Feather picking and self-mutilation

Feather-damaging behavior, also called behavioral feather picking or pterotillomania (Lumeij and Hommers, 2008) is one of the most common behavior problems seen in captive psittacine birds (Lawton, 1996). It is characterized by feather removal, feather damage, and/or soft tissue trauma with no apparent medical, nutritional, or physical explanation (Fig. 21.3).

Boredom, defined as a lack of stimulation (Rushen *et al.*, 1993), or a lack of opportunity to interact with the environment (Wemelsfelder, 1993), is often presumed to be the cause of feather-damaging behavior. This presents an overly simplistic view of the behavior. Many of the individual birds presented for feather-picking problems do not meet the criteria for boredom. They play with toys, interact with humans and other birds, and some are



Fig. 21.3. Goffin's cockatoo (*Cacatua goffiniana*) with chronic pterotillomania. (Author's own image.)

even in breeding programs and allowed free-flight opportunities. Successful treatment of feather-damaging behavior will need to incorporate a broader approach, evaluating early developmental deficiencies, the needs of individual birds, neurochemical correlates, and species-specific interventions.

Excessive preening may be evidence of conflict. Conflict-induced displacement behaviors are behavioral patterns that appear to have no contextual relevance and result from the ambivalence of a conflict situation (Wilson, 1975). Orange-chinned parakeets (*Brotogeris jugularis*) exposed to stressful situations increased preening, head scratching, ruffling of the plumage, beak wiping, and flight intention (repeated crouching and leaning forward on the perch) (Power, 1966). Inappropriate housing conditions, frustration, stress, sexual behavior, attention-seeking behavior, overcrowding, separation anxiety, and changes in routines have also been implicated as causes of self-inflicted feather damage (Rosenthal, 1993; Welle, 1999). Feather-damaging behavior may result from management conditions that do not allow the bird to engage in species-typical behaviors, or do not provide appropriate target stimuli for these behaviors (Jenkins, 2001).

Feather-damaging behavior has been compared to a condition in humans affecting impulse control, with noted behavioral similarities (Bordnick *et al*., 1994). Trichotillomania, an impulse-control disorder of humans, is characterized by removal of hair resulting in alopecia, hence the use of the term pterotillomania when birds are affected. Additional characteristics of the disorder in humans include hair twirling, chewing or mouthing the hair, trichophagia, and skin picking (Stein *et al*., 1995). Avian practitioners have observed oral manipulation of removed feathers by psittacine birds with pterotillomania.

Obsessive–compulsive disorder is characterized by obsessions, intrusive thoughts or images, compulsions, and repetitive behaviors performed in an attempt to reduce anxiety. Hand washing is an example of a compulsive behavior in humans, which may share similarities with repetitive grooming behaviors in animals, including feather picking in birds (Grindlinger, 1991; Stein, 1996). Identifying similarities between avian disorders and human conditions may contribute to our understanding of the etiology of the disorder and the negative emotional experiences of the affected individual.

In addition to feather-damaging behaviors, captive birds may engage in a variety of nonproductive, repetitive behaviors (stereotypies) that are often interpreted as evidence of poor welfare or poor mental health. Stereotypic behaviors observed in captive birds include pacing, spot pecking, beak wiping, perch running, repetitive vocalization, head shaking, head bobbing, weaving, and flight intention movements (crouching, posing) (Sargent and Keiper, 1967). Dilger and Bell (1982) postulated that the stereotypic head movements seen in some birds might be an early sign of neurosis, which could eventually lead to further behavioral abnormalities. The importance of stereotypic behaviors in captive birds as an indicator of poor emotional health is currently unclear and warrants further study.

21.9.2 Screaming and excessive vocalization

Because many parrots are noisy and communicate vocally, excessive vocalization is a common complaint of avian caregivers. Intense calling and vocalization are typical when arriving or departing from roosting sites. It is generally considered normal for pet psittacine birds to vocalize loudly several times a day (Harrison and Davis, 1986). There

are, however, species differences in noisiness and differences in caregivers' tolerance of noise. Excessive vocalizations are often made worse when the caregiver responds directly to the noisy bird, providing positive reinforcement for the behavior. Birds lacking environmental enrichment may be predisposed.

While screaming is often evidence of normal or exuberant behavior, it can also be a symptom of an environmental or emotional deficiency, indicating fear, undesirable changes to the environment, boredom, or frustration. It is important to determine the temporal patterns, eliciting stimuli, housing conditions, and opportunities for social interaction, as well as other potential causes for excessive vocalization before recommending any interventions.

Contact calling occurs in avian species when they are separated from flock members. In some cases, it will be appropriate for the caregiver to answer the bird when it vocalizes, and in other cases, this intervention will be ineffective.

Captive birds may present with fear- or stress-induced screaming. Alarm vocalizations have been measured in wild birds, documenting similarities across species in responses to flying predators and other threats (Jurisevic and Sanderson, 1994). Captive birds may also vocalize to indicate distress or injury. It is crucial that safe housing and accessories be provided and that pet birds be treated like curious toddlers with attention to bird-proofing the environment.

Treatment considerations for excessive vocalization should target the needs, both physical and emotional, of the individual bird. It is helpful for the caregiver to keep a diary of excessive vocalization behavior, including date, time of day, location, duration of screaming without intervention, and persons and stimuli present during the episodes. If there is a pattern to the behavior, feeding, play time, or training sessions can be scheduled just before the bird's 'loud times'. Enriching the environment and rewarding appropriate behaviors can lessen the severity of screaming problems. The environment should be modified to maximize stress reduction, which might include the provision of environmental sounds, exposure to other birds and household activities, hiding places, quiet times, predictable schedules, and reduced confinement. When necessary, a time-out or removal of attention (a form of negative punishment) can be used to discourage screaming.

21.9.3 Aggression problems

Aggression problems are reported in pet birds, although not as commonly as feather picking and screaming. The relatively heavy jaw musculature allows parrots to crack seeds and nuts and inflict injuries. Psittacine birds have evolved flexible necks that allow rapid movement and detection of predators, and, along with the beak, allow the bird to inflict injury rapidly during restraint. Parrots also tend to use their beaks as 'hands' to explore the environment.

The causes of intraspecific and interspecific aggression in psittacine birds have not been systematically classified. The author uses a similar classification system as that used for other species, with some modifications for species differences (e.g., Beaver, 1983; Overall, 1993). Possible causes of human-directed aggression in birds include territorial defense, fear, intolerance of handling, hormonally induced aggression, redirected aggression, play, attention seeking, lack of learned bite inhibition, and inappropriate mouthing.

21.9.4 Territorial aggression

A territory is defined as an area occupied exclusively by an individual by means of repulsion through overt defense (Wilson, 1975). Many avian species establish, maintain, and protect access to particular areas in their natural habitats. However, the prevalence of territorial behavior among psittacine species has not been determined. Territorial defense may involve defense of feeding areas, roosting positions, or nesting sites. Nest defense should be differentiated from mate guarding – close association with mates to ensure paternity – a common feature of the early stages of nesting in some species.

Aggression may be directed against any intruder, regardless of familiarity. Pet birds with territorial aggression may be friendly when taken away from the vicinity of their cages. Treatment involves working in a neutral area on cue training with positive reinforcement and gradually moving training sessions closer to the cage area (desensitization and counterconditioning).

21.9.5 Fear aggression

Many situations can predispose a pet bird to a fear-induced aggressive episode, including inconsistent use of reprimands or punishment by the caregiver, confinement

to restrictive areas (cages) that do not allow escape, inappropriate housing conditions contributing to stress, absence of flock support, inadequate socialization to humans, and unstable perching surfaces. Aggressive responses can be modified by learning over time (negative reinforcement of aggressive displays), such that aggression becomes the distance-increasing behavior of choice any time the bird feels threatened.

Redirected aggression occurs when the caregiver is present, the bird is exposed to an offensive stimulus, and the caregiver becomes the recipient of aggression. Redirected aggression can occur when strangers approach the cage, during veterinary visits, or during exposures to unfamiliar environmental stimuli. Through classical conditioning, the bird can learn an association between the caregiver and the fear-evoking stimulus, resulting in persistent fear of the caregiver and aggression whenever that person is present.

The treatment of fear-induced aggression involves avoidance of fear-evoking situations, gradual desensitization and counterconditioning, and favorite treats and toys provided only when the feared individual is present (Seibert *et al*., 2001).

21.9.6 Play aggression, inappropriate mouthing, and lack of bite inhibition

Play behaviors, seen most commonly in juveniles, imitate essential adult activities without consummating any serious goals (Wilson, 1975). Juveniles of several psittacine species have been observed to engage in social play in the wild (Levinson, 1980). Play behaviors include clawing, play biting, and mock fighting.

During play with conspecifics, young birds would presumably learn the maximum amount of beak force that can be applied without injuring their playmates. Restricted early contact with clutch mates could jeopardize this early learning, resulting in excessive mouthing of human caregivers. Inappropriate responses to this behavior by human caregivers can cause fear.

Young birds should be provided with chew toys and opportunities for locomotor, object, and interactive play. Simply discontinuing interactions when mouthing becomes excessive will teach the bird to inhibit mouthing behavior.

21.9.7 Reproductive causes of aggressive behavior

Problems may arise as pet birds reach sexual maturity, with reports of behaviors that seem to indicate that the bird is misdirecting sexual behaviors toward a human caregiver. Undesirable behaviors include attempts to allofeed (regurgitate), masturbation, excessive contact seeking or calling, aggressive attempts to drive away other members of the family, and defense of the cage as a nesting site (Harrison and Davis, 1986). The onset of these behaviors may coincide with the natural breeding season, increasing day length, or excessive artificial photoperiods.

Treatment may require that other family members assist with feeding and maintenance care while a healthier relationship between the bird and its primary caregiver is cultivated. Reproductive behaviors can be diminished by decreasing the photoperiod, removal of nesting areas, and avoidance of handling that may be stimulating for the bird. Desensitization and counterconditioning have been successful when the bird is with the preferred caregiver and others gradually approach them.

21.9.8 Dominance in psittacine birds

The term 'dominance' has been grossly misused in the field of avian behavior. Dominance is not synonymous with aggression, and in fact, the formation of stable dominance hierarchies is associated with a reduction in aggression. Stable flock membership requires mutual recognition of members and a system for allocation of group resources. Within a dyadic encounter, a dominance relationship is presumed to exist when the individuals behave with predictable assertive or submissive responses based on previous experiences with each other. By using ritualized postural signaling, overt aggression is avoided. Once relationships are established, there is consistency of the social interactions, resulting in fewer, or less intense, aggressive assertions of dominance (Bernstein, 1981). With the exception of a study of captive cockatiels (*Nymphicus hollandicus*), there are very few studies that have systematically measured dominance relationships in psittacine birds (Seibert and Crowell-Davis, 2001).

Assuming that all aggression is dominance-related is counter-productive and sometimes harmful. There is no direct evidence that psittacine birds aggressively challenge the social status of their human caregivers. Most of the aggression observed in psittacine birds does not meet the criteria for a dominance-related problem, which is described as aggressive challenges by socially mature birds

accompanied by species-specific dominance postures, which are not location or stimulus-specific. Cage or resource guarding is not evidence for a dominance-related problem. Frightened birds will often aggressively defend their space. Attempts by caregivers to 'establish dominance over their birds' are likely to increase stress and induce fear responses.

A relationship between perch height and dominance status has not been established for any psittacine species. If a relationship does exist, species differences are likely based on variations in natural habitats and ecology. An inverse relationship between perch height and dominance status may exist with lower-ranking birds preferring higher perches. Many birds prefer higher-perching sites, which is more likely to be a safety issue than a dominance-related issue. Likewise, difficulty removing a bird from the top of its cage is not an indication of a dominance problem. Lowering cages and perches for a problem bird may result in increased anxiety. For any behavior problem, including aggression, it is crucial to identify and understand the causative factors, take a detailed behavioral history, make a specific behavioral diagnosis, and develop a treatment plan based on accepted practices of behavioral medicine.

21.10 Enhancing the Quality of Care for Captive Birds

Potential bird caregivers should be advised not to acquire a psittacine bird unless they are prepared for a lifelong commitment. Veterinarians and aviculturists can assist in the selection of the appropriate species and individual, taking into consideration longevity, exercise requirements, disease susceptibility, cost to purchase and maintain, and social needs. It is important to locate a reputable source for the bird and obtain a healthy bird that has already been weaned. Providing quality preventive healthcare and nutrition is critical for maintaining health and emotional well-being.

Early socialization experiences are important for young birds, and caregivers should expose their birds to a variety of people, stimuli, and situations, without causing fear or risking disease exposure. Avian playgroups and social gatherings are available in many communities. Well-socialized birds can take car trips, visit friends, and participate in animal-assisted therapy programs.

Evans (2001) has reviewed housing requirements for pet birds. Enclosures should address the needs of the bird, should be constructed of non-toxic materials, should provide the appropriate bar spacing, and should be large enough to allow a full range of movements. Cages need to provide privacy and security, such that one side of the cage is placed against a wall or partially covered.

The position of the enclosure is also important. Varying the location may be beneficial for some birds. Some birds may require an area with more activity, and some may require a quieter area of the house. Enclosures should be positioned at eye level of standing family members with varying perch heights. The position of the enclosure should also provide exposure to fresh air and natural sunlight, but avoid drafts. Birds should never be exposed to pesticides, aerosols, scented oils, or cigarette smoke.

Birds should be allowed out of their cages on a regular basis, with appropriate supervision, and given opportunities to exercise. This can be accomplished by using playpen stands, tree stands, free-standing perches, cage-top gyms or activity centers, hanging perches, or the caregiver. Harness training allows flighted birds safe access to outdoors and opportunities for flight.

The benefits of enrichment interventions for psittacine birds are well-documented (Coulton *et al*., 1997; Vanhoek and King, 1997; Meehan *et al*., 2003b; Rodríguez-López, 2016). A stimulating environment can improve emotional well-being and prevent aberrant behaviors. Recommendations include providing stimulating toys, without overcrowding the enclosure, and rotating them on a regular basis. Caregivers must be certain that any toy offered to the bird is safe, non-toxic, and will not be consumed. Some toys should provide the bird with an opportunity to chew, such as wooden ice cream sticks, plain cardboard, paper towel rolls, whiskbrooms, rawhide pieces, pieces of nontoxic wood, or alfalfa cubes. There are a variety of commercially available toys for birds, and individual preferences may require the caregiver to offer several varieties before identifying the most favorable objects. Unique color preferences of individual birds can influence their choice of toys and foods. Less confident birds may initially avoid novel items, so gradual or repeated introductions of novel items and foods may be necessary.

A variety of perching materials of variable diameters are recommended for healthy feet and for behavioral enrichment purposes. Nontoxic, chemical-free, natural branches provide an opportunity to chew, as well as the perch diameter variation

that is recommended for optimal pedal health. Other perching options include manzanita wood, PVC pipe, concrete, braided sisal, and cotton rope.

Maintaining a natural to semi-natural photoperiod variation will provide adequate rest and help prevent the onset of undesirable reproductive behaviors. Day length can influence hormone production. Providing a sleeping cage in a quiet room will give the bird a quiet, undisturbed sleeping area during dark hours. A minimum of 10 hours daily sleeping time has been recommended (Evans, 2001).

Avian caregivers should set a regular schedule for daily activities that is somewhat predictable. Scheduled feeding times simulate natural foraging habits. Foraging enrichments include providing chew foods and using food puzzles or toys to hide food and promote searching behavior.

Many psittacine species also enjoy bathing. Bathing is important for overall feather health. Baths can be provided by misting with a spray bottle, taking the bird into the shower, or providing a shallow water bowl.

Avian caregivers often serve the functions of a flock member, and should talk to the bird, interact with the bird, play with the bird, preen the bird, and involve it in family activities. Some birds respond favorably to hearing familiar sounds, especially in the caregivers' absence, such as tape recordings of family activities, other birds, nature sounds, or music. In a case-control study to identify nonmedical risk factors associated with feather-damaging behavior in gray parrots, a minimum of 4 hours per day of human–bird contact was found to reduce feather-damaging behaviors by nearly 90% (Gaskins and Hungerford, 2014).

Pet birds should be taught basic cues using positive reinforcement, such as a highly palatable food treat, praise, a favorite toy, or attention. Cue training can teach the bird appropriate behaviors and can be used to redirect inappropriate behaviors (Fig. 21.4). Birds should be encouraged and rewarded for playing by themselves, for sitting quietly, and for chewing on appropriate objects. Ignoring undesirable behaviors will prevent inadvertent reinforcement of the behaviors. After a pause in the undesirable behavior, the bird can be redirected to obey a cue that has been previously taught. Physical punishment is never appropriate for psittacine birds. Simply leaving the room, withholding attention, or placing the bird in a time-out cage for a few minutes when it misbehaves are often effective interventions.



Fig. 21.4. Macaw being taught to step up ('up' cue) onto a person's hand. (Author's own image.)

Clayton and Tynes (2015) have advocated for creating captive environments that allow exotic pets to thrive, by providing well-balanced diets, environments that prevent illness or injury, opportunities to self-maintain with species-specific shelter and substrates, opportunities to express normal species-specific behaviors, and opportunities for choice and control over their environments. An understanding of the native behavior of psittacine birds is essential to the prevention and treatment of behavioral disorders of birds in captivity and for optimizing emotional health. The importance of flock social interactions for various species and the effects of isolation on welfare are also pertinent issues. Recognizing that psittacine birds have evolved as prey species should alert caregivers to the importance of environments that provide a sense of security and predictability, particularly in the absence of a flock. Caregivers should also be aware that the sensory experiences of birds will be different from that of humans due to their specialized visual capabilities. The intellectual capacity of psittacine birds should not be underestimated and should motivate avian caregivers to provide intellectual stimulation for the birds in their care.

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22 Mental Health and Well-being in Reptiles

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22.1 Introduction

Mental health and well-being in animals are now accepted as serious and essential issues within science and ethics, as well as major objectives of modern husbandry. While some such recognition has long persisted for, notably, many mammals, it is largely within the last two decades that reptiles have attracted relatively broad interest and concern regarding their mental health. Two reasons may underlie the previous oversight: first, a historical lack of investigative research, and second, an even more historical presumption that reptiles were inherently stoical and mentally uncomplicated animals – so there was nothing to research (Warwick, 1995)! Fortunately, the former hindrance has been settled by many investigations in which research has dispelled probably every derogatory presumption regarding reptilian cognitive and behavioral complexity. Reptiles are now known for complex learning and cognitive processing (Wilkinson and Huber, 2012; Burghardt, 2013; Szabo *et al*., 2021; Font *et al*., 2023), tool use (Dinets *et al*., 2015; Font *et al*., 2023), play (Burghardt, 1988, 1998; Kramer and Burghardt, 1998; Burghardt and Layne-Colon, 2023; Font *et al*., 2023), engaging in human-designed problem-solving activities (Manrod *et al*., 2008; Leal and Powell, 2012; Burghardt and Layne-Colon, 2023; Font *et al*., 2023), picture–object recognition (Wilkinson *et al*., 2013), numerical counting (Pianka *et al*., 2004), and manifest individuality and personality (Siviter *et al*., 2017; Burghardt and Layne-Colon, 2023; Doody, 2023), among other characteristics long thought to be only within the domain of 'advanced' animals. All these issues will be examined in this chapter. The old view of reptiles as simple-minded, reflex-driven creatures has, at least technically, had its day.

Unfortunately, outside of the scientific cohorts studying reptilian attributes, some communities have yet to appreciate that reptiles may not merely rival but may surpass some or most avian and mammalian species in terms of both mental capacities and associated behavioral expression. The terms 'mental', 'mind', 'cognition', and 'psychological' are sometimes used interchangeably and share a common feature – relating to processes within the head. For this chapter, the dominating term of choice will be mental, not because it is better than others, but because it adheres to the theme of this volume, and because it is adequately relevant. That said, at times, the terms cognition and psychological may hold a better contextual fit and will be used. It is not possible to discuss mental issues without frequently straying into, if not mostly including, implications for behavior. Mental and behavioral factors can, of course, to some degree be considered in isolation; but, within reptilian studies behavior has enduringly provided insights into mental issues. In a holistic biological context, psychological, behavioral, physiological, and even environmental considerations are largely inseparable. A spontaneous mental event can constitute a driver of behavior to interact in a certain way with the organism's environment, and conversely so. Between the initiator of an event, whether mental or environmental, resides physiology and behavior as variable actors. In brief, while mental issues lead this content, readers should presume a background of physiological, behavioral, and environmental factors have at least some relevance.

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This chapter aims to provide a basic introduction to key aspects of mental health and well-being in reptiles by summarizing some examples setting out in several subsections where current science is regarding: essential biological considerations, including brain, consciousness, self-awareness, cognition, learning, memory, problem-solving, sociality, play, individuality and personality, sentience, and innateness and ancestral traits; as well as ectothermy, thermoregulation, metabolism and energetics, stress, psychobehavioral problems in captivity, space, disturbances to quiescence, rest and sleep; and finally, a protocol for assessing and remedying mental health issues. It is hoped that through greater understanding of relevant reptilian welfare biology, readers will not only better appreciate, but also act wherever necessary for the benefit of, mental health and well-being issues in these often-overlooked animals.

22.2 Essential Biological Considerations

22.2.1 The brain

The reptilian brain (central nervous system) has long been unappreciated, perhaps largely due to misconceptions about differences pertaining to anatomical organization, localized functions, and size (see summary reviews in Naumann *et al*., 2015; Roth *et al*., 2019; Font *et al*., 2023). For example, there is a frequent perception that reptile brains lack the same cerebral cortex structures to which 'advanced' performances are often attributed in certain birds and mammals. However, reptile brains have a large pallium composed of three to four cortical regions, as well as a dorso-ventricular ridge that may equate to key components of the mammalian cortex and a broad forebrain structure resembling that of birds and mammals (see summary reviews in Roth *et al*., 2019; Font *et al*., 2023). Indeed, there are a number of biological similarities between reptiles and birds, hence the nowadays commonly used scientific reference to reptilian animals as 'non-avian reptiles'. Thus, while it is possible to state that there are certain variations between reptilian and mammalian brains, there is no evidence nor any valid rationales to assume that reptile brains are inferior to those of other animals, including birds and mammals.

Brain size varies among reptiles as it does among birds and mammals and may be smaller in certain groups, but this issue is not a determinant of complexity or performance; neither brain size (actual or proportionate to body) nor anatomical organization infers better abilities over smaller and superficially less complex brains. Furthermore, classical brain neuroanatomy is not required in order to facilitate normal definitions of consciousness, awareness, thinking, learning, memory, cognition, intelligence, and problem-solving. For example, some humans, due to historical hydrocephalus (a neurological disorder caused by increased intracranial pressure), possess little to no remaining normal brain architecture, having only a minimal membrane of tissue lining their skull, yet they function as normal people (Feuillet *et al*., 2007; Ferris *et al*., 2019). Also, despite diminutive brains, honeybees are capable of cognitive performance and problem-solving that exceeds human abilities in some tasks (Chittka, 2017).

Regardless, mental or psychological faculties comparable to birds and mammals are now well reported across various orders and species within the reptile class. Therefore, even though reptiles may possess some different brain organization, this does not imply deficiencies of mental functions, cognition, and consciousness compared with so-called 'higher' animals.

22.2.2 Consciousness

Consciousness (and by extension awareness) is at the root of sentience. Despite the fundamental and ubiquitous nature of consciousness and awareness to life, even today – perhaps bizarrely – we do not fully understand it, nor do we possess full knowledge of its origins, operation, or location; i.e., whether it is, as convention argues, a purely internal and neurological condition, or, as more esoteric posits suggest, a non-local – external – and/or organically mediated quantum-based phenomenon (van Lommel, 2013; Hameroff and Penrose, 2014; Martial *et al*., 2020; Warwick, 2023). Consciousness occurs regardless of, and including in the absence of, mental activities such as memory and thinking, as can be easily experienced through certain meditational techniques; the phenomenon is an 'other' element to mind. There is no scientific rationale for regarding reptiles to be any less conscious and aware than people and other animals (Font *et al*., 2023; Warwick, 2023).

22.2.3 Self-awareness

Self-awareness can be considered, measured, and established in various ways. For example, it is

plainly arguable that all animals have self-awareness in that they are able to know their own body size compared with others and environmental features, such as whether they can overwhelm and consume certain prey, or should avoid a threat, or can access a crevice of the right dimensions; clearly reptiles have such self-awareness (Warwick, 2023). There are numerous specific experimental examples of self-awareness in reptiles. One study involved monitors (*Varanus* sp.) where food items were concealed in holes in tree stumps; the lizards first attempted to insert their heads, but then switched to using their smaller forelimb (see Mendyk and Augustine, 2023). Such issues clearly demonstrate measurable self-awareness. Other experimental work found that reptiles demonstrated olfactory chemical self-recognition (Burghardt *et al*., 2021; Burghardt and Layne-Colon, 2023; Font *et al*., 2023; Freiburger *et al*., 2024). Some may regard visual self-recognition as perhaps more meaningful, but there is no evolutionary reason for assigning one type of sensory self-recognition, such as vision, more importance than another, such as olfactory.

22.2.4 Cognition: learning, memory, and problem-solving

Reptilian high-level cognitive processing, learning, memory, and problem-solving are among the most under-appreciated factors of their biology that are now well established and central to many investigations (e.g., Wilkinson and Huber, 2012; Burghardt, 2013; Wilkinson *et al*., 2013, 2017; Soldati *et al*., 2017; Szabo *et al*., 2021; Williams *et al*., 2022; Burghardt and Layne-Colon, 2023, Font *et al*., 2023; Gillingham and Clark, 2023). A raft of important cognitive abilities have been identified in reptiles, including habituation, classical/instrumental conditioning (e.g., maze learning, detour problems and delayed reaction, food aversion learning, predator avoidance learning, and target training), discrimination learning (e.g., visual/color discrimination, chemical discrimination), picture–object recognition, mirror perception, imprinting-like phenomena and critical periods (e.g., food imprinting, geomagnetic imprinting, and navigation cues), spatial learning, latent learning, probability learning, reversal learning, and social learning (e.g., social facilitation, local enhancement, stimulus enhancement, and copying-imitation) (Wilkinson and Huber, 2012; Burghardt, 2013; Wilkinson *et al*., 2013; Szabo *et al*., 2021; Williams *et al*., 2022; Burghardt and Layne-Colon, 2023; Font *et al*., 2023; Gillingham and Clark, 2023). The point should be made that had scientists long ago elected to test reptiles based on evolutionarily relevant tasks, then early – and some persistent – misconceptions regarding their abilities may have been decisively silenced.

Accordingly, the research literature pertaining to reptilian cognition is rapidly growing, and only a few examples can be included here. Just one area of significance involves spatial cognition tests in reptiles, such as problem-solving maze exercises, which have demonstrated the remarkable abilities across a wide range of species from all main groups (turtles, tortoises, crocodiles, lizards, and snakes) (e.g., Manrod *et al*., 2008; Leal and Powell, 2012; Mueller-Paul *et al*., 2014; Roth *et al*., 2019; Burghardt and Layne-Colon, 2023; Font *et al*., 2023). Indeed, despite tests being of human design, and thus not necessarily entirely conceived within a complete natural ecological context, problem-solving activities in reptiles can exceed those of the human student designers. A study of tortoises (*Chelonoidis* sp.) found that animals were able to operate a touchscreen as well as solve a related spatial two-choice task (Mueller-Paul *et al*., 2014). Another study of monitors (*Varanus* sp.) described how these lizards are adept at solving puzzle-feeding devices, such as turning pots in specific ways to access food (Fig. 22.1), and various studied snake and turtle species show similar attributes for inventive puzzle-solving to locate prey items (summarized in Mendyk and Augustine, 2023) and reversal learning using colored discs (Fig. 22.2).

In another study of monitors (*Varanus* sp.), researchers found that these lizards were capable of numerically counting up to six food items (snails) by initially offering set amounts then decreasing the number of snails, leading to the lizards searching for the missing items (Pianka *et al*., 2004). Tool use has been described in crocodiles (Dinets *et al*., 2015; Font *et al*., 2023). Taking advantage of seasonal nesting behavior of birds, the crocodiles used sticks to lure birds seeking nest-building materials, which they then ambushed.

22.2.5 Sociality, play, individuality, and personality

Despite the frequent misperception that reptiles are stoical and mentally uncomplicated, they possess complex behavioral repertoires that commonly



Fig. 22.1. Lizard (*Varanus* sp.) solving a puzzle-feeding device. (Photograph courtesy of Grant Kother, used with permission.)



Fig. 22.2. Lizard (*Anolis* sp.) performing a reversal learning task. (Photograph courtesy of Manuel Leal, used with permission.)

match or surpass those of birds and mammals (Burghardt, 2013; Burghardt and Layne-Colon, 2023; Doody, 2023; Font *et al*., 2023; Gillingham and Clark, 2023; Warwick, 2023). Summarizing the diversity and complexity of these behaviors is beyond the scope of this chapter and is better presented in recent major reviews (see Burghardt and Layne-Colon, 2023; Doody, 2023; Font *et al*., 2023; Gillingham and Clark, 2023). Nevertheless, it is worth emphasizing that key indicators of complex behavior are well established in the reptile class. Reptiles have been discovered to possess the widest range of social behaviors among vertebrates, including intricate sociality, elaborate courtship, delicate parental care, monogamy, group occupation, sibling complex communication, and grouping for locating food and shelter or for predator avoidance (reviewed in Burghardt and Layne-Colon, 2023; Doody, 2023; Gillingham and Clark, 2023), which firmly dispels the myth of them being non-social cold-blooded creatures. Play has also been documented in reptiles for many years, which shines an entirely different light on reptile mental and behavioral attributes (e.g., Kramer and Burghardt, 1998; Burghardt and Layne-Colon, 2023; Font *et al*., 2023). For example, several studies show that reptiles play with inanimate items, such as balls, hoops, and colored discs, among other things (Burghardt and Layne-Colon, 2023; Doody, 2023; Font *et al*., 2023; Gillingham and Clark, 2023). Indeed, such toys have become common features of environmental enrichment at many zoos to help avoid under-stimulation (Fig. 22.3).

Individuality and personality are another fascinating, yet by now should not seem surprising, aspect of reptilian life (Siviter *et al*., 2017; Burghardt and Layne-Colon, 2023). Individuality and personality relate not only to the fact that incubation temperature can affect the personality of offspring, but also to the plain interpretation of difference and 'personage' attributable to genetics and learned experience (see review in Font *et al*., 2023). Current research now strongly supports the notion that reptiles are individual beings with their own characters.

22.2.6 Sentience

Sentience is the capacity to experience consciousness and self-awareness, and to subjectively perceive and feel positive, neutral, and negative experiences or emotions (such as pleasure, enjoyment, rest, fear, pain, and suffering) (Mendl *et al*., 2017; Broom, 2019, 2020, 2022, 2023; Mellor, 2019; Browning and Birch, 2022; Jones, 2022). Sentience has been identified across all animal classes (Iwama, 2007; Chittka and Niven, 2009; Sneddon, 2012; Horvath *et al*., 2013; Brown, 2015; Barron and Klein, 2016; Klein and Barron, 2016;



Fig. 22.3. Soft-shelled turtle (*Trionyx* sp.) playing with plastic hoops. (Photograph courtesy of Gordon M. Burghardt, used with permission.)

Carere and Mather, 2019; Ginsburg and Jablonka, 2019; Van Huis, 2019; Birch and Browning, 2021; Crook, 2021; Lambert *et al*., 2019, 2021, 2022a, 2022b; Jones, 2022; Mather, 2022; Narshi *et al*., 2022; Klobučar and Fisher, 2023), and reptiles are no exception (Lambert *et al*., 2019; Learmonth, 2020; Arena *et al*., 2023; Font *et al*., 2023; Lillywhite, 2023). Therefore, the same considerations and values pertinent to sentience that are accepted for all other animals – including humans – are equally justified for reptiles. Moreover, as Dawkins (1990) stated so eloquently in the introduction to her influential 1990 article, 'Let us not mince words: Animal welfare involves the subjective feelings of animals.' Sentience, then, is arguably the single most important factor in animal well-being, and if individuals were not sentient then we would have no moral obligation to protect their welfare.

22.2.7 Innateness and ancestral traits

Innate behaviors can include any traits or responses that occur without prior – post-birth – learning, giving rise to the concept of an organism being 'hard-wired'; i.e., involving the inheritance of genetically programmed cognitive and behavioral attributes. In contrast, an animal that is 'soft-wired' would correspond more closely to dependence on learning via parentally and environmentally delivered information and experience. Some innate behaviors involve what may be described as 'simple' responses, such as nervous system reflexes where an individual blinks following contact of an object on an eye or pedal withdrawal following acute stimulation. Simple innate actions and responses may be present in all organisms whether single-cell microbes, humans, other animals, and plants. Although sharing the link of being hard-wired, these innate responses are not to be confused with consciously controlled states (relating to mind and behavior) arising from strong ancestral traits. Soft-wiring is a strong and common characteristic of avian and mammalian biology, whereas hard-wiring is a strong and consistent feature of reptilian biology. There are no known predominantly soft-wired reptiles; all are born (whether from eggs or live birth) as fully functioning and extremely precocious individuals capable of escape, evasion, attack, defense, prey selection, recognition of social contexts, identification of correct habitat types, and many other features of mental awareness and processing, as well as an accompanying comprehensive and complex behavioral repertoire – other than being reproductively viable, they are essentially complete individuals (Burghardt, 2013; Warwick, 2023).

However, this predominant innateness does not imply an inability to learn, which is addressed more in Section 22.2.4. But because innateness is a commanding feature of reptilian biology, two important biological implications follow from its foundational presence. One implication is that all reptiles are born with overriding biological expectations for life under natural conditions (i.e., to act on genetically predetermined mental and behavioral parameters necessary to occupy an ecological system), and another implication is that mental and behavioral adaptations are essentially only compatible with novel challenges that are in the 'right biological direction'; i.e., conform to certain parameters founded on natural premises (Warwick, 1995, 2023). While these biological expectations should also be extended to include particular physical environmental conditions, such as thermal gradients, humidities, photo- and scoto-phase variation, and others, the mental drivers and associated behavioral expressions can be regarded as being as important as any other consideration.

Innate expectations for life imply mental and behavioral needs, often including complex long-distance exploratory locomotor and transient activity; home range, spatial, and habitat expectations; prey interaction and acquisition; habitat types; and other considerations (Gillingham and Clark, 2023; Warwick, 2023). Innate expectations for life and the frequent deprivations inherent to captivity are among the primary reasons why so many reptiles do very poorly in artificial conditions that result in prevalent indicators of stress, as well as associated outcomes of high morbidity and mortality (Warwick, 1995, 2014, 2023).

22.2.8 Ectothermy, thermoregulation, metabolism, and energetics

Ectothermy by definition involves a strong dependence on environmental, rather than physiological, temperature, and thermoregulation implies an alteration of the individual animal's situation and posture within the thermal gradients of their surroundings using behavioral activities (including via mental drivers) (Lillywhite, 2023). Precise, self-determined, temperature control is essential for well-being in reptiles, including physiological states, digestion, metabolism, movement, and immune competence (Frye, 1991a; Arena *et al*., 2023). Metabolic rate may appear to hold little relevance to mental issues; however, in reptiles, its role and importance may be exemplified. Metabolic rate in reptiles is fundamentally linked to their ectothermic biology and habitual thermoregulation (Lillywhite, 2023). Broadly, in reptiles, energy expenditure is around 2–5% that of a similarly sized bird or mammal (Nagy, 2005; Donoghue, 2006). Essentially, low metabolic rate can result in animals being slower to transition through the process of disease onset, symptomology, discomfort, and debilitation and, therefore, experience of longer than otherwise duration of illness, which reasonably implies potentially unusual languishment in conditions of both physical and mental stress.

22.2.9 Stress

Stress physiology and its effects in reptiles are broadly similar to those of other animals, including humans (Martínez-Silvestre, 2014; Gangloff and Greenberg, 2023; Warwick, 2023). Any captive scenario may involve some degree of stress for reptiles, even in the best zoos (Burghardt, 2013). However, certain situations are associated with significant, major, or extreme stress (mental and physical) in reptiles under human control. In particular, wild-caught and captive-bred reptiles are commonly confined in deprived and depauperate conditions for several sectors, notably, exotic pet trading and keeping, mobile exhibitions, and skin, culinary, and curio businesses (Ashley *et al*., 2014; Warwick, 2014; Grant *et al*., 2017; D'Cruze *et al*., 2020; Toland *et al*., 2020; Warwick and Steedman, 2021). Manifestly, in some of these situations (i.e., the skin, culinary, and curio businesses), the animals are also killed, often brutally, with obvious connotations for additional stress.

Accordingly, the physical and mental health and well-being of reptiles across all typical use situations has a high likelihood of involving some concerning level of systematic abuse. Relatedly, mental health and well-being implications for reptiles include the frequent concern that reptiles experience a series of cumulative stressors from which normal recovery is thwarted, resulting in effects being amplified (Warwick *et al*., 2023a,b, 2024). Therefore, if assessing reptiles for mental health and well-being, it is reasonable and pragmatic to presume that multiple stressors may be active in the current situation.

Morbidity and premature mortality among captive reptiles can be very high. For example, one study across several groups (turtles, tortoises, lizards, and snakes) found that at least 75% of pet reptiles died in their first year in the home (Toland *et al*., 2012) and a further study found that 52% of pet snakes died within 2 years (Cargill *et al*., 2022). Another study found that a death rate of 42% for reptiles (again turtles, tortoises, lizards, and snakes) within 10 days among animals held at pet wholesalers, and that in such conditions 72% mortality within 6 weeks, was an industry standard (Ashley *et al*., 2014). Inability to adapt to artificial conditions and associated captivity-stress constitute major components of morbidities and premature mortalities for captive reptiles (Cowan, 1980; Moore and Jessop, 2003; Morgan and Tromborg, 2007; Ashley *et al*., 2014; Warwick, 2023).

22.3 Psychobehavioral Problems in Captivity

The foundational points set out above confirm the importance of considering mental health and well-being issues as much for reptiles as for other

animals. Hereafter, the focus will include the mental challenges and problems imposed on reptiles by captivity and human control. Broadly, the term 'psychobehavioral' refers to situations where problematic mental and behavioral issues conjoin. Table 22.1 provides a list of behaviors commonly observed in wild (free-living) reptiles in a natural environment under conditions of stress, and Table 22.2 provides a list of abnormal and maladaptive behaviors and their related backgrounds commonly observed in captive reptiles in an artificial environment under presumed conditions of stress. From Tables 22.1 and 22.2 it can be seen that in both wild and captive contexts stress-related states are essentially the same, confirming their associations with negative mental states. In addition, these same states and their psychobehavioral manifestations are also well-known indicators of captivity-stress among birds and mammals (Seligman, 1972; Broom, 1981, 1991; Reinhardt *et al*., 1987; Poltyrev *et al*., 1996; Mench, 1998; Clubb and Mason, 2003, 2007; Hampstead *et al*., 2003; Nogueira *et al*., 2004; Garner, 2005; Morgan and Tromborg, 2007; Mendl *et al*., 2017), further confirming their accepted relevance to negative states. However, the abnormal maladaptive stereotypies that are commonly observed in birds and mammals, such as head-bobbing, weaving, jumping, pacing, and licking, as part of forced coping mechanisms (Mendl *et al*., 2017), have not been truly recorded in reptiles, which adds support to the position that reptiles in captivity have very low adaptive plasticity, few to no relevant coping mechanisms, and, thus, a poor ability to adapt. Table 22.3 provides a list of behavioral indicators of positive mental states reported across reptile class, which are important to aid well-being assessments.

Notably, in the list of reptile-associated psychobehavioral problems (Table 22.1) several signs are more specific to this class, in particular, boundary exploration (Fig. 22.4) and interaction with transparent boundaries (ITB) (e.g., pushing against, attempting to climb a glass wall or front of an enclosure) (Fig. 22.5), which are especially common and etiologically founded on an inability to adapt to artificial conditions (Warwick, 1995, 2023). Over 30 psychobehavioral signs and problems have been identified in captive reptiles.

22.3.1 Space

A fundamental component of nature is the amount of space that an animal occupies as part of its normal ecology – its usual home range. Home ranges can be relatively constant, i.e., an animal remains within that range, or it can itself be adjusted by the individual or group to expand or differ. Additionally, it may be essentially constant for the group as a whole but involve transient individuals that periodically or permanently leave one area to occupy others. The amount of space an animal occupies is important regarding such factors as exercise, acquisition of sustenance, sociality, reproduction, and security. Space is also important in terms of the complexities that it provides, such as chemical and visual cues, topographical orientation, habitat diversity, and stimulation. Detailed studies reveal that reptiles commonly occupy extensive home ranges,

Table 22.1. Normal behaviors commonly observed in free-living reptiles under conditions of stress.

Behavior	Description	References
High-level locomotor activity	Threat (e.g., perceived or real predatory) avoidance, fear.	Gillingham, 1995; Mancera *et al*., 2014, 2017; Telemeco *et al*., 2019; Gillingham and Clark, 2023
Escape activity	Threat avoidance, excessive heat, excessive noise, entrapment.	Gillingham, 1995; Warwick, 1995, 2023; Brown and Shine, 2004; Mancera *et al*., 2014, 2017; Martínez-Silvestre, 2014; Telemeco *et al*., 2019; Gillingham and Clark, 2023
High-level exploratory activity	Unsuitable environments (e.g., drought, social pressure), environmental searches.	Greenberg, 1985, 1995; Gangloff and Greenberg, 2023
Hypoactivity	Pain, morbidity, social competition.	Frye, 1991a,b; Greenberg, 1995; Gangloff and Greenberg, 2023
Aggression/repulsion	Fear, defense, social competition.	Gillingham, 1995; Greenberg, 2002; Martínez-Silvestre, 2014; Gillingham and Clark, 2023
Anorexia	Inappetence, stress, fear, disease.	Frye 1991a,b; Greenberg, 1995; Martínez-Silvestre, 2014; Gangloff and Greenberg, 2023; Gillingham and Clark, 2023

Table 22.2. Abnormal and maladaptive behaviors commonly observed in captive reptiles under presumed conditions of stress.

Behavior	Description	References
Hyperactivity	High-level physical activity, surplus or redundant activity, often associated with ITB, overcrowding, self-compounding and frequently injurious, overly restrictive, deficient, and inappropriate environments.	Warwick, 1990, 1995, 2023; Gillingham, 1995; Warwick *et al*., 2013; Mancera *et al*., 2014, 2017; Martínez-Silvestre, 2014; Benn *et al*., 2019; Gillingham and Clark, 2023; Mancera and Phillips, 2023; Warwick and Steedman, 2023
Escape activity	Animal observed clawing, climbing or snout rubbing at boundaries, corners, and other points, related to entrapment and exploratory activity, often associated with ITB, overcrowding, self-compounding, and frequently injurious, overly restrictive, deficient, and inappropriate environments.	Warwick, 1990, 1995, 2023; Gillingham, 1995; Warwick *et al*., 2013; Mancera *et al*., 2014, 2017; Martínez-Silvestre, 2014; Bashaw *et al*., 2016; Gillingham and Clark, 2023
High-level exploratory activity	Frequent searches of environment and boundaries, high-rate of tongue-flick/ other scenting, often associated with ITB, overcrowding, self-compounding, and frequently injurious, overly restrictive, deficient, and inappropriate environments.	Warwick, 1990, 1995, 2023; Gillingham, 1995; Warwick *et al*., 2013; Mancera *et al*., 2014, 2017; Martínez-Silvestre, 2014; Bashaw *et al*., 2016; Benn *et al*., 2019; Gangloff and Greenberg, 2023; Gillingham and Clark, 2023
Hypoactivity	Reduced activity relative to normal, hypothermia, co-occupant harassment, infection/organic dysfunction, disease, injury, pain, transport trauma.	Warwick, 1990, 1995, 2023; Frye, 1991a,b; Gillingham, 1995; Greenberg, 1995; Warwick and Steedman, 1995, 2023; Warwick *et al*., 2013; Mancera *et al*., 2014, 2017; Martínez-Silvestre, 2014; Bashaw *et al*., 2016; Benn *et al*., 2019; Gangloff and Greenberg, 2023; Gillingham and Clark, 2023
Aggression/ repulsion	Aggressive or defensive displays, biting, chasing cage mates, often related to courtship routines, inability to avoid cage mates when required, hunger, overly restrictive, exposed, deficient, and inappropriate environments.	Warwick, 1990, 1995, 2023; Gillingham, 1995; Warwick *et al*., 2013; Gillingham and Clark, 2023; Warwick and Steedman, 2023
Anorexia	Loss of appetite, emaciation, weakness, inactivity, hypothermia, pain, fear, co-occupant harassment, organic dysfunction, disease, injury, transport trauma.	Frye 1991a,b; Gillingham, 1995; Greenberg, 1995; Warwick, 1995, 2023; Warwick *et al*., 2013; Martínez-Silvestre, 2014; Wilkinson, 2015; Gangloff and Greenberg, 2023; Gillingham and Clark, 2023

Other reported abnormal, maladaptive, and stress-related behaviors in reptiles include: interaction with transparent boundaries (ITB); hyper-basking (overly long periods located at a heat source); hyper-alertness; rapid body movements; flattened body postures; head-hiding; inflation of the body; hissing; human-directed aggression; clutching (grasping a person tightly); death-feigning; loop-pushing (resisting contact using abductive movements); tonic immobility; hesitant mobility; wincing; prolonged retraction of head, limbs, and tail; squirting blood from eye; pigmentation change; cloacal evacuations; projection of penis or hemi-pene; voluntary regurgitation of food; tail-autotomy; venom-spitting; open-mouth breathing; panting; and positioning in atypical locations. (Derived from Bashaw *et al*., 2016; Grant *et al*., 2017; Tetzlaff *et al*., 2018; Benn *et al*., 2019; Warwick *et al*., 2019, 2021; D'Cruze *et al*., 2020; Howell *et al*., 2020, 2022; Spain *et al*., 2020; Azevedo *et al*., 2021; Hollandt *et al*., 2021; Cargill *et al*., 2022; Gangloff and Greenberg, 2023; Warwick, 2023.)

measuring from tens of hectares to tens of kilometers (Bull and Freake, 1999; Thompson *et al*., 1999; Pearson *et al*., 2005; Row and Blouin-Demers, 2006; Slavenko *et al*., 2016; Castellón *et al*., 2018).

Relevantly, spatial preference studies in captive reptiles also demonstrate drives towards larger and more environmentally complex habitats (e.g., Case *et al*., 2005; Rose *et al*., 2014; Tetzlaff *et al*., 2018; Spain *et al*., 2020; Hollandt *et al*., 2021; Warwick *et al*., 2021; Cargill *et al*., 2022; Arena and Warwick, 2023; Warwick and Steedman, 2023). It is important to note that the supplying of regular provisions such as water, food, shelter, and where relevant conspecific mates, has been used to suggest

Table 22.3. Behavioral indicators of positive mental states reported across reptile class.

Sign	Summary description	History
Normal/relaxed alertness	Relaxed interest/awareness in proximate or novel objects, relaxed visual explorations	Normal environmental investigation
Calmly smelling or tasting objects or air	Chemical sampling of surroundings	Normal environmental investigation; food searches
Subtle changes in body posture and orientation	'Stretching out' of limbs whilst basking; rectilinear postures in snakes; relaxed adoption of body angles using furnishings	Normal thermoregulatory behavior and rest
Unhurried body movements and locomotion	Relaxed environmental exploration; rectilinear movement in snakes	Normal environmental investigation; food searches
Moderate to relaxed grasp on handler or object	Snake or lizard maintains relaxed (but possibly firm) grasps on human or object	Normal relaxed behavior and rest
Relaxed drinking	Unhurried drinking	Normal maintenance behavior
Relaxed feeding	Unremarkable feeding habits	Normal maintenance behavior
Relaxed breathing	Unremarkable breathing habits	Normal relaxed behavior
Physical quiescence	Unremarkable relaxed activity, e.g., free from apprehension and fear activities	Normal relaxed behavior
Sleep	Naturally contextualized sleep pattern	Normal maintenance behavior
Positive social behavior	Positive interactions with co-occupants	Normal behavior
Absence of negative signs		

Derived from Warwick, 1990, 1995, 2023; Warwick *et al*., 2013, 2019; Martínez-Silvestre, 2014; Bashaw *et al*., 2016; Benn *et al*., 2019.

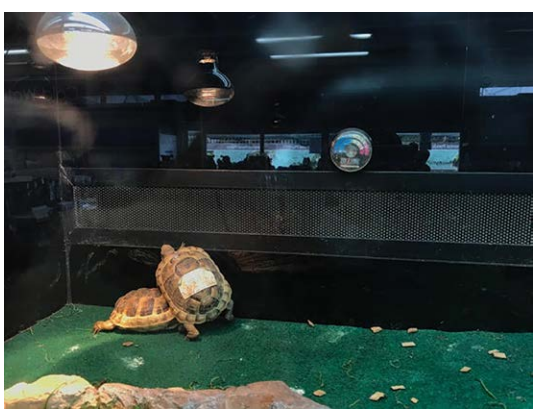


Fig. 22.4. Tortoise (*Testudo* sp.) manifesting a common psychobehavioral problem: boundary exploration. (Photograph courtesy of Catrina Steedman, used with permission.)



Fig. 22.5. Lizard (*Physignathus* sp.) manifesting a common psychobehavioral problem: interaction with transparent boundary. (Photograph courtesy of Maksim Lobanov, iStock/Getty Images, used with permission.)

that large home ranges are less necessary because normal search and acquisition for these elements becomes redundant. However, such a perspective is invalid; issues including innate drive states and under-stimulation in captive conditions promote extra-habitat searches (Warwick, 2023). Lack of space, exemplified by typical enclosures used for captive reptiles, *de facto* infers that individuals are essentially incarcerated or 'trapped' (Warwick, 2014; Morin, 2016); grossly limited or deprived of highly important elements of movement, specific habitat use, and chemical and visual (e.g., large scale vista) sensory stimuli (Arena and Warwick, 2023; Warwick, 2023), and also, for snakes, commonly unable even to fully stretch their bodies (Warwick *et al*., 2019, 2021; Hollandt *et al*., 2021; Cargill *et al*., 2022).

As indicated previously, for reptiles, innateness imparts strong drivers with respect to home range and spatial utilization. Therefore, spatial factors may arguably be more pertinent to reptiles, including their mental health and well-being, than for some other animals (Warwick, 2023). Relatedly, physical conditions such as friction lesions and arthritis, and psychobehavioral problems such as hyperactivity, persistent boundary exploration, and frequent escape attempts, are associated with the spatial restrictions of captivity on reptiles.

22.3.2 Disturbances to quiescence, rest, and sleep

Rest and sleep – including dreaming – in reptiles appear to be comparable with, and as important as, that for other animals, including birds, mammals, and people (Font *et al*., 2023), and there are no reasons to assume these elements hold any lower relevance to reptilian mental health and well-being (Warwick, 1995, 2023). Quiescence is an essential part of homeostasis maintenance, good health, and recovery from stress. Noise, light, vibration, movement, and disruption of circadian rhythms are all documented to have negative implications for all health and well-being issues (Warwick, 1995, 2023; Mancera *et al*., 2014, 2017; Mancera and Phillips, 2023). Relatedly, nocturnality, which implies both scoto-phase and twilight (morning and evening) activities, is also a common feature among reptiles (Gillingham and Clark, 2023; Warwick, 2023), which clearly conflicts with the normal diurnal patterns of humans. This conflict gives rise to two problems having mental health implications for the animals. First, the exposure of reptiles to invasive daytime disturbances due to the activities of people (e.g., noise, vibration, light, and background movement) (Warwick, 2023) can negatively impact normal quiescence, rest, and sleep. Second, relevant indicators of stress in nocturnal animals would most probably manifest at night when humans are normally sleeping, allowing such signs to go undetected (Warwick *et al*., 2018; Arena and Warwick, 2023; Warwick, 2023).

22.4 Protocol for Assessing and Remedying Mental Health Issues

Clearly, the behavioral signs presented in Tables 22.1, 22.2, and 22.3 provide a foundation for identifying potentially negative and positive mental states in reptiles based on the interrelatedness between behavior and mental condition. Indeed, behavior should be the guiding influence for assessing and remedying reptilian mental health issues, not least because reptiles lack certain otherwise common indicators of mental condition in animals and people, such as facial expressions and some social interactions. Furthermore, assessment of reptilian mental states is not only more dependent on overt behavioral signs, but also on highly subtle and nuanced indicators that require perceptive observation, and often a precise knowledge base of normal and healthy species-specific, or even individual-specific, behavior. The presence of one or more such signs does not necessarily infer a genuine mental health problem, but a precautionary principle implies pragmatic concern.

Accordingly, assessing and remedying mental health issues in reptiles may usefully employ the basic approach described in Fig. 22.6 as an overarching and simple 'mind-prompt' guide to condition and care. For this approach, a precautionary priority is indicated for veterinary attention because many common signs may indicate or be concomitant with clinical conditions and can warrant urgent intervention. In the event that veterinary assessment rules out obvious clinical causes, then the protocol progresses to primarily mental and behavioral factors. An important mindset to hold when assessing and remedying mental health issues in reptiles is to consider the elemental concept and principle that animals essentially require control over their environments as part of their welfare or well-being needs (Dawkins, 1990; Broom, 1991; see Chapter 8, this volume); indeed, facilitating such control is vital and highly remedial.

22.5 Conclusions

In a short chapter such as this, conveying sufficient background information, and inspiring a need to want to know more, constitutes a challenge – although a challenge not likely lost on this audience. Certainly, it is no longer possible for any scientist to rationally believe that the mental health and well-being of reptiles is less deserving of consideration than for any other animals. At the very least, the mental health and well-being of reptiles is something that we need to address as a matter of obligatory husbandry; however, we need also to try to think about how they may think, in order to, as much as possible, see the world through their eyes.

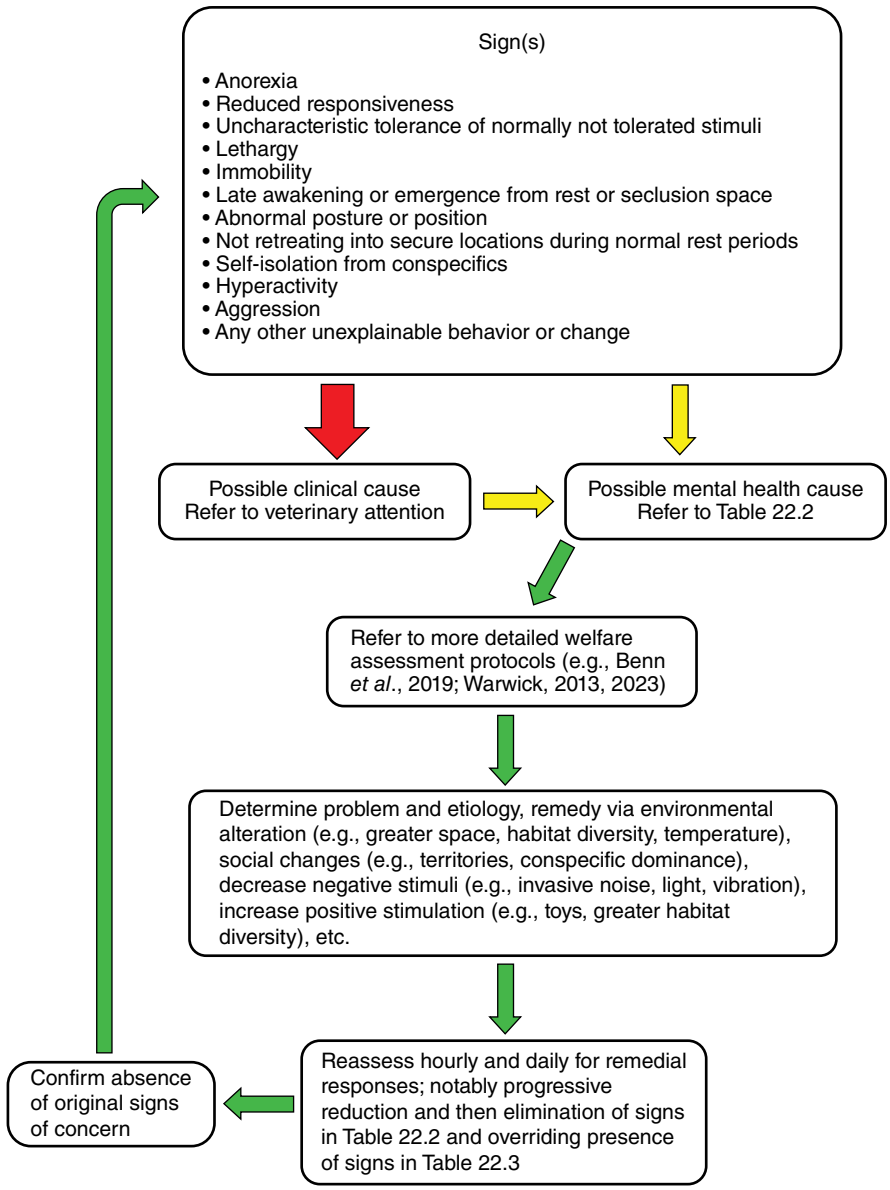


Fig. 22.6. Essential protocol for assessing and remedying mental health and well-being in reptiles. Size and color of arrow indicate prioritization/urgency: red, first immediate priority/urgency; yellow, second priority/caution; green, remedial procedures.

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Part 5 Assessment and Management of Emotional Distress and Disorders

23 Assessing Affective States in Animals

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23.1 Introduction: Mental Health, Well-being, and Emotional States

In this book, we have seen that nonhuman animal (hereafter animal) mental health and well-being can be affected by many things. These include the extent of control an animal has over its life, the quality of its social relationships, the opportunities it has to express a wide behavioral repertoire and to choose how to allocate its time, and the degree to which it is resilient to life's challenges or prey to disorders of cognitive function such as compulsions, hyper-aggression, and forgetfulness. A recent consensus definition of positive animal welfare also emphasized a multifactorial set of influences on well-being: 'Positive animal welfare is defined as the animal flourishing through the experience of predominantly positive mental states and the development of competence and resilience' (Rault *et al*., 2025; see also Lawrence *et al*., 2019). These views reflect theories in the field of human positive psychology that a person's emotional state, but also their experiences of 'accomplishment', 'positive relationships', 'engagement', 'environmental mastery', 'life satisfaction', and 'meaning and purpose', all influence their overall well-being (Diener *et al*., 1999; Ryff and Singer, 2008; Seligman, 2011; Franks and Higgins, 2012).

Such perspectives suggest that a comprehensive assessment of an animal's mental health and well-being requires us to monitor the status of each individual with respect to all these factors. This in turn necessitates quantifying concepts such as 'flourishing', 'competence', 'accomplishment', 'meaning', and 'life satisfaction', a challenging task given that it is not clear whether and which nonhuman species experience such states or how they should be operationally defined. However, the concept of *animal emotion* has received substantial scientific attention, and definitions and methods for assessment have been developed (LeDoux, 1996; Panksepp, 1998; Paul *et al*., 2005; Rolls, 2005; Veissier *et al*., 2009; Anderson and Adolphs, 2014; Mendl *et al*., 2022; Paul *et al*., 2024). Moreover, it is possible that the other factors exert their effects on well-being by altering emotional states (Fig. 23.1), and that the balance between positive and negative states is the ultimate determinant of how well a person or animal feels (Bradburn, 1969; Webb *et al*., 2019; Reimert *et al*., 2023). Emotional state may in fact act as a 'common currency' (McNamara and Houston, 1986; Cabanac, 1992) that integrates the influence of a range of experiences and provides the best indication of an individual's current well-being.

In this chapter, we follow this view and argue that accurate assessment of animal emotion can provide a foundation for scientific investigations into the mental health and well-being of animals. We first discuss what emotion actually is and the inherent challenges of studying a phenomenon that is generally defined in terms of human conscious experience. We then briefly describe two ways of conceptualizing emotion in humans and the pros and cons of translating these to animals. At this point, we clarify terminology that we will employ in the rest of the chapter, and then discuss ways in which we can infer the occurrence of different emotional states in animals. We finish by briefly reviewing some methods that have been used to assess animal emotion, focusing in particular on recent developments in the use of 'emotionally expressive' behavior and cognitive markers.

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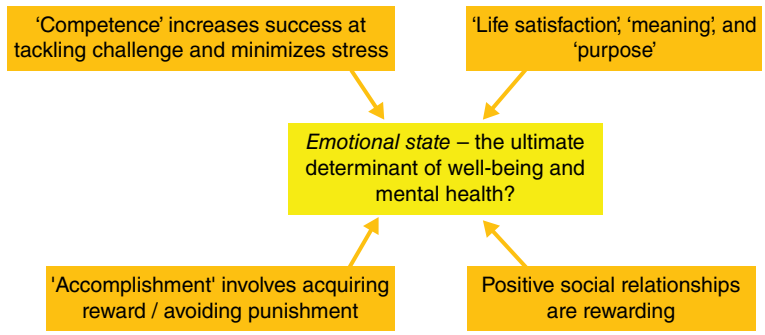


Fig. 23.1. Putative contributing factors (in orange) that may influence overall well-being and mental health by altering emotional state. See text for details.

23.2 What Is Animal Emotion? Consciousness and Concepts

23.2.1 Emotions as conscious subjective experiences: a potential barrier to their study in animals?

Our concept of animal emotion inevitably stems from our own experience of emotions – feelings that we label with terms such as 'happy', 'serene', 'anxious', 'embarrassed', 'angry' and so on. Emotions are a category of subjective mental experience, the key defining characteristic of which is that we experience them as positive or negative, pleasant or unpleasant, rewarding or punishing; they have what is called 'valence'. Transferring this concept to other species is of course tricky and open to the accusation of uncritical anthropomorphism. We cannot know for certain what private mental states, including emotions, another individual is experiencing, or even whether they are capable of having such subjective experiences (the 'Problem of Other Minds'; Farah, 2008). When considering other people, language helps us to tackle this obstacle (although people can of course lie), but this option is not available for nonhuman animals.

So, can we proceed beyond this potential impasse to study animal emotions? One approach, advocated by Wemelsfelder (1997), is to argue that animal subjectivity can actually be studied directly because it is revealed to an observer through the *expressive quality* of the animal's behavior. A more commonly agreed upon stance is that mental experiences are not directly accessible in other species, but that evidence from behavioral, cognitive, and neurophysiological studies points to at least some species being subjectively aware (e.g., Birch *et al.*, 2020; Paul *et al.*, 2020). Accordingly, signatories of the 2012 *Cambridge Declaration on Consciousness* (Low, 2012), and the 2024 *New York Declaration on Animal Consciousness* (Andrews *et al.*, 2024), argue that there is strong scientific evidence to support attribution of consciousness to mammals and birds, with the latter stating that there is also a realistic possibility of consciousness in *all* vertebrates and many invertebrates. While there remain significant disagreements as to which taxa and species have the capacity for conscious experience (e.g., Macphail, 1998; Panksepp, 1998; Rolls, 2005; Key, 2016; Barron and Klein, 2016), if we assume that at least mammals and birds do, we need to develop measures that can provide insights into what emotional state an animal may be experiencing at any one time (i.e., the *contents* of conscious experience). This requires us to become more specific about what we mean by 'emotion'.

23.2.2 Discrete emotions and the dimensional view of emotion

Human psychologists have adopted two main approaches to conceptualizing emotion. The *discrete emotions* approach reflects our usage of emotion words such as 'sad', 'happy', 'angry', and so on, by arguing that these words describe the subjective experience of distinct emotional states that are instantiated in the activity of specific neural circuits in the brain. Advocates propose that there are a limited number of such 'basic' emotion systems and that these form the building blocks for all emotional experience. Although researchers vary in their beliefs about how many and which basic emotional states exist (Ekman, 1992; Plutchik, 2001; Izard, 2007), they concur that each state is grounded in the functioning of a modular neurobehavioral

system that is activated by particular stimuli and generates behavioral changes such as specific facial expressions, and a distinctive profile of physiological responses.

An alternative *dimensional view* of human emotion stems from studies that use factor analysis to analyse the clustering in time of self-reported emotional experiences, and/or the categorization of discrete emotion words. Most studies detect two or three underlying dimensions that account for much of the variation in the data. *Valence* (positivity or negativity of the experience) is one of these dimensions and, as mentioned above, can be thought of as the defining characteristic of subjective emotions (Cacioppo and Berntson, 1999; Watson *et al*., 1999; Carver, 2001; Russell, 2003). Another commonly detected dimension is *arousal*, the degree of 'activation' experienced. Both these dimensions characterize the prominent *core affect* model of felt emotion (Russell, 2003; Fig. 23.2).

Both models of human emotion have their supporters and detractors. Yet they can be combined by visualizing discrete emotions as being located in dimensional space. For example, 'sadness' would lie in the low arousal / negative valence quadrant of the core affect model (Q3 in Fig. 23.2). However, ongoing arguments contest the primacy of each view. For example, do dimensional, core affect processes combine with other information about current context and past experience to construct the experience of an emotion that falls in the 'sad' category, or is 'sadness' a basic, discrete emotion that contributes to a 'higher level' abstraction of

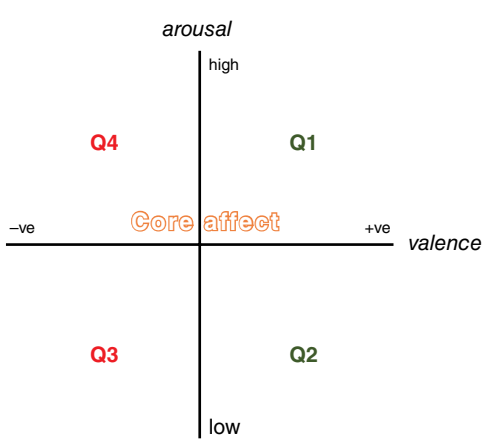


Fig. 23.2. The core affect dimensional model of emotion (Russell, 2003). See text for details.

overall valence and arousal? Whether one set of processes gives rise to the other, or vice versa, or both influence each other, remains the subject of vigorous debate (Izard, 2007; Panksepp, 2007; Adolphs, 2017; Barrett, 2017). For example, reliable co-occurrence of particular reported discrete emotions and specific behavioral, physiological, and neural changes is found in some reviews of the literature (Kreibig, 2010; Vytal and Hamann, 2010; Kragel and Labar, 2016), but others suggest that such changes map more closely to dimensional concepts (Mauss and Robinson, 2009; Lindquist *et al*., 2012).

23.2.3 Translating discrete and dimensional emotion concepts to animals (Pathway 1 in Fig. 23.3)

The ideas just discussed can be translated to animals, as illustrated in a conceptual framework that bridges the gap between the phenomenon of consciously experienced human emotion, the ultimate driver of our interest in animal affect, and the identification of such states in other species (Fig. 23.3; see Mendl *et al*., 2022). Briefly, our experience of conscious *emotional feelings* underpins discrete and dimensional human *emotion concepts*, which we can critically translate to other species (Fig. 23.3, Pathway 1).

In making this translation, our view is that the dimensional core affect model has some advantages. One reason is that the discrete emotions approach relies on the use of human emotion words. This is problematic because these words are not universal across human cultures. For example, there are no direct English equivalents for, amongst many examples, *wab-sabi* (Japanese: feeling pleasure in impermanent things) or *weltschmerz* (German: feeling world-weary), hence questioning the wisdom and validity of generalizing emotion words across human cultures, let alone to other species. Whilst it is plausible that, for example, fear-like states are widespread across the animal kingdom, as species' sensory, perceptual, and cognitive abilities become increasingly different from ours, and their evolved behavioral repertoires also diverge, the chances that they will share other discrete emotions are likely to diminish. Second, human emotion words inevitably imply felt subjective states whereas, as we have discussed, we cannot be sure that such states are consciously experienced in other species (LeDoux, 2017).

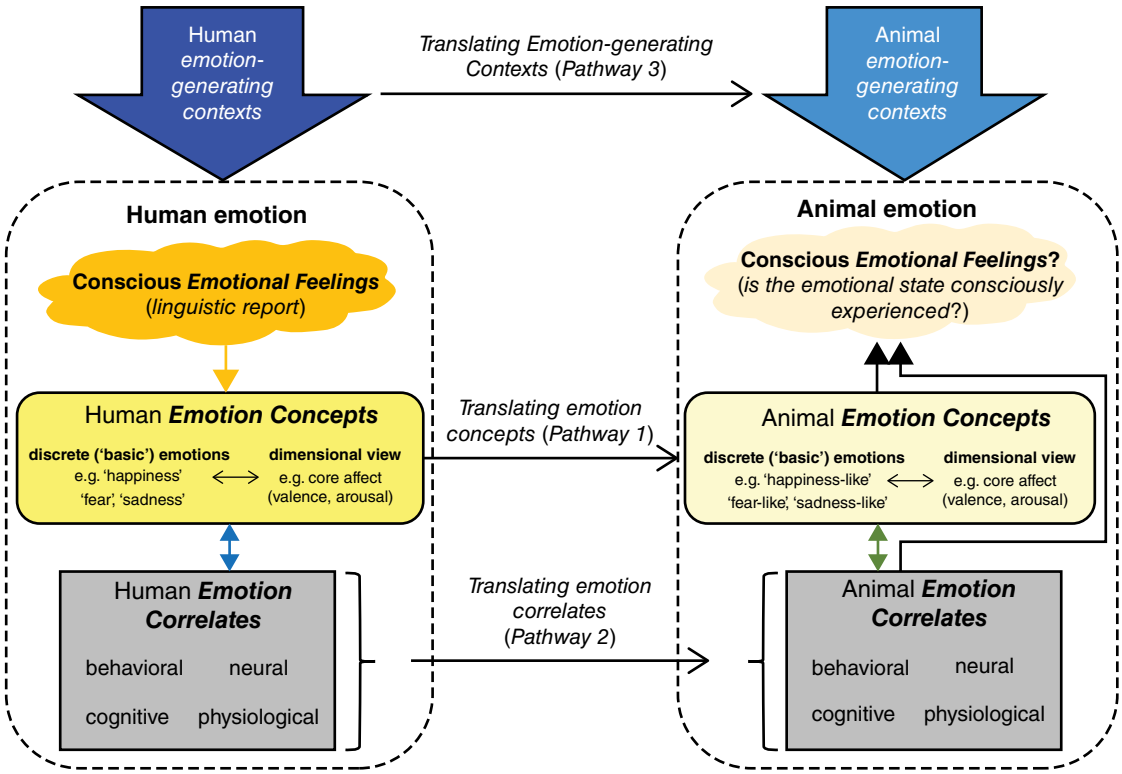


Fig. 23.3. Conceptual framework bridging the gap between consciously experienced human emotion and the identification of such states in other species. (From Mendl *et al.*, 2022, with some changes, under CC-BY 4.0 license (https://creativecommons.org/licenses/by/4.0/).)

Consequently, in a comparative context, the use of discrete emotion words like 'happiness', 'sadness', and especially terms such as 'jealousy' or 'guilt', becomes increasingly questionable as we move away from humans across the phylogenetic tree.

The dimensional core affect model avoids some of these problems by identifying four simple states that are not direct translations of human emotion words (Q1–4 in Fig. 23.2), and which can be readily transferred across species. Although this might seem too simple a perspective from which to summarize the emotional lives of at least some nonhuman species, the four states can be viewed as the source from which a potentially wide range of affective states can be constructed in combination with other contextual information (Barrett, 2017). Such states will be influenced by species' sensory, perceptual, and cognitive capacities and hence be species unique and not always easily captured by human emotion words (Bliss-Moreau, 2017). Furthermore, the core affect model provides a framework for conceptualizing how different types of emotional state are related to each other (e.g., joy and contentment may primarily differ in arousal), whilst the discrete emotions approach treats individual emotional states in a piecemeal fashion. Although we personally favor the dimensional perspective, we will consider both views in the rest of this chapter.

23.3 Animal Emotion Terminology

Given the above discussion, we propose the following use of terms (for more detail, see Mendl and Paul, 2020; Mendl *et al.*, 2022). We use 'animal emotion' and 'animal affect' as umbrella terms for the general area of study. More specifically, 'affect' or 'affective state' are overarching terms for *valenced* states (i.e., those experienced as positive or negative). These include short-term states generated by specific stimuli or events and referred to as 'emotions' in human psychology research (Russell,

2003; Scherer, 2005), and longer-term 'moods' which are free-floating and not perceived to be caused by a specific object or event. Sensations (e.g., pain) and motivations (e.g., hunger) may also have valenced (affective) components. When using discrete emotion words (e.g., 'happy', 'sad', 'angry', etc.), we add the suffix '-like' to indicate that we cannot be certain whether they are subjectively experienced in other species (cf. 'episodic-like memory' in animals; Clayton and Dickinson, 1998) and, if they are, how similar they may be to our human experiences. Finally, we use 'feelings' only when referring specifically to the consciously felt component of an affective state.

23.4 From Animal Emotion Concepts to Animal Emotion Assessment

Having laid the groundwork, we now consider how we might measure the concepts that we have discussed. In doing so, we follow the componential view of emotion espoused in human psychology that affective states comprise subjective, behavioral, physiological, and neural 'components' (Paul *et al*., 2005; Scherer, 2005). While we cannot directly assess the subjective component, we can objectively measure the others. The challenge is to establish which changes in these components are reliable indicators of which discrete or dimensional affective states. Returning to Fig. 23.3, we see that consciously experienced discrete or valenced emotional states in people may be reliably accompanied by particular changes in behavior, cognition, and neurophysiology (measurable *emotion correlates*) and also occur in specific situations (*emotion-generating contexts*). We now consider whether and how these *correlates* and *contexts* can be translated to animals.

23.4.1 Translating emotion correlates (Pathway 2 in Fig. 23.3)

This pathway of inference involves systematically identifying behavioral, physiological, and neural indicators of specific reported emotional states in humans and then monitoring these biological markers in animals under the assumption that they are associated with the same affective states. The advantage of this approach is that people provide our best model of how objectively measurable indicators co-vary with subjectively experienced feelings. The disadvantages, as discussed earlier, include that there is still debate as to whether there actually are repeatable and reliable indicator profiles for specific discrete emotions or affective dimensions in humans, and that other species may not share the same discrete emotion-like states with humans.

A related approach is to infer affective states from the animal's behavior, often based on the intuitive assumption that behaviors appearing similar to those expressed by emotional humans reflect similar affective states in other species. Examples include the intuition that playing animals are in a 'happy', 'joyful', or otherwise positive affective state and that individuals showing hunched postures and low activity are 'depressed'. However, the links between play and positive affect are not always straightforward (Held and Spinka, 2011; Ahloy-Dallaire *et al*., 2018), and inactivity may have many causes that require careful teasing apart to establish any relationship to depression-like states (Fureix and Meagher, 2015). Furthermore, this intuitive method will be less convincing and feasible as phylogenetic distance and morphological differences from humans increase.

A more theoretically based version of this approach is qualitative behavioural assessment (QBA) in which the expressive nature of an animal's behavior is rated by human observers and used as a marker of its subjective state (Wemelsfelder *et al*., 2001). As mentioned earlier, this is grounded in philosophical arguments that subjectivity can be directly observed in expressive behavior (Wemelsfelder, 1997). A different theoretical perspective is taken by Anderson and Adolphs (2014), who propose that many species share 'emotion primitives' (valence, scalability, persistence, generalization) and that indicators showing these properties can thus be used as markers of animal affect. A third example is the 'cognitive bias' approach, which translates the relationship observed between human affective valence and decision making to animals and combines it with arguments from evolutionary theory to generate a rationale for inferring affective valence from decision-making behavior (Mendl *et al*., 2009, 2010b; see Section 23.5.2).

23.4.2 Translating emotion-generating contexts (Pathway 3 in Fig. 23.3)

This pathway of inference involves translating the observation that particular human emotional states (e.g., pleasure, anxiety) can be reliably evoked by particular contexts (e.g., presence of desired stimuli [evolutionarily likely to enhance fitness] and situations

predicting danger [and fitness harm]). An example is the assumption that exposure of burrow-dwelling nocturnal rats or mice to a brightly lit open field or the unprotected arms of an elevated plus-maze induce 'anxiety-like' states. Another is that drugs which induce certain (desired or aversive) emotional states in humans will also do so in other species. If successfully implemented, this approach allows us to infer an animal's *ground-truth* affective state in a particular context and then to assume that indicators that change reliably in such contexts are useful markers of that state. It can be reasonably supported by arguments based on knowledge of the behavioral biology and physiology of the species of interest, but our anthropocentric perspective makes us prone to errors. For example, we may be unaware that a certain olfactory stimulus generates a 'pleasure-like' state in our animals and, consequently, misinterpret or misattribute behavior in situations where the odor is present. We thus need good knowledge of the species' biology to effectively identify contexts that will induce specific affective states. Increasing phylogenetic distance between ourselves and our study species will again diminish the accuracy of our inferences.

As with Pathway 2, a theoretical framework can provide an explicit rationale for translating emotion contexts. One example is the translation of ideas from human appraisal theory that specific discrete emotions occur when a person appraises a stimulus or event in a particular way. For instance, fear arises if a situation is appraised as sudden and of low predictability, pleasantness, or familiarity (Scherer, 2001). Désiré *et al*. (2002) proposed that a 'fear-like' state would therefore occur in animals exposed to sudden, unpredictable, unpleasant, and unfamiliar events, with other discrete emotion-like states occurring in response to other event profiles based on appraisal theory (Veissier *et al*., 2009). If translation of the links between stimulus appraisal profiles and human discrete emotions seems plausible for our study species, this provides a theoretical grounding for inferring discrete emotion-like states.

Theoretical scaffolding for the dimensional approach can be provided by a reinforcement-based operational definition of emotion (Millenson, 1967; Gray, 1987; Rolls, 2005): 'Animal affective states are elicited by rewards and punishers or their predictors. A reward is anything for which an animal will work, and a punisher is anything that it will work to escape or avoid' (Mendl and Paul, 2020, based on Rolls, 2005). Researchers following this definition can infer that an animal is in a positive state if exposed to situations that it will work to acquire, and in a negative state if exposed to situations that it will work to avoid. Affective valence can thus be identified according to context, and indicators that change reliably in these situations can be considered valid markers of valence. Strengths and limitations of this prescriptive definition, plus others that conceptualize emotions in terms of 'emotion primitives' (Anderson and Adolphs, 2014) or states that mediate goal-directed learning (Dickinson and Balleine, 2009), are discussed by Paul and Mendl (2018).

23.4.3 Pathways 2 and 3 map to validation tests for animal affect indicators

The approaches to assessing animal emotion that we have just discussed map to four tests that can be used to establish the likelihood that a particular indicator reflects a particular affective state (for more details see Mason and Mendl, 2025).

- **Pathway 2**: Translation of emotion correlates
  Test 1: Does the indicator of interest accurately track self-reported affective states in humans?
- **Pathway 3**: Inference from emotion-generating contexts[1]
  Test 2: Does the indicator of interest reliably change in animals exposed to stimuli that they prefer/avoid, thus indicating positive/negative valence?
  Test 3: Does the indicator of interest reliably change in animals exposed to ancestrally fitness-boosting/fitness-harming situations, thus indicating positive/negative valence?
  Test 4: Does the indicator of interest reliably change in animals given affect-modulating drugs?

We believe that clear and logical arguments for how we infer discrete emotion-like states or affective valence in animals are essential for development of a rigorous science of animal emotion and identification of valid indicators of animal affect. Use of the Pathways and Tests can help in this endeavor.

23.5 Assessing Animal Affect: Recent Developments in Research on Expressive and Cognitive Indicators of Affective State

Scientists in a range of disciplines including neuroscience, psychopharmacology, drug development, and animal welfare science have been using a variety

of indicators to assess animal affect for many decades. Prominent amongst these are measures of stress physiology (Mormede *et al*., 2007; von Borell *et al*., 2007; Palme, 2012), reflecting the long-standing notion that bodily physiological changes are intimately involved in human emotional experience (James, 1884; Critchley *et al*., 2004). Behavior in standardized testing paradigms such as the open-field, elevated plus-maze, startle, novel object, sucrose consumption, tail-suspension, and forced-swim tests (Pellow *et al*., 1985; Ramos and Mormede, 1998; Cryan and Mombereau, 2004; Forkman *et al*., 2007), and neural markers of affective processes involved in, for example, fear-conditioning, and responses to reward (LeDoux, 1996; Panksepp, 1998; Rolls, 2005) have also been used.

Because there are many excellent reviews of these 'traditional' measures, including those cited above, we focus here on approaches that have been developed more recently. These have emerged partly because of the limitations of existing indicators, including that physiological stress responses are better indicators of arousal than of affective valence (Paul *et al*., 2005; Buwalda *et al*., 2012), that behavioral tests developed for rodents often have limited relevance in other species due to differences in species' behavioral biology (Paul *et al*., 2005), and that the invasive techniques needed to tap the undoubted potential of neural markers are often not appropriate in animal emotion studies.

Here, as in the previous edition of this chapter (Mendl and Paul, 2019), we briefly consider *expressive behavior* and *cognitive markers of affective valence* and, due to space constraints, focus on recent developments in two of the six indicators that we previously discussed: facial behaviors and cognitive bias. We select these because they have been subject to different developments in the use of computational modeling and/or machine-learning methods for measurement and/or analysis. This fast-moving area clearly has great potential for future animal affect and welfare assessment, and deserves consideration.

23.5.1 Expressive behavior: facial behaviors

In *The Expression of the Emotions in Man and Animals*, Charles Darwin (1872) explored the idea that discrete emotion-like states are expressed behaviorally across many species, through facial behaviors, body postures, vocalizations, and movements. The psychologist Paul Ekman (1992) was an enthusiastic advocate of this view, arguing that there were specific human facial expressions reflecting discrete emotions such as happiness, sadness, fear, disgust, anger, and surprise, and that these were universal, conserved across countries and cultures. Darwin's (1872) 'principle of serviceable habits' posited that expressions reflect adaptive movements associated with the emotional state; for example, opening eyes wide to gather more information when fearful, or closing the nostrils to avoid aversive stimuli in disgust (Susskind *et al*., 2008). If discrete emotions have particular adaptive functions that can be facilitated by behavioral expression, then links between affect and expression may occur across species.

With this background in mind, we note that Waller *et al*. (2020) have recently argued for the use of the term 'facial behavior' rather than 'facial expression' because the latter implies external expression of an internal (e.g., emotional) state, but evidence for this association is often lacking. This argument chimes with the need to systematically accrue evidence for the validity of an affect indicator, and we follow it here.

Facial behaviors have been studied in nonhuman primates (hereafter primates) for many years. In seminal studies, van Hooff (1976) noted that particular behaviors occurred in particular contexts. The bared-teeth 'grin face' often occurred when animals were under threat, and appeared to communicate a submissive state. The open-mouthed 'play face', on the other hand, was exhibited during bouts of play-fighting and hence might function to communicate non-serious intent. Van Hooff argued that human smiling and laughter evolved from these behaviors, raising the possibility that the ancestral displays might also be linked to emotional experience. More recently, using methods based on Ekman *et al*.'s (2002) human facial action coding system (FACS), which systematically describes precise shifts in facial musculature, Parr and colleagues (2007) employed a chimpanzee FACS (cf. Waller *et al*., 2012; Caeiro *et al*., 2013) to demonstrate that the same facial movements occur during both primate play faces and human laughter, just as van Hooff had suggested. Pathway 2 and 3 reasoning was thus used to infer links between these facial behaviors and affective states.

In other research using inference from emotion-generating contexts, Parr (2001) demonstrated that chimpanzees were able to match the negativity or positivity of a scenario (e.g., respectively, an image

of a hypodermic needle or a favorite food) to images of conspecific facial behaviors assumed to share the same emotional valence (e.g., bared-teeth 'grin face' or open-mouth 'play face'). Such findings support the idea that primate facial actions may be useful indicators of affective valence, although Waller *et al*. (2017) caution against assuming that these behaviors have evolved solely to reflect current emotion-like states that can be 'read' by others.

Studies investigating links between facial behavior and affective states now extend well beyond primates. Facial indicators of pain have been a particular focus, including in mice (Langford *et al*., 2010), rats (Sotocina *et al*., 2011), rabbits (Keating *et al*., 2012), horses (Dalla Costa *et al*., 2018), cattle (Gleerup *et al*., 2015), and sheep (McLennan *et al*., 2016). Most of the resulting 'grimace scales' are based on inference from emotion-generating contexts linking facial changes to, for example, naturally occurring conditions assumed to be painful (e.g., footrot, mastitis), post-operation recovery, and the presence or absence of analgesia. Some of the observed facial changes (e.g., orbital tightening) occur in putatively painful situations in several species including humans, suggesting that they may be conserved across mammalian taxa.

Facial changes observed in other emotion-generating contexts also show similarities across species. For example, Berridge and Robinson (2003) argued that behaviors linked with gustatory 'liking' (e.g., tongue protrusion, lip-licking) and disgust (e.g., mouth gaping) in response to sweet and bitter tastes are conserved across humans, primates, and rodents. Similarly, orbital widening appears to occur in threatening or otherwise aversive situations in species including humans (Susskind *et al*., 2008), sheep (Reefmann *et al*., 2009), and cattle (Sandem *et al*., 2006), and open-mouth 'play faces' are observed in dogs (Palagi and Scopa, 2017) and other carnivores (Poole, 1978) as well as primates and humans. Cross-species similarity of certain facial behaviors suggests that they may have conserved adaptive value, for example, in detecting danger (Susskind *et al*., 2008). However, contrasting findings caution against uncritical translation across species. For example, Le Moëne and Larsson (2023) measured seven facial parameters in mice during emotion-generating contexts (tastes, tactile stimuli, etc.). A notable finding was that eye opening increased in response to palatable tastes, stroking, and brushing, all assumed to generate positive valence, contrary to the above-mentioned links in other species between orbital widening and negative valence.

Use of machine learning to detect facial behaviors

The use of computer vision and machine learning to discriminate animal affective states on the basis of facial behaviors is a new and growing area of research. Early methods automated the detection of relevant video images for manual coding (e.g., Sotocina *et al*., 2011) whilst more recent techniques train a neural network to discriminate between images associated with inferred affective states. For example, Tuttle *et al*. (2018) trained and tested a convolutional neural network (CNN) on 6862 images of mouse faces annotated by researchers as expressing 'pain' or 'no-pain'. The CNN correctly detected 90.5% of 'pain' faces (sensitivity) and 96.1% of 'no-pain' faces (specificity) with an overall 93% correct detection rate (accuracy; see Table 23.1 for information on detection terminology). Hansen *et al*. (2018) trained a CNN on images of sows in assumed 'no stress' (pre-social mixing) and 'stress' (post-mixing) states and found that it could correctly predict whether a non-trained image was from a 'stress' or 'no stress' emotion-generating context around 90% (sensitivity) and 98% (specificity) of the time respectively, and had an overall accuracy of ~94%. Analysis of which areas of an image tend to activate the network in each context indicated that facial features (e.g., eyes, ears, snout, forehead), but also shoulders and legs, were used by the CNN to discriminate the assumed states.

Nie *et al*. (2024) trained a neural network on images of pig faces from 40 3–5-h video sequences. Images were manually extracted, poor-quality ones removed (due to blur, obstructions, unfavorable lighting, etc.), and the remaining 2700 labeled according to facial behaviors hypothesized, from previous studies, to reflect specific emotional states (see Table 23.2). Subsequent manipulations of image contrast, brightness, and orientation produced a total of 5400 images increasing the training set and hence generalization of the trained network. Putative 'Happy' expressions were detected with high accuracy, but accuracy was lower for 'neutral' expressions, around 50% for 'fear' and 'anger', and background noise was sometimes categorized as an emotion.

Table 23.1. Terms and equations used to quantify the effectiveness of an indicator, in this case machine-learning algorithms for classification of animal affective states from images, at detecting a particular state.

Machine prediction of state from expression	'Ground truth' state represented by expression (coded by humans based on pathways of inference)	
	Pain	No-Pain
Pain	*True positive (TP)*	*False positive (FP)*
No-Pain	*False negative (FN)*	*True negative (TN)*

Sensitivity = Machine's ability to detect Pain when it is present = *TP/(TP+FN)*
Specificity = Machine's ability to detect No-Pain when it is absent = *TN/(TN+FP)*
Accuracy = Machine's ability to correctly detect either Pain or No-Pain = *(TP+TN)/(TP+TN+FP+FN)*
High Sensitivity, Specificity, and Accuracy (e.g., close to 1.0) indicates better performance and hence greater validity of the indicator.
Related machine-learning terms include Recall (same as Sensitivity) and Precision (proportion of positive detections that are correct: TP/(TP+FP).

Table 23.2. Facial postures and contextual information used by human observers to generate ground-truth categorization of pig affective states in images used to train a neural network.

	Facial changes				
Category	Eye	Nose	Lip	Ear	Scene context
Happy	Eyes slightly closed	None	Pull up the upper lip	Pull back the ears	Generally in the eating state
Neutral	None	None	None	None	Normalcy
Fear	Eyes slightly closed	Reduced wrinkles	None	Droopy ears	Generally in a state of shock
Anger	Eyes wide open	Deepened wrinkles	Pull up the upper lip	None	Generally before initiating an act of aggression

From Nie *et al*., 2024, under CC-BY 4.0 licence (https://creativecommons.org/licenses/by/4.0/).

Boneh-Shitrit *et al*. (2022) compared two methods for discriminating facial behaviors in Labrador Retriever dogs exposed to contexts assumed to induce 'positive anticipation' or 'frustration'. One used automatic detection of DogFACS markers in images followed by a decision-tree classifier of whether these indicated a positive or negative state and was 71% accurate. It was also transparent as to which cues were important in discriminating affective states: 'eyes up' appeared to be key, but this could have been a non-affect related artifact of the particular emotion-generating contexts used. The other method employed supervised or unsupervised deep-learning and was more accurate (81–89%), but less transparent as to which cues the algorithm used to discriminate states.

Dolensek *et al*. (2020) also used unsupervised learning, clustering images of mice on the basis of similarity without using a labeled training set. By exposing the mice to a number of different, and largely negative, emotion-generating contexts (e.g., sucrose: 'pleasure'; quinine / salt: 'disgust'; LiCl: 'malaise'; tail-shock: 'fear') and filming the resulting facial behaviors, they showed that machine-learning algorithms could effectively discriminate and categorize the different states (i.e., inferred discrete emotions). The algorithms also appeared to detect underlying dimensional components of affect such as valence, for example flipping between 'pleasure' and 'disgust' facial categorization as salt concentration increased, and more readily categorizing facial behaviors as 'pleasure' when a mouse drinking sucrose was in a thirsty rather than quenched state.

The promise of machine-learning approaches is clear, with automated real-time 24/7 monitoring of animal facial behaviors on the horizon, offering the potential for detecting and quantifying occurrences of good and poor welfare and alerting animal caretakers accordingly. Such approaches are also being used to detect vocal expressions of animal affective states (e.g., Coffey *et al*., 2019; Briefer *et al*., 2022).

However, significant challenges remain. Supervised training requires collection of large numbers of images that humans need to label with relevant 'ground-truth' affective information – a time-consuming process. Moreover, the translational Pathways and Tests outlined in Section 23.4 need to be applied just as carefully and logically as in validation of more conventional affect indicators because any errors at this stage will be reproduced by the resulting algorithms. For example, it may be that the physical descriptions of 'fear' and 'anger' used to annotate images in the study by Nie *et al.* (2024; Table 23.2) failed to capture the full range of facial behaviors that characterize these states in pigs, and led to relatively poor performance of the algorithm.

Unsupervised training avoids the need for image annotation but will usually require some way of generating images that reflect a range of different affective states, for example by using emotion-generating contexts as in several of the above studies. Irrespective of training method, the number and variety of training images will influence performance generalization and accuracy (e.g., under challenging visual conditions), and there is clearly room for improvement in sensitivity, specificity, and accuracy of current algorithms. These may be tailored to a user's requirements by, for example, placing high sensitivity (avoidance of false negatives) as the top priority when seeking to detect negative affect and poor welfare, even at the cost of a high number of false alarms. Finally, although it is usually unclear as to what image features are being used to cluster, categorize, and discriminate different behaviors, methods exist to interrogate algorithms and gain this information (e.g., Hansen *et al.*, 2018). In some cases, this may result in identification of completely new behavioral markers of affective states; a potential strength of using machine learning to categorize facial behaviors.

Summary

Facial behaviors hold considerable promise as indicators of animal affect, occurring spontaneously and hence not requiring the use of specific testing situations, being amenable to non-invasive recording, and offering opportunities for automated monitoring. Questions remaining to be resolved include: (i) whether specific facial behaviors map to particular discrete emotion-like states and/or can be used as markers of affective valence; (ii) whether they reliably co-occur with such states (high sensitivity), are sometimes not expressed, or are expressed in other contexts in the absence of such states (low specificity); (iii) whether they reflect longer-term as well as short-term affect; (iv) whether they can tell us anything about emotional feelings in animals. Regarding this last question, Langford *et al.* (2010) showed that mice with damage to the rostral anterior insula, an area of the brain implicated in human conscious experience of the affective unpleasantness of pain, exhibited attenuated grimace behavior but continued to display abdominal constriction, which also co-occurs with assumed pain states. One speculative interpretation of these findings is that facial behaviors are more than just reflex responses to nociceptive stimulation, and may instead reflect a conscious pain state.

23.5.2 Cognitive markers of affective valence: cognitive bias

One disadvantage of facial indicators of affect is that they may be species-specific, making the search for generalities challenging and the translation of findings across species difficult. Cognitive markers are a relatively new category of animal affect indicator that stem from empirical and theoretical links between affective states and objectively measurable cognitive functions such as decision making, anticipation (Spruijt *et al.*, 2001), and attention (Bethell *et al.*, 2012). These may hold across species and even across diverse taxa. Here we briefly consider cognitive biases in decision making.

The rationale for the most widely used cognitive bias method for assessing affective valence, 'judgement bias', is primarily based on translation of human emotion correlates (Pathway 2, Fig. 23.2), and theoretical arguments regarding function. The former includes findings that people in negative states make more negative (pessimistic) judgements about ambiguous events and situations than people in more positive states (Mathews and MacLeod, 1994; Mineka *et al.*, 1998; Paul *et al.*, 2005). The latter includes arguments that, following the reinforcement-based definition of animal affect described earlier, an animal's affective valence reflects its experience of past rewarding or punishing events. Affective valence may also, therefore, act as a Bayesian prior for the likelihood of these events occurring in future; it makes adaptive sense for individuals who have experienced a preponderance

of aversive events and hence are in a more negative state to also predict that such events are more likely to occur in future ambiguous situations, and hence to make negative judgements under ambiguity (Mendl *et al*., 2010b; Nettle and Bateson, 2012).

Around 200 studies have used the judgement bias task (JBT), initially developed for rats by Harding *et al*. (2004; Fig. 23.4), to measure 'optimistic' and 'pessimistic' decision making. Because the theoretical basis of the approach generates predictions that are expected to hold across taxa, studies have been performed in a wide range of species including mammals (e.g., rats, mice, sheep, dogs, pigs, horses, cattle, monkeys, humans), birds (e.g., starlings, chickens), and even insects (e.g., bumblebees, honeybees); see reviews by Mendl *et al*. (2009), Gygax (2014), Baciadonna and McElligott (2015), Bethell (2015), and Roelofs *et al*. (2016). The majority of studies support the hypothesis that negative affective states are associated with a 'pessimistic' judgement bias, although some studies have null or even opposite results (meta-analyses: Lagisz *et al*., 2020; Neville *et al*., 2020a).

One reason for this heterogeneity in findings is that experimental affect manipulations may sometimes induce different states to those intended. For example, pre-test withdrawal of an acute manipulation designed to induce a negative affective state might instead result in the animal being in a relatively positive 'relief-like' state during the following JBT (Doyle *et al*., 2010; Burman *et al*., 2011). This type of problem is relevant to studies of any affect indicator and emphasizes the importance of carefully using the Pathways and Tests in Section 23.4 to identify 'ground truth' affective states and validate indicators. A different reason for variation in JBT findings is that affect can exert its influence on decision making in more than one way. For example, affective states may not just alter estimates of the *likelihood* of positive and negative decision outcomes, but also their *value*, and these two factors will interact to determine how individuals respond to ambiguity.

Computational modeling to dissect processes underlying affect-induced judgement biases

Computational modeling, as employed in the burgeoning field of computational psychiatry (Montague *et al*., 2012; Seriès, 2020), can shed light on whether affective state is influencing JBT performance via more than one putative underlying process (see Neville *et al*., 2024). In a human JBT, Iigaya *et al*. (2016) used a Bayesian decision-theoretic approach to model whether and how parameters reflecting a subject's: (i) *perceptual ability* to discriminate cues (e.g., tones in Fig. 23.4); (ii) *bias* in categorizing ambiguity positively or negatively;

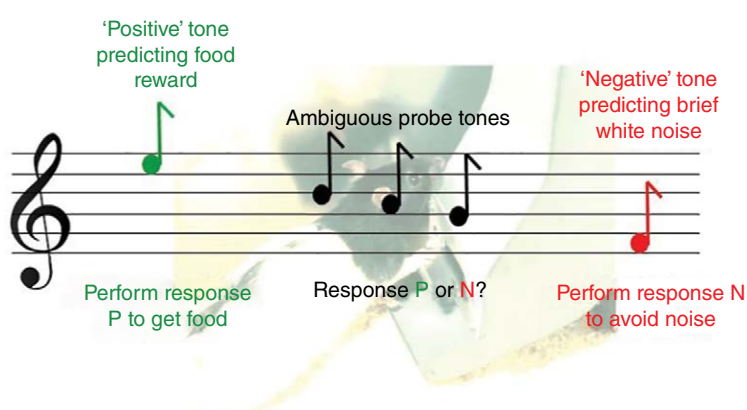


Fig. 23.4. Schematic of the judgement bias assay. In this variant, animals are trained to perform response P when they hear a positive tone to get a reward (food pellet), and response N when they hear a negative tone to avoid an aversive stimulus (brief white noise). Once trained, they are presented with occasional ambiguous intermediate tones to see whether they make response P, indicating anticipation of a rewarding outcome and hypothesized to reflect a positively valenced affective state, or response N, indicating anticipation of an aversive outcome and hypothesized to reflect a negative state. The effects of affect-induction treatments on these responses can be tested.

(iii) *valuation* of positive or negative outcomes; and (iv) propensity for *attentional lapses*, influence their probability of making an 'optimistic' or 'pessimistic' decision under ambiguity. Fitting the model to JBT data revealed that subjects in a mild negative affective state showed the predicted negative *bias*, but they also *valued* positive over negative outcomes. These contrasting effects would likely cancel each other out resulting in no overall influence of negative affect on decisions under ambiguity. This is indeed what was found, explaining the absence of a link between 'pessimism' and negative affect in this study, and supporting the idea that affect can influence both perceived *probability* and *valuation* of decision outcomes. Similar modeling has been used in other human JBT studies (e.g., Neville *et al*., 2021a,b; Lutkenherm *et al*., 2024), and a rat study, which revealed associations between a mild negative state and enhanced valuation of positive outcomes (confirmed by independent motivation tests), again helping to illuminate the absence of a predicted pessimistic bias (Neville *et al*., 2020b).

Drift-diffusion models that simulate decision making as the accumulation of evidence towards one or other (e.g., positive or negative) decision threshold have also been applied to JBTs. Hales *et al*. (2016) showed that the predicted 'pessimistic' bias of rats in an assumed negative affective state may occur due to an elevated threshold of evidence needed to make an 'optimistic' decision, whilst 'optimistic' biases in rats in a positive state may be associated with enhanced prior estimations of the likelihood of good things happening and/or a tendency to more readily accumulate evidence in favor of a positive decision (Hales *et al*., 2017).

Computational modeling of JBT decision data can therefore shed light on putative processes underlying the links between affective state and decision making, thus helping to explain unexpected and heterogenous findings in the literature and, in line with the wider aims and rationale of computational psychiatry, to identify new computational markers of affective valence and affective disorders in humans and nonhuman animals alike.

Summary

JBTs are promising new animal affect indicators based on decision-making theory (Mendl and Paul, 2020) and translation of human emotion correlates to other species. With a specific focus on affective valence – a key determinant of animal welfare – and *a priori* predictive frameworks for how decisions under ambiguity should alter in different affective states, they can be readily translated across species. Nevertheless, training on the core discrimination task (Fig. 23.4) can take between around 1 h (e.g., dogs; Mendl *et al*., 2010a) and many training sessions across days to achieve. Consequently, the development of quicker and automated tests is an important focus of research (e.g., Brydges and Hall, 2017; Hintze *et al*., 2018; Jones *et al*., 2018). The recent application of computational modeling to data analysis is helping to clarify findings and better understand the complexities of affect–decision-making links. An important contribution of this approach is to identify information-processing correlates of affective states, such as estimations of outcome probability and value, that can then be used as new markers of animal affect.

23.6 Concluding Remarks

The evaluation of animal mental health and well-being necessarily involves accurate assessment of affective states. This is a challenging enterprise that requires clear definitions of concepts and terms, recognition of the logic by which human emotion theories, models, and measurements can be applied to animals, and awareness that inferences about the conscious experience of affective states in nonhuman animals should be made carefully and rationally (Fig. 23.3). For example, findings of affect-induced judgement biases in insects (e.g., Bateson *et al*., 2011; Solvi *et al*., 2016) naturally raise the question of whether such biases tell us anything about conscious experience of the inferred states (Mendl and Paul, 2016). In this case, we suggest that JBTs can be reliable markers of affective states that are instantiated in the activity of underlying neurophysiological systems. As with every other indicator of animal affect, however, whether these inferred states also comprise a conscious component requires evidence from different types of study that specifically address the possibility of consciousness in other species. Such studies may focus on, for example, the presence or absence of neural structures and functions thought to be involved in human conscious experience, and the occurrence of particular behavioral and cognitive abilities such as metacognition, episodic memory, future planning, and theory of mind that can be argued to require consciousness (Boly *et al*., 2013;

Birch *et al*., 2020; Paul *et al*., 2020). We believe that the framework for developing a scientific study of animal affect outlined here can provide a basis for identifying new and better affect indicators, and that expressive behavior and cognitive marker measures exemplify the novel and exciting developments, including the uptake of computational methods, taking place in this important enterprise.

Note

[1] Tests 2 and 3 take a dimensional perspective to identify relatively positively and negatively valenced states. A comparable test for discrete-like emotions would be: Does the indicator reliably change in animals exposed to situations with stimulus characteristics that induce, through appraisal, specific discrete emotions in humans?

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24 The Importance and Intended Use of the Mental State Domain in the Five Domains Model

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24.1 Introduction

During the last 60 years, scientific and public interest in animal welfare has grown, as has the perceived importance of applying scientific principles to justify our approaches to managing or otherwise interacting with animals. Animal welfare is assessed for a variety of reasons, including for legal or industry compliance, to access higher-value markets for animal products, for benchmarking against others in the same field or tracking changes over time, to reassure the public, to select the best (or least harmful) of the available options, to develop better methods for managing animals, or to decide whether an intervention is justifiable at all.

In many jurisdictions, there is now explicit acknowledgment that some animals, at least, are sentient; they have mental experiences that matter to them. Even in those jurisdictions that have not made this recognition explicit, the existence of animal protection/welfare laws indicates that animals are not viewed merely as objects or property but as having some degree of intrinsic value (Blattner, 2024). As a result, we have moved beyond focusing solely on animal health and productivity in our welfare evaluations towards more holistic ways of assessing welfare that also consider the emotional lives of animals (Fraser *et al*., 1997; Browning and Birch, 2022). Accordingly, contemporary approaches to assessing animal welfare should represent this expanded understanding.

The Five Domains Model for welfare assessment aligns with this focus on animals' mental experiences. The Model was formulated 30 years ago as a response to perceived limitations of the UK Farm Animal Welfare Council's Five Freedoms for the purposes of detailed scientific welfare assessment and was first applied to evaluate the impacts of research procedures on animal welfare (Mellor and Reid, 1994). Since then, the Model has been progressively expanded to reflect the evolution of thinking and scientific evidence relating to animals' capabilities for various mental experiences, both negative and positive, with the latest iteration focusing attention on how interactions with humans can influence animal welfare (Mellor *et al*., 2020). It has been widely embraced and numerous organizations representing interests in farmed, research, sport, companion, free-living, and captive wild animals support its use. At least 56 non-governmental organizations (NGOs), industry bodies, and companies worldwide have adopted it as the theoretical basis of welfare assessment, notably the International Whaling Commission, the World Association of Zoos and Aquariums, and Tyson Foods Inc.

In this chapter we will begin by briefly describing the theoretical background to the Five Domains Model and explaining how it is applied. We will then highlight the importance of the fifth domain, representing the animal's mental experiences, to understanding its welfare and how the fifth domain

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should be properly employed to avoid misunderstanding or misinterpretation. We will finish by describing key challenges associated with the use of the Five Domains Model and its emphasis on mental experiences for assessing welfare.

24.2 An Overview of the Five Domains Model

The Five Domains Model is a multi-dimensional approach to assessing animal welfare. It is based on the understanding of welfare as a state within the animal itself that arises due to the integration of its various mental experiences at a point in time (Mellor *et al*., 2020). Mental experiences that have valence (i.e., are negative or positive) matter to the sentient animal and are also referred to as 'affective experiences' or 'affects'. An animal's welfare reflects how it is experiencing itself and its world, and its overall welfare will vary over time on a continuum from very poor to very good as those experiences vary.

The Model provides a systematic and structured framework for considering the various factors or conditions that might give rise to such experiences and thus impact the animal's welfare. However, as mental or affective experiences are internal and subjective, they cannot be directly assessed. To apply the Model, evidence of impacts on, or opportunities for, the animal is organized into four domains which relate to its:

1. Nutrition and hydration.
2. Physical environment.
3. Health or functional status.
4. Behavioral interactions.

This evidence can be provided by a variety of observable or measurable indicators (Dawkins, 2003). This information is then used to infer the animal's likely mental/affective experiences in Domain 5; as noted, it is these experiences that are most relevant to its welfare state (Fig. 24.1).

24.2.1 Indicators to support inferences of mental experiences

Inferences of animals' mental experiences must be made with caution and proposed welfare indicators validated to the best extent possible (Beausoleil and Mellor, 2017). Welfare indicators are those measurable or observable variables that provide information on an animal's likely mental state. Indicators can be animal-based (e.g., an animal's body weight) or non-animal-based (e.g., the quantity of food offered) indicators; the latter include resources available to animals or management procedures applied to them. Animal-based (AB) indicators represent the *outcome* of the animal's perception and interpretation of its internal conditions and/or external environment and thus provide the strongest justification for inferring mental experiences (Harvey

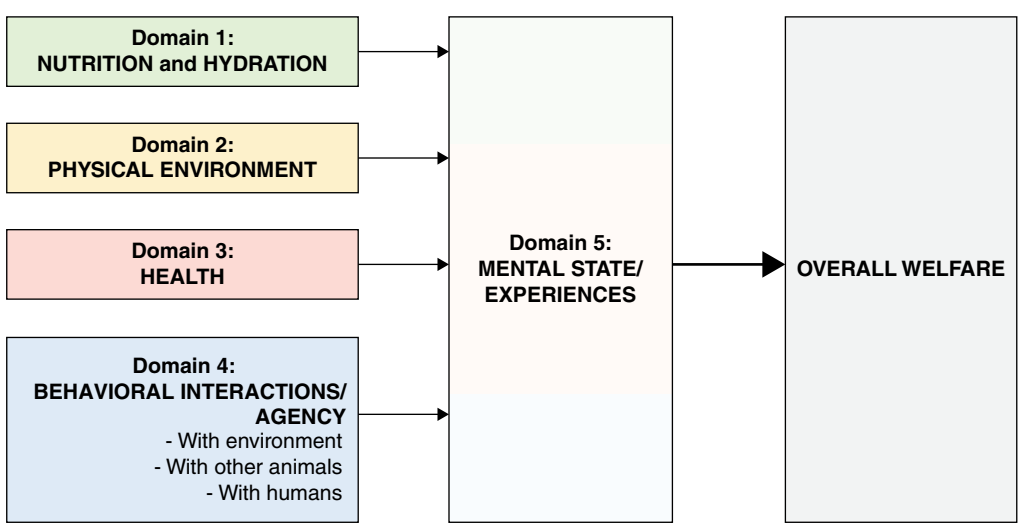


Fig. 24.1. Generic schema of the Five Domains Model for animal welfare assessment illustrating how evidence of impacts in Domains 1 to 4 is used to infer affective experiences in Domain 5. (Adapted from Mellor *et al*., 2020.)

et al., 2020). Such measures or observations can be made directly from the animal or can be drawn from records.

In Domains 1 to 3, AB indicators used to recognize impacts/opportunities include various qualitative or quantitative physical, physiological, pathophysiological, biochemical, immunological, neurological, and behavioral parameters (see Table 24.1 for examples). In contrast, Domain 4 focuses on the animal's behavioral interactions with its environment, other animals, and humans; accordingly, AB indicators used in this domain are usually behavioral (see Table 24.2 for examples). This domain helps evaluate the animal's opportunities to exercise agency, i.e., its ability to engage in behaviors it is highly motivated to perform (Littlewood *et al.*, 2023). Behavioral parameters may indicate when animals can and do have agency (choice, control, and challenge) over their interactions and when their agency is restricted (see Chapter 8, this volume, for further discussion on control and choice).

We can also evaluate the potential for welfare impacts by assessing features of the environment or management system. Resource- and management-based indicators such as the space or food provided or the capability of stockpeople represent *risks* to the animal's welfare (inputs or alerting indicators) but do not provide direct evidence that those resources and management activities influence the focal animal's mental state (Harvey *et al.*, 2020). Examples of non-AB indicators used in Domains 1 to 3 include the amount, type, and presentation of resources such as food, shelter, space, and preventative and reactive health management (Table 24.1). Non-AB indicators used in Domain 4 include features of the animal's physical and social environment that allow it to express agency by making choices, taking control, and solving problems (Littlewood *et al.*, 2023). These might include the space and complexity available in the animal's environment, the animal's ability to engage with, or retreat from, other animals and the quality of handling by humans (Table 24.2).

On their own, non-AB indicators provide less valid support for inferring mental experiences, as not all individuals in a group will interact with, perceive, or respond similarly to the same features or management. Nor do these indicators facilitate comparison across different management systems or situations as they become self-defining. However, AB indicators only indicate the past and present state of the focal animal (Harvey *et al.*, 2020) – they do not provide information on how stable conditions (and thus welfare) are likely to be between assessments or how likely other animals in the group are to experience similar welfare. Importantly, AB indicators do not necessarily provide an accurate reflection of the organizational culture that is likely to predict future welfare states. Resource- and management-based measures are helpful when AB measures are unavailable, not feasible, or impractical, and they are often faster, cheaper, and easier to perform and can be more reliably measured. Thus, a combination of AB and non-AB indicators in each of Domains 1 to 4 will provide the best understanding of the various aspects of welfare.

Another way of thinking about different types of indicators is as reflecting the animal's welfare status or the risk to its welfare. Many AB parameters are *welfare status* indicators – they reflect the animal's mental experiences most directly. For example, limping following an injury is taken to reflect the animal's current mental experience of pain. Some AB indicators (and all non-AB indicators) are *welfare alerting* in that they only alert us to the *risk* of a particular mental state (Harvey *et al.*, 2023). For example, the geriatric age of an animal might alert us to the greater risk of osteoarthritis but does not, on its own, indicate that joint pain is occurring. Likewise, an empty water trough alerts us to the risk of thirst or the possibility of thirst arising in the near future if the trough is not filled. Other examples that can be used in Domains 1 to 4 are shown in Table 24.3. Welfare-alerting indicators encourage us to look for more direct evidence that the experience is occurring or to take actions to prevent, remedy, or mitigate the risk. The challenges of integrating welfare status and alerting indicators to understand impacts in each domain and overall are discussed in Section 24.4.3 below.

24.2.2 Application of the Model is influenced by the purpose of welfare assessment

The Model can be used for two broad assessment purposes: compliance and monitoring for welfare improvement; the purpose of assessment influences the way the Model is applied. Examples of recent assessments and their purpose are provided in Table 24.4.

Compliance assessments aim to provide an overall evaluation of animal welfare in a particular context and are typically in the form of risk assess-

Table 24.1. Proposed physical or functional states or available conditions being assessed in Domains 1 to 3, alongside examples of potential welfare indicators and mental states that might be inferred in Domain 5 from such indicators.

	Domain 1 (nutrition)		Domain 2 (physical environment)		Domain 3 (health)	
	Nutritional or hydration status		Substrate, shelter, microclimates, space allowance, external disturbance to physiological systems (musculoskeletal, integumentary, olfactory, respiratory, auditory, visual)		Injury, disease/infection status, functional status of physiological systems, physical fitness	
Indicator type						
Animal based	Body condition score, plasma osmolarity, skin tent test time		Panting, shivering, restlessness, red or broken skin, coughing, squinting		Presence/absence of injuries or clinical signs of disease, exercise intolerance	
Resource based	Amount of food available, water quality		Pen size, shelter available, air quality or ventilation, lighting regime		Presence/absence of injury-causing objects, disease-causing agents in environment	
Management based	Method or frequency of food presentation, water trough maintenance		Habitat cleaning, stocking density, schedule changes to avoid thermal extremes (e.g., late evening milking)		Vaccination frequency, wound management, biosecurity measures, record keeping	
Examples of mental state(s) inferred (Domain 5)	*Negatives:* Hunger, weakness of starvation, thirst	*Positives:* Postprandial satiety, masticatory pleasures, quenched thirst	*Negatives:* Physical discomfort, muscle tension, skin irritation, overheating, chilling	*Positives:* Physical comfort, well rested	*Negatives:* Pain, debility, malaise, breathlessness, nausea, exhaustion	*Positives:* Vitality of fitness

Table 24.2. Proposed behavioral interactions being assessed in Domain 4, alongside examples of potential welfare indicators and mental experiences that might be inferred in Domain 5 from such indicators.

	Behavioral interactions with the environment	Behavioral interactions with other animals	Behavioral interactions with humans
Indicator type			
Animal based	Abnormal behaviors, activity level, e.g., time spent at rest	Frequency of social injuries, affiliative/aggressive behaviors during encounters with other animals	Avoidance distance, voluntary approach, demeanor towards handlers, evidence of effective or ineffective learning/training
Resource based	Stall dimensions, presence/absence of various materials to manipulate	Presence/absence of other animals, places to hide or retreat	Training equipment, e.g., prong collar, nose twitch
Management based	Frequency of introducing novel objects	Herd structure and size	Stockperson behavior, experience and training
Examples of mental state(s) inferred (Domain 5)	*Negatives:* Boredom, frustration, loneliness, feeling threatened, fear, anxiety, insecurity, helplessness, depression, neophobia, anger, fatigue	*Positives:* Interested, excited, pleasantly occupied, calm, in control, engaged, energized, focused	

Table 24.3. Examples of welfare-status and welfare-alerting indicators in each of Domains 1 to 4. All welfare-status indicators are animal based. Welfare-alerting indicators can be animal-, resource-, or management-based.

Domain	Welfare-status indicators	Welfare-alerting indicators
1 Nutrition/ hydration	Bodyweight, body condition, food-seeking behavior	Poor-quality food, empty water trough, inappropriate frequency of food presentation, variety of preferred foods presented
2 Physical environment	Shivering, panting, limping, skin lesions, squinting, reduced lying, use of shade	Cold ambient temperature, high levels of ammonia, frequent loud noise, availability of shade
3 Health	Limping, wound, labored breathing, fever, raised white blood cell count, playing	Sharp object in enclosure, surgical procedure with no analgesia, vaccination
4 Behavioral interactions	Avoiding certain humans, pacing, excessive grooming, actively engaging with toys or puzzles, playing	Poor knowledge of normal species behavior, demonstrating poor handling techniques, barren habitat, refuge/hides available, availability of toys or puzzles

ments, benchmarking, auditing, or certification schemes. The goal of compliance is to present a final value that can be compared to others or to a set of approved values in order to demonstrate that a threshold or standard has been met. Compliance-focused assessments often include a fixed set of indicators that reflect problems that are already well known in the context and are usually applied to groups of animals. As such, grading of welfare impacts (negative or positive) is not usually a goal of these sorts of assessments.

In contrast, welfare improvement assessments are less focused on an overall evaluation of welfare and more concerned with identifying features that could be improved upon or monitored over time for improvement or with comparing the impacts of different options or interventions. Unlike compliance-focused assessments, these aim to provide users with sufficient information to implement changes by modifying practices, or more broadly using extension or education programs. Therefore, the more detail that can be retained in the outcomes of assessment, the more targeted and effective changes can be.

The problems explored and the indicators used in improvement-focused assessments may be less pre-determined and evaluations can be undertaken at both individual and group level. In such cases, the generic schema of the model presented in Mellor *et al.* (2020) can provide detailed guidance

Table 24.4. Examples of recent applications of the Five Domains Model demonstrating its utility in a range of contexts and the main purpose of each assessment.

User/source	Application	Purpose of assessment
Beausoleil *et al*., 2023	Restructure existing commercial audit to align with Five Domains, improving understanding of what is assessed	Compliance
Boys *et al*., 2022, 2023	Identify welfare indicators for, and assess welfare state of, stranded cetaceans	Support policy development and decision making
Johnson *et al*., 2022	Identify on-farm improvements to provide opportunities for pigs to experience positive mental states	Welfare improvement
New Zealand National Animal Welfare Advisory Committee (NAWAC, 2023)	Assess the impacts of different farrowing housing systems on the welfare of sows and piglets	Risk assessment
New Zealand Thoroughbred Racing (2024)	Five Domains guiding principles used to inform development of more specific assessment protocols, identify areas for deeper scrutiny, research, or improvement	Welfare improvement
NZ SPCA Welfare Certified Programme (SPCA New Zealand, 2020)	Require certified farmers to meet standards exceeding minimum legal requirements, identify opportunities to promote positive welfare in animal production systems	Compliance
Sharp and Saunders, 2011	Assess the relative impacts of different vertebrate pest control methods to identify least harmful methods	Rank options, support decision making
Sherwen *et al*., 2018	Ongoing assessment and monitoring of zoo animal welfare	Welfare improvement
Wilkins *et al.,* 2024	Ongoing assessment and monitoring of companion animal welfare status by owners/ guardians using a digital 'app'	Welfare improvement

to the users about the kinds of evidence to explore in the various domains. In addition, there may be value in generating relative grades from such assessments to facilitate comparison of different options, interventions, or times to support decision making. A qualitative grading scheme has been developed for the Model to facilitate its use in contexts where overall welfare comparisons are desired, and structured versions of this approach have been frequently applied to Five Domains assessments, particularly for wildlife management (e.g., Sharp and Saunders, 2011). However, the aggregation process relies on 'scientifically informed good judgement' to create an overall score (Mellor and Beausoleil, 2015). While this qualitative aggregation technique is not accepted by all welfare scientists (Hampton *et al*., 2023), it is consistent with the conceptualization of animal welfare as a subjective mental state. The challenges and limitations of quantifying animal welfare and aggregating welfare measures are addressed in detail in Section 24.4.3.

24.3 The Importance of Domain 5 (Mental Experiences) and Its Proper Application

24.3.1 Importance and value of Domain 5, reflecting mental experiences

The defining feature of the Five Domains Model is that it requires users to interpret observable/measurable information about the animal's physical state and its interactions with its environment in terms of its own experiences. In other words, scientifically derived evidence, collated in Domains 1 to 4, must be used to infer the animal's unobservable/unmeasurable affective experiences, outlined in Domain 5. This approach aligns most closely to the 'affective state' orientation to welfare, according to which good welfare can be achieved when animals have few, minor, and/or transient negative mental experiences and have frequent and meaningful positive experiences (Mellor, 2015).

Other approaches to welfare assessment might collect the same observations or measures but balk

at using that information to draw conclusions about the animal's subjective internal state. In particular, assessments based on the 'biological functioning' orientation reflect only the extent to which the animal is healthy and functioning well (Fraser *et al*., 1997). In making inferences about mental experiences, caution is certainly advisable (see Section 24.3.2 below) but there are good reasons to emphasize the affective state orientation in welfare assessment. First, as noted above, affective experiences most directly link the animal's welfare state with its own perceptions and interpretations of various features of its world.

Second, affective experiences and biological functioning are dynamically related. In accordance with this, the structure of the Five Domains Model explicitly reflects the understanding that an animal's mental experiences arise due to processing of sensory information gathered about its physical state (internal bodily processes/biological functioning) and its external environment (Mellor *et al*., 2020). Most mental experiences inferred from indicators in Domains 1 to 3 are negative and associated with responses necessary for the animal's survival. Some such 'survival-critical' experiences motivate actions to avoid or mitigate potentially life-threatening conditions. For example, thirst or hunger motivate the animal to seek water or food, pain promotes persistent avoidance or guarding behaviors, and fatigue encourages resting during illness. In other cases, negative experiences accompany involuntary homeostatic responses, such as thermal discomfort during shivering or breathlessness until increased rate and depth of breathing restore blood levels of carbon dioxide. Survival-critical experiences are usually subserved by specific neurophysiological pathways.

In contrast, non-survival-critical, or 'situation-related', affects may arise due to the animal's perception of its situation, including the degree to which that situation provides opportunities to express agency (choice, control, and challenge) (Littlewood *et al*., 2023). These types of experiences may serve to motivate animals to seek other conditions or switch to another task (Heslop, 2024). Nonetheless, animals can be kept in situations that provide little or no choice or control and that severely restrict their ability to express agency, and they will survive and may even maintain physical health and productivity.

The Model's structure deliberately keeps measurable or observable states (Domains 1 to 4) and affective experiences (Domain 5) separate. This contrasts with other assessment frameworks such as Welfare Quality® or the Five Freedoms, in which observable physical states such as injury and unobservable affective experiences such as pain, distress, or 'positive affective state' are intermixed, making it more difficult to provide clear evidence and justification for conclusions drawn about welfare-relevant experiences (Beausoleil and Mellor, 2017). The Model also encourages users to show the links between the impacts (observable evidence in Domains 1 to 4) and the *specific* experiences to which those give rise (inferred in Domain 5) wherever possible. For example, injury to tissues gives rise specifically to the experience of pain, increased plasma osmolarity (dehydration) gives rise to thirst, while the absence of social contact in a gregarious species may give rise to loneliness. These are qualitatively different experiences with different causes and solutions, and they may have different significance for welfare state.

It may not always be possible to identify the specific quality of affect, but only that some kind of negative (or positive) experience is occurring. In particular, there may be insufficient scientific knowledge to confidently validate indicators of a specific affective state for a particular kind of animal, and this should be made clear (see section below: *Appropriate attribution of specific capabilities to the subject of assessment*). However, being specific about the animal's likely affective state, wherever possible, is useful as it facilitates targeted preventative or mitigating actions, helps those caring for animals understand the significance of their experiences, and identifies specific priorities for future research (Steiner *et al*., 2019). On the other hand, using generic terms such as 'stress', 'distress', and 'suffering' can be problematic in detailed scientific welfare assessments. Such terms are variously defined in different scientific fields and are difficult to recognize because they may have different primary causes and associated affective qualities (Beausoleil *et al*., 2018). For example, 'distress' or 'suffering' could be used to describe an animal experiencing extreme, prolonged, or overwhelming hunger, thirst, fear, pain, or boredom (Chapter 11, this volume). In the application of the Five Domains, such terms cannot be linked clearly to supporting evidence in Domains 1 to 4 and so do not support development of actions to improve welfare. Thus, for scientific welfare assessment, the use of specific terms makes it easier for users to transparently justify their conclusions about overall welfare state.

Third, the emphasis on affective experiences reflects many people's intuitive understanding of welfare in other beings (Mendl and Paul, 2004). As noted above, animal protection/welfare laws are infused with terminology that reflects animals' affective states – pain, distress, and suffering are all emotion-related terms mentioned in New Zealand's Animal Welfare Act (New Zealand Ministry for Primary Industries, 1999). As a society, we care about the affective states of animals. This is evidenced by the fact that consumers are convinced to buy 'higher welfare' products when they are labeled as coming from 'happy cows/chickens/pigs', and companion animal owners focus much attention on ensuring their animals are 'happy' (Serpell, 2019; Furtado *et al*., 2021). Recognition of the ability to have affective experiences may also influence whether people think an animal has a mind; if an entity is perceived to have a mind, it is more likely to be valued and protected (Gray *et al*., 2007). Focusing attention on the animal's mental experiences may increase our sense of responsibility to evaluate welfare impacts at all, to genuinely include the knowledge gained in decision making about animal management, and to give animal welfare more appropriate prominence in those decisions than is often apparent (Beausoleil *et al*., 2018).

Although the Five Domains Model emphasizes animals' affective states, it also incorporates aspects of the other main orientations to understanding animal welfare: biological functioning and naturalness (Fraser *et al*., 1997). Domains 1 to 3 align with the biological functioning orientation as they facilitate assessment of the extent to which the animal is healthy and functioning well. However, good biological function alone does not ensure good welfare. For example, animals housed in ways designed to maximize their health and functional capacity may have fewer opportunities to exercise agency.

Domain 4 aligns most closely with the natural living orientation, which focuses on the 'naturalness' of the animal's environment and/or its ability to express its full range of natural behavior (Fraser *et al*., 1997). Although Domain 4 does not directly consider the 'naturalness' of an animal's life, it focuses on the extent to which animals are able to exercise agency. It is often proposed that environments more like the animal's natural habitat provide more opportunities for appropriate challenge and control and thus facilitate the expression of highly motivated and rewarding behaviors (Veasey, 2017). However, naturalness alone does not mean good welfare (Learmonth, 2019). The natural environment can pose risks to welfare due to predation, competition, and thermal challenge. Additionally, domestic species are often physically and behaviorally different from their ancestors and may be better suited to the captive than wild environment. By incorporating aspects of all three main orientations, the Five Domains Model overcomes many of the limitations of considering welfare from a single perspective alone.

24.3.2 Key points for proper application of Domain 5

Understanding and depicting the essential relationship between the first four domains and the mental experience domain

The first key point for proper application of the Model is to recognize that Domain 5 is not separate from the other domains, and evidence separate or additional to that compiled in Domains 1 to 4 is not used to evaluate the animal's likely mental experiences. This potential misunderstanding is reflected in some visual depictions of the Model, which present the fifth domain on the same level of hierarchy (either linearly or on a circle) as the other four domains. Such depictions encourage users to consider mental experiences separately from the evidence of impacts in Domains 1 to 4, which is not possible in reality as those experiences cannot be observed or measured directly, i.e., with different information from that used to evaluate impacts/opportunities in Domains 1 to 4. Even if the creators of such figures do understand proper application of the Model, such arrangements of the domains can be misleading to others who do not.

Thus, it is incorrect to talk about Domains 1 to 4 of the Model representing the animal's physical welfare/well-being while Domain 5 represents its psychological or mental well-being. The animal's psychological or mental well-being is the *result of* the physical, environmental, and interactive factors that give rise to or influence its mental or affective experiences. The desire to represent an animal's physical and mental well-being separately may reflect the intuitive understanding that it is not just the animal's biological function (largely captured in Domains 1 to 3) that influences its welfare but also non-survival-critical experiences, such as frustration, boredom, fear, anxiety, loneliness, and others, that relate to its perception of its environment and its interactions with other

animals. The environmental and behavioral factors giving rise to these kinds of affective experiences can be considered and evidenced using Domain 4 in the same way that physical or functional impacts can be evidenced in Domains 1 to 3.

To discourage this type of misunderstanding, we recommend using depictions of the Model that make those relationships clear. Figure 24.2 shows a suggested arrangement to facilitate accurate understanding of the Model for public/laypeople although it is not useful for collating the detailed information needed to scientifically support evaluations undertaken using the Model.

Appropriate selection of animal type for Five Domains assessments

Because the Model is predicated on inferences of mental/affective experiences to understand animal welfare, a fundamental consideration is whether the subject of assessment is, in fact, capable of any welfare-relevant experiences, i.e., is it sentient? This issue is particularly topical for insects, which are produced and used in vast quantities as animal and human food and whose farming is likely to become more prevalent in future. Current evidence does not conclusively support the occurrence of sentience in insects as a broad taxon (Barrett and Fischer, 2023). This position is reflected by the extremely rare coverage of any invertebrates other than cephalopod molluscs and decapod crustaceans in animal welfare legislation (Delvendahl *et al.*, 2022).

Thus, at present, it would be inappropriate and potentially lead to spurious conclusions and actions to use the Model to assess insect welfare, as it relies on a poorly supported assumption of sentience. However, as in other taxa (Billington and Cerqueira, 2020), there is likely to be substantial variability in sentience-relevant capabilities among insect families and species which is yet to be investigated. As more ecologically salient approaches to understanding cognitive and emotional abilities in animals develop (Godfrey-Smith, 2017), the discovery of welfare-relevant mental capabilities in insects and other invertebrates may warrant evaluation using models such as the Five Domains.

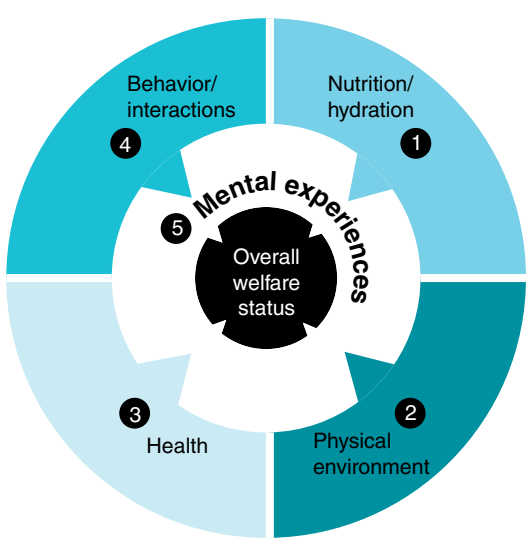


Fig. 24.2. Suggested visual depiction of the Five Domains Model for laypeople. Note, the arrangement shown in Fig. 24.1 is more useful for laying out the detailed evidence supporting scientific assessments using the Model. (Created by E. Hendrikse, used by permission.)

Appropriate attribution of specific capabilities to the subject of assessment

Related to the caveat above, users of the Model have a responsibility to provide evidence that the animal subject of their assessment is capable of any *specific* mental experiences being inferred. For example, while there is strong scientific support for the ability of many nonhuman mammals to experience forms of breathlessness (respiratory discomfort; Beausoleil and Mellor, 2015), there is no information to support or refute analogous experiences in birds or fish. Likewise, whether rodents or ruminants can experience nausea or motion sickness is unclear. This process is important to guard against claims of anthropomorphism, which could weaken confidence in the outcome of welfare assessments. It is also important to avoid under- or over-estimating the impacts of management on animal welfare. For example, if birds are not capable of breathlessness associated with inhaling higher-than-normal levels of carbon dioxide, breathlessness-related welfare compromise would not provide grounds for moving away from using such gases for commercial stunning.

When there is insufficient scientific evidence to support such claims for a particular type of animal, but value in presenting proposed affects, users may provide a standardized indication of their confidence in the inference, based on the available data. This approach has been used in Five Domains-based

assessments of the relative welfare impacts of vertebrate pest control methods (e.g., Beausoleil *et al*., 2016) and other wildlife management activities (e.g., Colloff *et al*., 2024). This approach is valuable for addressing concerns about anthropomorphism, ensuring conclusions drawn are transparently supported, and stimulating targeted research on animals' mental experiences if knowledge is lacking. However, it is acknowledged that there are sensation-related mental states in animals not experienced by humans that we are unlikely ever to be able to validate, e.g., pleasures of flying, magnetic perception, or echolocation.

Five Domains assessments can only ever produce qualitative information

Briefly, the results of Five Domains assessments should always be presented as qualitative. This is because the outcomes, while based on observable/measurable variables, reflect an interpretation of that information in terms of what those mean to the animal. As the inferred states in Domain 5 are not directly observable, they can never be validated in the truest sense. Thus, to suggest any degree of precision or accuracy in the outcomes would be misleading, and only indicators of the relative impacts (negative or positive) are genuinely possible.

Further, to suggest that we can precisely quantify and quantitatively integrate the various negative and positive affective experiences of an animal is unrealistic. Even for negative experiences, we do not know how to compare qualitatively different affects and integrate information on the intensity and duration of those experiences. For example, is moderate pain worse than moderate breathlessness? Likewise, is moderately intense pain experienced for a long time worse or better than extreme pain experienced for a short time? Until we can develop a common metric for unpleasantness, such questions will remain unresolved, and the outcomes of welfare assessments founded on affective states will remain fundamentally imprecise. Further discussion can be found in Beausoleil and Mellor (2015), Harvey *et al*. (2020), and Mellor *et al*. (2020), and in Section 24.4.3 regarding the challenges of aggregation in welfare assessment.

Five Domains assessments do not decide what is acceptable or unacceptable

Finally, it is important to note that welfare assessments undertaken using the Model simply provide science-based information to support ethical decision making about the use or management of, or interactions with, animals. The Model does not, as has sometimes been suggested, *decide* what is acceptable or not acceptable or permit or prohibit any particular option or practice evaluated. As noted above, the outcomes of the Model are qualitative and relative only to other options or time points evaluated (Sharp and Saunders, 2011). Thus, users can integrate this information about relative welfare impacts into broader decision making about whether, when, and how animals are managed.

24.4 Challenges of Assessing Welfare Using the Five Domains Model

24.4.1 Mental states are subjective and cannot be validated

As noted above, the states of ultimate interest to welfare assessment using the Five Domains Model are subjective, inaccessible mental states. Even human mental states, where verbal self-report is possible, are difficult to study. For example, human experiences of pain can differ and depend on many factors (Rhudy and Meagher, 2000). It stands to reason that animal experiences are even more challenging to study and infer.

Dawkins (2001) uses the analogy of a shaky bridge over a river to describe inferences about mental states in animals. In the bridge analogy, we move from the 'firm ground' of objective 'scientific' evidence across a shaky bridge of inference to the 'unknown' of consciousness, sentience, and mental experience on the other side. This analogy presents a reductionist view of animal welfare science, whereby only the measurable or observable are open to scientific study. This challenge has led some animal welfare scientists to suggest that we move our evaluations away from mental experiences in animals, to reduce the risk of being 'unscientific' (Dawkins, 2021; Hampton *et al*., 2023). However, this is unsatisfyingly incomplete for many (e.g., Birch, 2022; Browning and Veit, 2023) and the problems of focusing only on animals' biological function or on the naturalness of their environments or behavior have been outlined above.

In an attempt to provide a structured approach to validating inferences of subjective experiences, Beausoleil and Mellor (2017) presented a two-step protocol. The first step explores the evidence supporting the link between the proposed indicator

and the animal's physical state while the second explores the less often available evidence for the link between the physical state and a mental experience. This approach works well for survival-critical negative experiences with clear neurophysiological mechanisms but is not well suited to validating indicators of situation-related (Domain 4) or positive experiences for the reasons outlined in the next section.

Browning (2023) devised a different multi-step approach to validating indicators of subjective welfare states. This involves examining correlations between 'causal indicators' and 'effect indicators'. Causal indicators are those that cause the subjective state of interest (i.e., environmental or resource-based indicators). Effect indicators arise as a consequence of the target state (i.e., animal-based indicators). If cause and effect indicators vary in the same way in response to a range of conditions and interventions, this supports a correlation between the proposed indicator and the target subjective state. This process is repeated with other casual indicators to triangulate correlations for the proposed indicator, building the strength of validity. This form of validation is better suited to evaluating indicators of generalized negative or positive welfare states, rather than specific affects.

Another approach is to use Expert Knowledge Elicitation (European Food Safety Authority, 2012) to achieve consensual validity for inferred affects in Five Domains Model assessments. This involves gathering a group of stakeholders with a range of complementary expertise (e.g., in animal welfare science, physiology, behavior, veterinary science, animal management, species biology) to use the available scientific evidence and their expertise to collectively infer the mental experiences, and thus impacts of, specified procedures or conditions on the welfare of the focal animal(s). This approach can facilitate systematic, evidence-based and repeatable welfare assessments, as long as explicit information is provided about the selection of the panelists, the source data and the processes used to develop the results. It has been applied to explore the relative welfare impacts of pest control and other wildlife management activities (e.g., Colloff *et al*., 2024) and the validity of indicators of stranded whale welfare state and survival likelihood (Boys *et al*., 2022). As noted above, the panel assigning confidence scores to reflect their degree of certainty about the inferences made using the data also helps to retain scientific rigor (Beausoleil *et al*., 2016; Harvey *et al*., 2020; Wilkins *et al*., 2024).

24.4.2 Indicators of situation-related and positive affective experiences are especially difficult to validate

The original focus of welfare assessment was recognizing and mitigating physical states that impair the health and productivity of farmed animals and the associated negative experiences (Harrison, 1964; Brambell, 1965). As our understanding of animals and their welfare states has advanced, and societal expectations about our treatment of animals have changed, we are increasingly focusing on non-health-related impacts on welfare and on positive mental experiences. However, recognizing and supporting inferences of non-survival-critical affects and of positive experiences remains a significant challenge.

As noted above, mental experiences inferred from indicators in Domains 1 to 3 are usually negative and associated with responses necessary for the animal's survival. These survival-critical negative experiences are usually subserved by specific neurophysiological pathways, the presence of which, and activity within, provide relatively strong support for inferences of the associated mental experiences (Beausoleil and Mellor, 2017). In addition, the physiological and behavioral indicators of many such affective states are well understood. As a result, successful interventions or legal actions for animal cruelty or neglect usually relate to this kind of negative affect.

As noted above, the inclusion of Domain 4 acknowledges the possibility that healthy, productive animals may still have poor welfare states. However, validating inferences of situation-related affects in Domain 5, such as loneliness, boredom, and frustration, is more challenging. These affects often do not arise due to simple activation of a specific neurophysiological pathway and the affective significance of, and behavioral responses to, a given situation are likely to vary substantially, even among individuals of the same type (Heslop, 2024). This makes it much more difficult to provide evidence to support improvements or legal actions on the basis of animal suffering caused by situation-related affects (Ledger and Mellor, 2018).

For similar reasons, indicators of positive experiences have proven difficult to validate. Animals apparently deprived of opportunities for positive

experiences often remain healthy and productive. In addition, in contrast to the relatively 'universal' affects necessary for survival (e.g., hunger, thirst, pain), what one individual perceives as positive, another may not. Nonetheless, it is now commonly acknowledged that good or acceptable animal welfare states cannot be achieved by simply avoiding or mitigating negative experiences (Mellor, 2015). Thus, significant scientific attention is being paid to systematically identifying and validating indicators of positive experiences (e.g., Keeling, 2019).

A further challenge is the difficulty of assigning specific qualities to positive experiences. For example, when animals have opportunities to exercise agency and engage in highly motivated behaviors, how do we name the particular mental experience that results from this engagement? Positive mental states have usually been named after the behavioral interaction itself (e.g., playfulness, sexual gratification). Alternatively, it may be sufficient to name these mental experiences 'positive affective engagement' (Mellor, 2015; Littlewood *et al*., 2023). As noted above, named experiences help focus development of mitigation strategies, but mitigation is not required for positive mental states. Instead, we should aim to provide animals with opportunities to exercise agency through choice, control, and challenge. The resulting mental experience(s) may not need to be specifically named, provided we can find ways to demonstrate that some positive state is occurring.

24.4.3 Problems of aggregation

While systematic consideration of the multiple factors that can influence welfare state is a key strength of Five Domains assessments, it also presents the challenge of appropriate aggregation. For some purposes, the goal of assessment is to compare overall welfare state across different groups of animals, different management systems or procedures, or for the same animal(s) over time. Thus, aggregation to provide a single metric reflecting overall welfare state is particularly desirable for benchmarking, auditing, and certification schemes, and policy decisions often rely on a single aggregated metric (Browning, 2022a,b).

The problem of aggregation is not at all unique to Five Domains Model assessments; it is a challenge to be considered for any multi-dimensional approach to understanding animal welfare (Sandoe *et al*., 2019). Yet, attempting to avoid this problem by using single, 'universal' measures such as fitness metrics (e.g., reproductive success) or biomarkers of stress may be problematic in different ways, including a lack of sensitivity or 'dose dependency', problems of validation, and challenges of differentiating effects on the marker due to experiences of negative or positive valence (Bateson, 2015; Babington *et al*., 2024). In addition, reducing animals' experiences to a single summary value is likely to be unsatisfactory to many and may reduce people's empathy towards animals and hamper attempts to understand and improve various aspects of their lives.

Aggregation when using the Five Domains Model is problematic at multiple levels. Within a single domain, how should information on the actual status of the animal be integrated with information about risks to welfare? For example, how should welfare-status (animal-based) and welfare-alerting indicators be integrated? Some multi-dimensional assessment protocols keep welfare-status and welfare-alerting indicators separate and present two outcomes – one reflecting risks to welfare and another reflecting the animal's current state (Harvey *et al*., 2023). The former would highlight areas of welfare risk and focus on areas requiring further investigation (Sherwen *et al*., 2018). Accordingly, Dalla Costa *et al*. (2016) used a two-stage process, whereby the first stage is primarily made up of non-animal-based indicators that can alert users to the need for a second-stage assessment using more animal-based indicators. Each stage can be treated as separate occurrences, negating the need for aggregation, or the second stage can build on the first. Another approach is to give all indicators equal weight in the domain 'score or grade' and acknowledge the likelihood that welfare impacts will be overestimated (e.g., Serres *et al*., 2024).

Within a single domain there is also the question of how multiple impacts should be aggregated. To illustrate, how should evidence of insufficient ventilation in hot weather and dirty substrate underfoot be aggregated to understand the physical impacts on the animal in Domain 2? This challenge is amplified when aggregation is attempted across domains – how might simultaneous starvation (Domain 1) and injury (Domain 3) affect the animal's welfare overall? Several studies evaluating the impacts of vertebrate pest control using a Five Domains approach have addressed this issue by taking the highest qualitative impact grade from Domains 1 to 4 (none to extreme; reflecting intensity of

impact) and using that to assign the intensity grade in the mental domain (whilst noting the various specific affective qualities that might contribute to that overall grade) (e.g., Beausoleil *et al*., 2016; Baker *et al*., 2022). This approach assumes an intense negative experience will dominate the animal's consciousness, which may be appropriate in the context of lethal pest control where all effects are negative (Beausoleil and Mellor, 2015). However, it fails to account for the possibility that other negative experiences may amplify the intensity of the overall experience or for the potentially modulating effects of any positive experiences that may occur in other contexts. While clearly imperfect (Hampton *et al*., 2023), this approach seeks to avoid implying precision in understanding mental experiences and focuses rather on the relative impacts of different options.

Alternatively, weightings may be applied to different indicators or even domain scores in the generation of overall grades. If this approach is taken, key questions are who should decide on the relative weighting and how? Sandøe *et al*. (2020) present an approach in which experts decided the relative importance of different features of sow management and then applied those weightings to generate scores for different management systems. But the argument is made that different experts or non-experts might prioritize or emphasize different aspects of animals' welfare and thus come up with different weightings, which could lead to dramatically different outcomes and management decisions.

Related to this, compliance-focused assessments sometimes use 'iceberg indicators' to alert assessors to the risk of broader welfare problems. Most often these indicators are derived by looking at correlations between the individual indicators and the overall outcome measure using multiple indicators. However, the approach to weighting of various individual measures in the calculation of the overall value has been shown to have a large impact on the predictive value of iceberg indicators, and the finding that a single measure (particularly a resource-based measure) is a major driver for characterization of overall welfare arguably negates the value of multi-dimensional assessment (Heath *et al*., 2014).

Aggregation in Domain 5 is further complicated by the inclusion of negative and positive affective states. Do positive experiences cancel out negatives? Does a greater number of positive than negative experiences equate to overall positive welfare? Again, the issues of quality and relative intensity of different affective experiences further complicates any attempt at aggregation. By grading welfare compromise and enhancement separately, the Model's grading scheme aims to overcome the issue of aggregating differently valenced affective states but is still subject to problems of aggregating affective experiences of differing quality and intensity (Mellor and Beausoleil, 2015). Related to this, a final challenge is that of how to aggregate the individual's welfare state over time to give an integrated reflection of the impacts of various events, procedures, or conditions in sequence, or even an overall reflection of its quality of life.

Aggregation is problematic across individuals within a group or population of animals (Sandøe *et al*., 2019), a problem that will not be addressed even by using single universal measures of overall welfare state. For example, averaging scores at group level allows good/high scores for some individuals to cancel out or compensate for poor/low scores for others. In welfare risk assessments, using the Five Domains Model, one approach has been to very specifically stipulate the scenario being assessed, which is usually the best application of a procedure (e.g., Colloff *et al*., 2024). However, this does not account for real-life variation in the animals' responses to, or experiences of, that procedure. Nor does it reflect the effects or prevalence of deviations from best practice in reality. Another approach in risk assessments has been to try to integrate the range of possible impacts, based on data reflecting the prevalence of real-life outcomes for different events such as injuries. This approach was attempted when evaluating the risks of different housing systems on sow and piglet welfare (National Animal Welfare Advisory Committee, 2023).

Finally, aggregation may be avoided altogether. This may be feasible if the purpose of the assessment is to improve welfare but is unlikely to be accepted for compliance purposes. What is clear is that there are ethical implications to any approach to aggregation when multiple facets of welfare are assessed or when aggregation is attempted across groups of animals (Sandøe *et al*., 2019). For the reasons outlined above, we strongly suggest that mathematical manipulations such as averaging not be undertaken. Perhaps the best we can do at this stage is to be completely transparent about the mechanisms of aggregation and the limitations of our interpretation and application of the outcomes of aggregated assessments.

24.5 Conclusions

The Five Domains Model is a multi-dimensional approach to understanding and assessing animal welfare that is based on the 'affective state' orientation. As such, the fifth, mental experience, domain is given greatest emphasis as affective experiences most directly link the animal's welfare state with its own perceptions and interpretations of various features of its world. However, the Model incorporates aspects of the other two main orientations to understanding animal welfare; biological functioning is represented in Domains 1 to 3 and naturalness, indirectly, in Domain 4.

It is important for users of the Model to understand that Domain 5 is not separate to Domains 1–4, and it is not necessary or correct to collate additional evidence to evaluate mental experiences. Rather, evidence of impacts or opportunities collated in Domains 1 to 4 is used to infer likely mental experiences in Domain 5, i.e., mental experiences arise from the physical, environmental, and interactive factors addressed in Domains 1–4. The Model encourages users to show the links between the observable evidence in Domains 1 to 4 and the specific experiences to which those give rise (inferred in Domain 5) wherever possible. Showing evidence of these links and using specific terms to describe the likely affects makes it easier for users to transparently justify their conclusions about welfare state.

As the Model is based on inferences of mental/affective experiences, it should only be applied to evaluate the welfare of sentient animals, i.e., those with the capacity to have subjective experiences that matter to them. Where scientific evidence for sentience in a species is lacking or equivocal, it would be inappropriate to use the Model to assess welfare. Similarly, inferences about specific mental experiences in the target animal should be made cautiously, and only in cases where there is strong scientific evidence to support the capacity for such experiences.

Whilst a key strength of the Model is the systematic consideration of multiple factors that can influence welfare state, this poses challenges when it comes to integrating different pieces of information about welfare status. There is currently no scientifically validated method of aggregating information about mental states of different quality, intensity, or duration within an individual animal, let alone at the group level. This problem is not unique to the Five Domains Model, but common to all multi-dimensional approaches to welfare assessment. Whilst some strategies for dealing with aggregation issues have been discussed in this chapter, we strongly recommend that quantitative approaches be avoided and, where they are deemed necessary, that the processes involved are explicitly and transparently reported.

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25 Psychological Trauma as a Form of Animal Cruelty: Advancing the Use of Scientific Evidence Under the Law

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> '[Let us] move toward compassion and away from cruelty, to feel empathy rather than cold indifference, to feel animals' pain in our hearts.'
>
> (Bekoff, 2007)

Regrettably, in our current world, some humans treat animals with cruelty and neglect. In our work with thousands of victims of animal cruelty and neglect, we have seen profound and enduring psychological suffering caused by the traumatic experiences they have lived through. In some cases, this leads to the death of the animal as surely as if they had been killed outright by the abuser, because the animal's quality of life is so poor, living in a state of perpetual terror that is refractory to behavioral rehabilitation, that euthanasia becomes the only humane endpoint to terminate their suffering. Why would an abuser not be charged with animal cruelty for the incapacitating psychological harm they had inflicted on the animal? We believe that as our understanding of animal emotional states advances it is time for the legal system to recognize psychological harm and trauma as a legally cognizable form of animal cruelty. This chapter will review how animal cruelty statutes can potentially encompass psychological harm, briefly review the ample and growing body of scientific literature concerning behavioral and physiological indicators of psychological trauma, and provide recommendations on how we can move toward compassion in the application of animal cruelty statutes. We will limit our discussion to the situation in the United States, recognizing that laws and regulations may differ – being both less and more restrictive – in other localities.

25.1 Animal Cruelty Laws

Well into the 19th century, the American legal system treated animals solely as property without legally protected interests of their own. There was a significant shift beginning in the second half of the 19th century, which accelerated in the 20th, towards recognizing that animals themselves deserve some legal protection (for an overview of the history of animal protection laws see Favre, 2024). Today, all 50 states and the District of Columbia (DC) have anticruelty statutes that prohibit both affirmative acts of cruelty and omissions (e.g., neglect), such as the failure to provide some minimum standard of care. In addition to misdemeanor penalties, all contain felony provisions that typically apply to the most egregious acts of cruelty or when there are one or more subsequent misdemeanor convictions. Other standard prohibitions in these statutes include abandonment, animal fighting, and sexual abuse of an animal.

Some state felony cruelty provisions are worded to explicitly require proof of *physical* injury. Tennessee's felony cruelty provision is one such example:

> (a) A person commits aggravated cruelty to animals when, with no justifiable purpose, the person

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> intentionally or knowingly: (1) Kills, maims, tortures, crushes, burns, drowns, suffocates, mutilates, starves, or otherwise causes serious *physical* injury, a substantial risk of death, or death to a companion animal; or (2) Fails to provide food or water to the companion animal resulting in a substantial risk of death or death.
>
> (Tennessee General Assembly, 2012; emphasis added)

More commonly, however, many state misdemeanor and some felony cruelty laws use ambiguous and undefined terms that provide an opening for legally viable arguments that acts or omissions that result in psychological harm to animals are cognizable under existing laws. Commonly used terms in cruelty statutes such as 'torment', 'pain', 'suffering', 'injury', 'mistreatment', 'sustenance', and even the term 'cruelty' itself, in the absence of statutory definitions that expressly require physical injury, present opportunities to advance the law based on the growing scientific understanding that human acts or omissions can result in psychological injuries to animals that may be more severe and longer lasting than physical ones, and therefore should be actionable under current cruelty statutes that are intended to protect animals from abuse and mistreatment. A 2005 New York case (People v. Mahoney, 2005) provides an example of how a court interpreted an undefined and vague term in the state cruelty statute, ruling that 'sustenance' includes the provision of veterinary care.

The DC's misdemeanor cruelty law is an example of an ambiguous statute in which the terms 'torment' and 'cruelty' are not defined. However, DC law (Council of the District of Columbia, 2024) also sets forth prohibited conduct of owners and custodians of animals:

> A person shall not sponsor, promote, train an animal to participate in, contribute to the involvement of an animal in, or attend as a spectator, any activity or event in which any animal engages in unnatural behavior, is wrestled or fought, mentally or physically harassed, or displayed in such a way that the animal is struck, abused, or mentally or physically stressed or traumatized, or is induced, goaded, or encouraged to perform or react through the use of chemical, mechanical, electrical, or manual devices, in a manner that will cause, or is likely to cause, physical or other injury or suffering.

By its terms, this provision of the DC's law applies to the sponsorship, promotion, and training of animals for activities and events. However, even if those elements are not present, the inclusion of mental stress, suffering, and trauma provides evidence that the legislature intended non-physical harm to be actionable under its animal protection laws and allows for a persuasive argument that such harms should be cognizable under its misdemeanor cruelty law.

Illinois provides another instructive example. Its misdemeanor cruelty statute provides that '[n]o person or owner may beat, cruelly treat, torment, starve, or otherwise abuse any animal' (Illinois General Assembly, 2016a). 'Cruelly treat', 'torment', and 'abuse' are not defined. However, Illinois's provision on owner duties states:

> Each owner shall provide for each of his or her animals: (1) a sufficient quantity of good quality, wholesome food and water; (2) adequate protection and shelter from the weather; (3) veterinary care when needed to prevent suffering; and (4) humane care and treatment.
>
> (Illinois General Assembly, 2016b)

In a 2020 Illinois case (People v. Kirkpatrick, 2020), which involved a dog that had sustained physical injury, the court stated, '[al]though "suffering" is not statutorily defined, the term's plain and ordinary meaning has been recognized as "experiencing physical pain or emotional distress".' The court drew this conclusion based on an earlier human case (People v. Debra V., 2016) where it determined that in the absence of a statutory definition in the Mental Health Code, it would 'give the word its plain and ordinary meaning', citing, among others, *Black's Law Dictionary* (Black and Black, 1990), which defines '"pain and suffering" . . . to describe not only physical discomfort and distress but also mental and emotional trauma'.

25.2 What Is Psychological Trauma/ Harm? (see also Chapter 12, this volume)

In an investigation of an overwhelmed animal rescue/large-scale hoarding situation in North Carolina, we discovered a mature chestnut Warmblood gelding in a box stall. The stall, approximately 12' ×12', consisted of wooden walls on three sides and an inside wooden wall with a sliding door topped with vertical metal bars. Gaps between the bars permitted olfactory and visual access to the barn aisle, but the horse could not put his head outside the stall. The stall was dimly lit by a small filthy window on the outside wall and a hole in the roof. The horse was unable to see other animals. The sanctuary's[1]

records indicated the horse had been in that box stall with no turnout to a pasture for several years. For the time we were there, the horse engaged in highly abnormal behavior. He repeatedly circled the stall, stopping at the same spot each time to bob his head up and down and rake his teeth against the wooden wall, then he resumed the circling in a continual cycle of stereotypic behavior.

It is unnatural for a horse to be kept in isolation where it cannot even see other animals, much less interact with them; the literature supports the claim that social contact is a basic need in horses (Krueger *et al*., 2021). Furthermore, horses normally devote a significant portion of their time to grazing, which involves moving and eating (Houpt, 2005). Long-term confinement to a box stall with no turnout drastically alters a horse's ability to behave normally (Mills, 2005). Animal behaviorists have long used stereotypic behavior to indicate current or prior psychological distress (Mason and Latham, 2004). Regrettably, in this case, the horse was too psychologically damaged by his experience. Being unable to recover from his trauma even when he was placed in an appropriate and enriched environment, he continued to engage in repetitive movements.

The horse exhibited classic signs of mental disturbance, or what we call psychological harm or trauma (we use harm and trauma interchangeably). We define psychological trauma as lasting harm or damage that results from exposure to stressors and experiencing significant distress. The harm can take the form of both behavioral deficits and physiological changes. What constitutes distress for an animal?

25.2.1 Stress and distress (see also Chapter 11, this volume)

Stress is challenging to define because terms are used confusingly and inconsistently across disciplines and authors (Koolhaas *et al*., 2011). Stress is a general label for the biological response that occurs when an animal perceives a threat to its homeostasis (its stable internal bodily systems). The threat is called a stressor. Stress is not necessarily bad – humans and animals sometimes seek stress in the form of thrill or sensation seeking (Zuckerman, 1984) – but, in general, stress is perceived as negative. This is typically when the term 'distress' is used. The implication is that an animal in distress suffers from harm or poor welfare.

Animal mistreatment can take the form of an acute or chronic stressor. An acute stressor could be a single incident of physical abuse by a caretaker. Animals can often cope with an acute stressor if it is short-lived. However, even a single adverse event can have long-term repercussions if sufficiently severe. If a stressor persists to the point that it becomes chronic, the impact tends to be more detrimental. Chronic stress can result from repeated adverse events (or the frequent threat of such events), such as recurrent fights between conspecifics, or prolonged, unrelenting stressors, such as highly restrictive confinement, a barren environment, or social isolation.

A distinction is also made between neurogenic and psychogenic stressors. Neurogenic stressors necessarily involve a physical insult, such as untreated wounds on a fighting dog or a nutritional deficit from an inadequate diet in a cat. Psychogenic stressors are purely psychological, such as a cat fearing a physical beating from its owner or a subordinate dog anticipating being attacked by a more dominant animal. Both elicit a similar biological stress response, but counterintuitive as it may seem, psychogenic stressors may be more damaging than neurogenic stressors because they can lead to long-lasting generalized anxiety (Agorastos *et al*., 2019). Many stressors have elements of both physical and psychological stress, such as a dog confined in a commercial breeding establishment (CBE, also known as a 'puppy mill' or 'puppy farm') by itself in a barren cage and enduring chronic pain from neglected dental disease.

When stress progresses to distress is far from straightforward (see Chapter 11, this volume, for a thorough examination of the concept of distress). For our purposes, we prefer the definition that McMillan (Chapter 11, this volume) proposes: Distress may be conceived of as 'a conscious, highly unpleasant, intensified affective motivational [state that occurs] in response to a perception that current coping mechanisms (involving, in part, physiologic stress responses) are at risk of failing to alleviate the aversiveness of the current situation in a sufficient and timely manner.' In other words, an animal in distress experiences negative emotions and is at risk of continuing to do so, at least while the stressor endures.

Understanding what constitutes distress is important because distress is often equated with suffering (e.g., Chapter 11, this volume), and many cruelty statutes include the phrase 'pain and suffering'. This phrase couples together two related, but distinct

phenomena. Pain is a physical phenomenon involving sensory receptor cells that, when activated, generate a signal transduced via afferent neurons, reaching the brain and providing critical information regarding physical harm to the animal (De Ridder *et al*., 2021). The crucial distinction is that pain is primarily an acute sensory experience tied to a specific insult to the body, which is neurobiologically separable from suffering; pain can, however, lead to suffering 'via cognitive, emotional, and autonomic processing' (De Ridder *et al*., 2021). Whether or not pain causes suffering is related to several features, including the intensity and duration of the sensory stimulation and individual differences (Appleby and Sandøe, 2002). Most importantly, pain is not required for suffering to occur. Various negative emotional states exist that, when very intense or chronic, cause suffering, such as chronic hunger, thirst, frustration, etc. (Dawkins, 1990). Physically preventing exploratory and goal-directed behavior as occurs in tethering or constant crating, for example, can lead to frustration (McPeake *et al*., 2019), rage (Panksepp, 2005), and, eventually, alterations to the reward pathway that render the animal unable to experience positive feelings (anhedonia), listlessness, and cognitive impairments (Huys *et al*., 2013). The psychological suffering that results from physical pain should be treated the same as the pain itself: it should be evaluated as if such actions were committed upon a person. In children, no form of abuse or neglect is believed to occur without coexisting fear, terror, anxiety, loneliness, hopelessness, helplessness, or other negative emotional state, and emotional harm is now widely considered the common factor and major destructive force underlying all forms of abuse and neglect (Monteleone, 1996; Oates, 1996). Thus, in animals, adverse events such as beating, shooting, stabbing, burning, drowning, and asphyxiating should be considered as causing both physical pain and psychological suffering.

Given that we cannot know in advance what a specific animal might find traumatic, the authors think that we should adhere to the recommendation made by Gregory (2004): we ought to look at the human experience to gauge what an animal might feel in a similar situation. This is congruent with the American Veterinary Medical Association's stance that if a procedure is painful to a human, it must also be painful to an animal. Likewise, if a human finds a situation traumatic, it is likely that an animal will as well.

If we accept that an experience psychologically traumatic to people would likely be traumatic to animals, then we have a starting point for categorizing the types of adversity inflicted by people upon animals for which cruelty charges could be applied. The types of acute adverse experiences we consider potentially psychologically traumatizing are physical abuse, sexual abuse, emotional abuse (e.g., terrorizing, abandoning, and socially isolating), and organized fights between dogs. If sufficiently severe, these experiences can result in long-term deficiencies, including alterations to emotional regulation and stress responses, decrements in physical health, and cognitive deficits. However, typically, these are not one-time events but instead occur repeatedly. Other types of chronically stressful conditions that we argue are potentially psychologically harmful involve animals' living conditions, such as highly restricted confinement, barren or impoverished living environments, extreme overcrowding (especially when it leads to frequent fighting over access to limited resources), and disrupted circadian rhythms and sleep deprivation from constant stimulation or continuous light or dark. Combinations of neurogenic and psychogenic stress are also common: prolonged food or water deprivation, pain from untreated injuries or illness, confinement in unsanitary environments, inadequate housing that exposes animals to excessively hot or cold temperatures, and inclement weather.

25.3 Relevance of the Stress Response for Documenting Negative Affective States in Animals

What constitutes a stressor varies considerably across species and even individuals within a species. Age, sex, experience, and genetics all play a role in an animal's response to stress. For instance, there is some evidence that males are more sensitive to prenatal stress than females, but throughout the lifespan, females are more susceptible to stress than males (Bale and Epperson, 2015). Female dogs display behavioral and physiological indicators of distress more often and for longer than males when experiencing an acute traumatic event (Bodnariu, 2008). Socialization history is another important factor influencing what an animal finds stressful. Numerous studies have found that, when animals were inadequately socialized with humans during development, they reacted with extreme stress when later handled by an unfamiliar person (Rooney *et al*.,

2016). Research is even revealing that some dog breeds are more susceptible to stress than others (Momozawa *et al*., 2020; Pongrácz *et al*., 2020).

The high intra- and interindividual variability in behavioral responses to stressors poses a significant challenge when trying to make a legal argument for the existence of psychological harm. One animal may exhibit dramatic distress responses, while another, exposed to the same conditions or experiences, might be highly resilient (for more on resilience in animals, see Chapter 13, this volume). For example, the authors assessed 91 mixed-breed dogs from a hoarding situation (Fig. 25.1). The dogs were morphologically similar and had a median 35% inbreeding coefficient, suggesting they were a closed breeding population. Many dogs bore scars from fighting over limited resources. Despite the overcrowding, intragroup aggression, unpredictable and unequal access to resources, and lack of socialization to the world outside of their enclosure, only 39 of the 68 adults were so fearful that they needed extensive behavior modification to be adopted as companion animals. The remaining animals appeared to have coped with the adverse conditions more effectively.

25.3.1 Indicators of stress

Behavioral responses

When faced with a threat, animals generally default to one of three strategies: fight, flight, or freeze. Animals tend to be quite expressive with their bodies when frightened or stressed. Dogs and cats may crouch or curl up in a ball to look smaller, pressing back their ears and tucking their tails. Dogs may lift a foreleg, lick their lips, flick their tongues, yawn exaggeratedly, salivate, and whine or yelp. Cats may pull their whiskers tight against their face, breathe more heavily, or pant. Horses are less able to alter their body size, but they may clench their muzzle, pin their ears, widen their nostrils, toss their head, paw at the ground, snort, or rub their head/neck on a front leg or object nearby. As an animal becomes increasingly distressed or frightened, some will intensify their behavior. A cat may switch to making itself look larger and threatening (the 'Halloween cat' display) and may yowl. A horse may hold its head and tail high, swish its tail, defecate, vocalize, pace, and forcefully blow air from its nostrils to create a loud 'huffing' sound. A dog may raise its hackles, show its teeth, growl, and lunge toward the stressor. Detailed ethograms for each species are available in the published literature (horse: Torres Borda *et al*., 2024; dog: de Winkel *et al*., 2024; cat: Kappel *et al*., 2024).

An animal's behavior is likely to become increasingly abnormal when chronically distressed. Dogs may exhibit repetitive movement patterns, such as pacing or circling, often combined with repetitive vocalizations, or they may remain inactive, although not sleeping, for excessive periods. Additional abnormal behaviors may emerge, including autogrooming, scratching, licking surfaces, shadow chasing, spinning, flank sucking, or hallucinatory behaviors such as fly chasing or staring. Likewise, cats may become restless and hypervigilant or immobile and unresponsive. The cat may pace, meow, or yowl, and scent mark by rubbing against environmental objects or urine spraying. Some will pace or vocalize repetitively, or groom excessively to the point of licking their skin raw or pulling out chunks of hair. Horses are highly susceptible to developing locomotor stereotypies, such as repetitive pacing or circling, pawing, stall weaving, stall kicking, head bobbing, or oral stereotypies, such as cribbing and wood chewing.

Physiological responses

When an animal experiences an acutely stressful event, in addition to feeling negative emotions, a

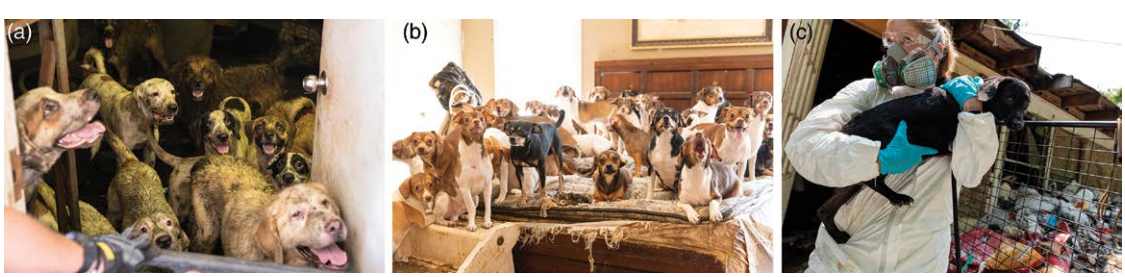


Fig. 25.1. Typical hoarding situations. (Photographs courtesy of the American Society for the Prevention of Cruelty to Animals.)

complex array of physiological changes is triggered to prepare the animal to resolve or manage the situation. Immediately, the sympathetic nervous system (SNS) activates – the adrenal medulla releases catecholamines (epinephrine and norepinephrine) into the bloodstream, triggering the fight, flight, or freeze response (Moberg, 2000). Epinephrine (adrenaline) causes the heart to pump blood into the muscles and vital organs and the lungs to take in more oxygen to send to the brain. Glucose and fats are also released into the bloodstream to supply energy to the body.

As the initial surge of adrenaline subsides, the second component of the stress response system, the hypothalamus–pituitary–adrenal (HPA) axis, kicks in. The hypothalamus releases corticotropin-releasing hormone (CRH). This hormone triggers the pituitary gland to release adrenocorticotropic hormone (ACTH), which stimulates the adrenal glands to release glucocorticoids – cortisol and corticosterone – into the bloodstream. These hormones keep the body on high alert by increasing glucose levels, enhancing cardiovascular activity, and optimizing immunological reactions (Sapolsky *et al*., 2000).

Both ongoing adversity and one or more incidents of severely distressing events can alter the animal's normal physiological response in long-lasting and sometimes devastating ways. Chronic stress alters the structure and function of the brain, including the prefrontal cortex, amygdala, and hippocampus (McEwen, 2007). While glucocorticoids play an important role, the mechanisms underpinning the effects of chronic stress on the brain are complex and involve a variety of mediators (McEwen, 2018). Traumatic events can lead to the formation of new synapses in the amygdala and the development of increased anxiety, a process that may be implicated in the development of posttraumatic stress disorder (PTSD), especially in individuals with low levels of cortisol at the time of trauma (McEwen, 2018). Stressed animals are susceptible to metabolic diseases, such as insulin resistance and ulcers, and immunosuppressive diseases and conditions, including cancer (Miller and Patronek, 2016). Stress can also suppress the functional capacity of leukocytes, which diminishes the animal's capacity to cope with future stressors (Miller and Patronek, 2016). As with behavioral effects, the physiological effects of trauma on an animal depend on many factors related to the individual, including predisposing demographic, genetic, developmental, and environmental factors (Edes *et al*., 2018).

25.4 Scientific Evidence for Psychological Harm in Animals

25.4.1 Animal models of human psychiatric disorders

Research on the psychobiology and treatment of human affective disorders has generated a wealth of information on how animals respond to adverse events. This is because research on human disorders relies in part on animal models based on the assumption that an animal's physiological and behavioral responses to harmful experiences closely resemble those experienced by humans (Miller and Patronek, 2016).

Animal models of learned helplessness have long been used to understand clinical depression in humans (Miller and Seligman, 1975; Chapter 11, and Section 12.3.4, this volume). The controllability of the stressor appears to be the critical factor in the development of learned helplessness. In addition to inducing passivity, a wide range of other behavioral changes follow uncontrollable aversive events, including heightened generalized anxiety, reduced aggression, reduced social dominance, neophobia, and potentiated fear learning (Maier and Seligman, 2016). It might be expected that the same types of behaviors would be observed in clinical cases of dogs that had been physically abused in their past, but, paradoxically, owners of these dogs reported higher than normal rates of aggression, hyperactivity, and repetitive behaviors (McMillan *et al*., 2015).

Much recent attention has been paid to developing fruitful animal models of PTSD (Richter-Levin *et al*., 2019; Bienvenu *et al*., 2021; Chapter 11, this volume). In humans, PTSD is a psychiatric disorder characterized by persistent traumatic memories, avoidant behavior, enhanced fear, and poor emotional regulation, following a traumatic event. Models of PTSD in animals incorporate a variety of aversive events to induce PTSD-like symptoms, including experience with an uncontrollable and unpredictable frightening or painful event, lengthy periods of restraint or immobilization, light or noise stimulation, exposure to cold temperatures, overcrowding, and social stress by placing an animal in the cage of an aggressive conspecific (Deslauriers *et al*., 2018). The behavioral changes that follow these types of

adversity map reasonably well onto the symptoms reported in humans diagnosed with PTSD, such as generalized anxiety and arousal, heightened vigilance and exaggerated startle responses, learned helplessness/depression, and sleep disturbances (Foa *et al*., 1992). Physiological responses include increased glucocorticoid receptor sensitivity, enhanced negative feedback of the HPA axis, increased activity of the amygdala, and reduced function and structural alterations in the prefrontal cortex and hippocampus (Deslauriers *et al*., 2018).

Attempts to document PTSD in companion animals outside of the laboratory setting have had mixed results (see also Chapter 12, this volume). In case studies of military working dogs (MWDs) whose performance declined during deployments, Burghardt (2013) reported the dogs showed signs of hypervigilance and hyperresponsivity to everyday stimuli, failure to perform previously trained behaviors, attempts to escape or avoid familiar situations, and changes in social interactions with their handlers. Burghardt (2013) claimed these behavioral changes were sufficiently like the class of behaviors suffered by humans with PTSD to dub this syndrome canine PTSD. Assessment and treatment of canine PTSD are now addressed in the *Clinical Practice Guidelines for Military Working Dogs* (Lagutchik *et al*., 2018). In contrast, Salden *et al*. (2023) examined the literature on search-and-rescue dogs and while they found that some dogs exhibited similar behavior changes after disaster deployments, the changes were short-lived. One explanation is that the frequency and intensity of aversive stimuli (explosives, gunfire, physical insults, etc.) faced by MWDs are both markedly higher, which, from a cumulative adversity perspective, would predispose them to developing PTSD. Documenting the behavioral phenotypes and physiological responses of animals rescued from abusive circumstances, such as dogs used in organized dogfighting, could prove fruitful in validating the presence of animal PTSD in real-life situations.

In addition to PTSD, animal models of human disorders exist for anxiety disorders, eating disorders, stress-related psychopathology, obsessive–compulsive disorder, early life adversity, and depression (Miller and Patronek, 2016). The various methods used to induce these psychological disorders in animals are comparable to some of the typical cruelty and neglect experienced by companion animals: inescapable and/or unpredictable painful events, continuous light or dark conditions, noise exposure, deprivation of maternal contact, isolation of social species, overcrowding, immersion or restraint in water, prolonged periods of restraint, exposure to extreme temperatures, and deprivation of food, water, or sleep. These models convincingly demonstrate that when animals are subjected to these experiences, they suffer psychological harm in much the same way as humans.

25.4.2 Early life adversity (ELA)

While an animal can experience traumatizing events at any time in their life, young developing animals are more vulnerable to the effects of trauma than adults in part because their brains are exceedingly plastic and their behavior is highly malleable (Corridan *et al*., 2024). Stress and trauma during development can cause 'remarkable functional and structural changes' that endure across the animal's lifetime (Agorastos *et al*., 2019; Chapter 12, this volume). ELA has been linked to poor emotional regulation, inadequate coping skills, deficits in learning and cognition, inability to form healthy social relationships, and a variety of other behavioral disorders (Bonapersona *et al*., 2019), in addition to some chronic diseases (Gaillard *et al*., 2022) and shorter lifespans (McEwen, 2007).

The deleterious consequences of ELA are a function, in part, of the intensity of the aversive event. Experiencing mild to moderate stress levels during development actually enables the animal to develop resilience, resulting in the animal exhibiting effective coping strategies when presented with subsequent stressful events (Levine, 1957; Lyons *et al*., 2010). It is as though some experience with stress 'inoculates' the animal against the types of stressful events that can be reasonably encountered in the environment. On the other hand, severe or prolonged stress, prenatally and/or during sensitive phases of development, can result in dramatic changes to the neural structures and pathways involved in the stress response (Fig. 25.2). With repeated or prolonged activation of the HPA axis, the amygdala becomes larger and more responsive to stressful events, which leads to excessive glucocorticoid release and dysregulation of the HPA axis. The severity and duration of the stress, as well as the timing during development, influences the extent of the alterations but this dysregulation can manifest as heightened or reduced sensitivity to stress throughout the animal's lifetime. Both hyper- or hypo-activation of the HPA axis represent deviations away from the

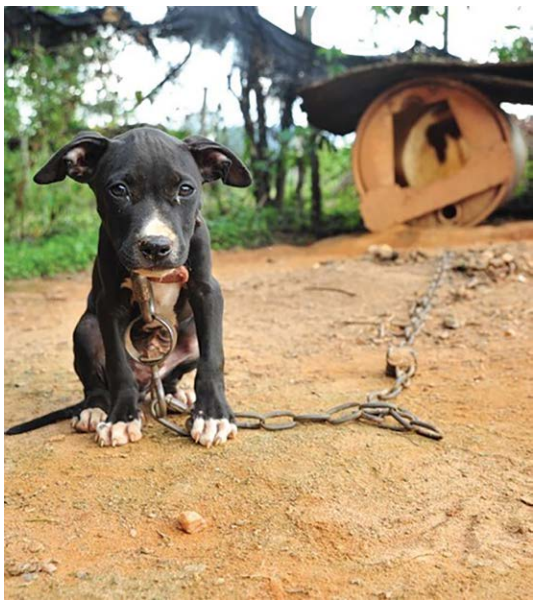


Fig. 25.2. A puppy living in the conditions typical of a dogfighting yard – forced to drag a heavy chain while tethered to a dilapidated shelter, ignored by people until old enough to train to fight, isolated while surrounded by other dogs staked just out of reach. These factors combine to result in perpetual frustration and abnormal social development. (Photograph courtesy of the American Society for the Prevention of Cruelty to Animals.)

normal, functional range of HPA axis activity, and both result in similar deleterious physical and mental health effects mediated by different mechanisms (Agorastos *et al*., 2019).

Some changes in brain organization and function are mediated by epigenetic effects of chronic stress in brain cells (Arzate-Mejia *et al*., 2024). Epigenetic changes, such as DNA methylation, influence the expression of the genome by up- or down-regulating genes rather than changing the genome itself (Burns *et al*., 2018). Depending on when the epigenetic changes occur, they can have life-long impacts on the organization and function of the neuroendocrine systems (Burns *et al*., 2018). Recently, methylation of oxytocin and glucocorticoid receptor genes was compared between dogs with a life history of adversity (per owner report via survey) and those without (Awalt *et al*., 2024). The authors found complex relationships between epigenetic changes in the dogs' methylation patterns related to a life history of adversity, cortisol response to a test, and attachment style to the owner (Awalt *et al*., 2024).

Animals with ELA-induced psychological trauma are more likely to remember associations made during stressful events and less likely to form associations between stimuli during non-stressful events (Bonapersona *et al*., 2019). This may partially explain the difficulty behaviorists experience when attempting to rehabilitate extremely fearful dogs from hoarding and CBE cases (Collins *et al*., 2022). Dogs born and raised in CBEs experience a variety of stressful events, including unpleasant handling, poor maternal care, early maternal separation, social isolation, and impoverished environments. Puppies born and raised in hoarding environments are likely to suffer from inadequate resources (including in utero), unsanitary conditions, overcrowding, and conspecific aggression. Despite the differences in types of adversity, dogs from both circumstances exhibit similar behavioral abnormalities in adulthood, including extreme levels of social and nonsocial fear, sensitivity to touch, and compulsive behavior (McMillan *et al*., 2011, 2013, 2016; McMillan, 2017). Indeed, dogs formerly used as breeders in CBEs are sometimes described by their owners as 'autistic-like' (F. McMillan, Ohio, 2024, personal communication).

The most significant commonality between CBE dogs and hoarded dogs is the lack of exposure to novelty, e.g., unfamiliar people and conspecifics and new experiences (Fig. 25.3). Fear of those stimuli that result from ELA is indistinguishable from that exhibited by a poorly socialized pet dog. Inadequate socialization should not necessarily be considered an act of cruelty or neglect, as the animal would not experience distress provided it is maintained in a stable, familiar environment. For this reason, when evaluating an individual animal for evidence of ELA-produced psychological harm, it is necessary to look for concomitant behavioral aberrations, such as learning deficits and/or the inability to form healthy social relationships.

An alternative strategy is to document behavioral phenotypes for entire populations from hoarding and CBE seizures to paint a picture of the overall harm that can result from being born and raised in an adverse environment. Both hoarding and CBE backgrounds are associated with profound behavioral impacts in the populations we receive from large-scale seizures. Many dogs from hoarding cases (~60%) present with moderate to severe fear on intake, while a smaller, but still substantial, segment of CBE case dogs (36%) present with moderate to severe fear (Cussen and Reid,



Fig. 25.3. Young dog in a hoarding situation. (Photograph courtesy of the American Society for the Prevention of Cruelty to Animals.)

2024a). The results for CBE cases are on par with human populations, where ~20–30% of people exposed to ELA develop enduring changes to their stress responses (Koolhaas *et al.*, 2011). The frequency of profound deleterious impacts on behavior occurs at over double this rate in hoarding-case dogs, possibly due to high levels of inbreeding without health or temperament screening. In an open-field test, individuals from these cases also showed altered behavioral responses to sudden environmental noise, suggesting that not only is the incidence of fear markedly higher than in other shelter-housed dogs in this population, but it is also an abnormally intense fear response (Cussen and Reid, 2024b).

25.4.3 Emotional contagion

A powerful demonstration of an animal's vulnerability to being traumatized stems from research on emotional contagion. Emotional contagion is the tendency for people and animals to experience the emotions of others. It is not just a matter of one animal detecting another animal's fear. There is a substantial body of scientific evidence that animals possess the capacity to be affected by and even share the emotional states of other animals, particularly negative emotional states (Pérez-Manrique and Gomila, 2022). Emotional contagion is thought to be a basic form of empathy (de Waal, 2008) that impacts the animal's neurophysiology, cognition, and behavior.

Dogs are sensitive to the emotional states of both people and other dogs. Dogs recognize frightened people's facial expressions and vocalizations and respond with stress-related behaviors, such as agitated movement, lip licking, and other fearful body language (Custance and Mayer, 2012). Dogs are so keenly perceptive of human distress that they displayed more stressful behaviors when smelling the sweat of a person experiencing a negative emotion than that of a person experiencing a positive emotion (D'Aniello *et al.*, 2018). Dogs that heard recordings of the distressed whines of a housemate dog experienced higher levels of cortisol and exhibited more empathic behaviors, including approaching, staying in proximity, touching, pawing, sniffing, and licking, toward the familiar dog when reunited than they did after hearing the whines of an unfamiliar dog (Quervel-Chaumette *et al.*, 2016). Horses exhibited negative facial expressions and increased heart rate when viewing videos of horses undergoing unpleasant veterinary procedures (Trösch *et al.*, 2020).

Witnessing another animal experience a traumatic event can also induce measurable neurobiological changes in the observer animal (Miller and Patronek, 2016). For instance, pain sensitivity in mice increases in the presence of other mice displaying behaviors indicative of pain (Decety *et al.*, 2016). In humans, functional MRI studies on children reveal activation of the amygdala and other interconnected regions involved in affective arousal while observing people in distress (Decety *et al.*, 2016).

The scientific evidence is overwhelming that animals are adversely affected by the experience of seeing another animal undergoing a traumatic event. They perceive and share the same emotions, especially when the suffering animal is familiar to them. We used this evidence in one of our cases to successfully gain legal ownership of an observer dog. Security camera footage showed a person in an elevator inflicting physical abuse on one dog while a second dog cowered in the corner. Both dogs were removed by law enforcement, but the defendant claimed that there was no basis for seizing the dog he had not harmed. We argued that the observing dog suffered just as much as the dog that was beaten, and after reading our report, the defendant surrendered both dogs.

25.5 Approaches for Substantiating Psychological Harm

Given this growing scientific evidence that animals experience mental distress and trauma, credible arguments can be made under existing cruelty laws so long as the law does not expressly require physical injury, as is the case in most states, at least when it comes to misdemeanor offenses.

Whether a prosecution based on psychological harm is brought under existing law or under an amended statute that makes psychological harm expressly cognizable, credible expert testimony, supported by data and research (ideally peer-reviewed) and using standardized assessment tools, is key. Most states have adopted what is known as the Daubert standard (American Bar Association, 2017) for the admissibility of expert testimony, which sets out a non-exhaustive list of factors a court can consider:

1. Has the technique been tested in actual field conditions (not just in a laboratory)?
2. Has the technique been subject to peer review and publication?
3. What is the known or potential rate of error?
4. Do standards exist to control the technique's operation?
5. Is the technique generally accepted within the relevant scientific community?

Some states use the Frye test, in which the court must determine whether the scientific evidence is generally accepted by a significant portion of the relevant scientific community (Cornell Legal Information Institute, 2022).

As science advances our understanding of psychological harm in animals, we are more able to meet these criteria. The following describes the types of scientific evidence that can be presented to bolster a charge of animal cruelty based on psychological harm.

25.5.1 Behavioral indicators

Thus far, to our knowledge, expert witnesses who have testified in court about how cruelty or neglect affected an animal's behavior have relied on describing the animal's abnormal behavior (e.g., severe fear in response to benign stimuli, stereotypic behavior, catatonia, etc.) and explaining how the conditions in which the animal was kept or how it was treated were the likely cause.

One notable case occurred in 2012 when the Animal Legal Defense Fund, People for the Ethical Treatment of Animals, and concerned citizens brought a civil cruelty action on behalf of Ben, a bear that had spent 6 years on display at a 'squalid roadside zoo' in Fayetteville, North Carolina (Animal Legal Defense Fund, 2018). The statute allows a court to order the removal of an animal based on evidence of 'cruelty', defined under the civil statute as 'every act, omission, or neglect whereby unjustifiable physical pain, suffering, or death is caused or permitted' (North Carolina General Assembly, 2024a). Confined to a 12-foot-by-22-foot concrete and chain-link enclosure that was urine-soaked, filled with feces, and devoid of any enrichment, the court ruled in favor of the plaintiffs, concluding that the term 'suffering' as used in the statute 'encompasses physical, mental, and psychological suffering'. In its decision, the court made extensive factual findings, including:

- Inhumane confinement to such a small cage prevented Ben from engaging in species-typical behaviors that are essential to physical and psychological health. Defendants have deprived Ben of the opportunity to run, dig, explore, swim, bathe, climb, hunt, forage, hibernate, or engage in other normal bear behavior.
- Internationally renowned bear experts provided credible, sworn testimony that Defendants subjected Ben to psychological suffering and physical pain.
- While housed by Defendants, Ben spent 75% of his waking hours pacing, an abnormal behavior that is common among animals who are subjected to cruel, inhumane conditions of confinement.
- In addition to stereotypic pacing, Ben exhibited other abnormal behaviors indicative of suffering, including biting, pawing at, and head-butting the chain-link fence around his enclosure, and eating his feces. Animal scientists recognize these behaviors as consistent with a negative welfare state and signs of suffering. Defendants placed Ben at risk for permanent and irreversible psychological damage.

This ruling provides a strong basis for a prosecution under the state's criminal misdemeanor cruelty statute, which likewise defines 'torment' as 'pain, suffering, or death' (North Carolina General Assembly, 2024b). Indeed, in the case described previously of the horse confined to a box stall for years and prevented from engaging in species-normal behaviors and exhibiting stereotypies, the defendant pleaded guilty to one count of misdemeanor cruelty based solely on the psychological harm sustained by the horse (internal American Society for the Prevention of Cruelty to Animals (ASPCA) records). Given the defendant's guilty plea, it is impossible to know, had the case gone to trial, whether a court would have found that psychological harm was cognizable under the statute.

However, the court's ruling in the Ben case would undoubtedly have been highly persuasive. State criminal complaints and indictments are not readily accessible, so it is unknown how many such charges have been attempted, whether successfully or not.

Contrasting an animal's behavior with a comparable animal or animals that have not experienced the same history of trauma can strengthen an argument for psychological harm. In a case that ultimately did not go to trial, a neighbor's video camera recorded an adult male regularly beating a dog with a golf club for eliminating on the balcony where the dog was confined. The man was arrested for animal cruelty, and the dog was seized. To bolster the charge by demonstrating that the dog was harmed psychologically, we documented the dog's reaction to various stimuli, including a man approaching carrying a golf club. Not surprisingly, the dog showed a strong fearful reaction to that stimulus, whereas the dog behaved in a friendly manner when the same man approached carrying a briefcase. To argue that the victim dog's extreme fear was the result of abuse suffered, we also documented responses to the same set of stimuli by a shelter dog of similar age and breed mix with no known history of abuse. That dog did not react fearfully to the man with the golf club.

For our large-scale cruelty cases, we have built behavioral phenotypes of animals at a population level. Future cases can then be compared to the established phenotype for the type of suspected cruelty to determine if the animal's behavior 'fits the profile'. When the ASPCA shelters a group of dogs from a suspected cruelty case, we conduct a standardized forensic behavior evaluation on each animal shortly after the seizure. The evaluation consists of subtests designed to present the dog with common everyday experiences, such as exploring a novel space, handling by an unfamiliar person, playing with a tug toy, and meeting an unfamiliar dog (described in greater detail in Reid, 2013). As mentioned previously, dogs from CBEs and hoarding situations tend to exhibit more social fear and neophobia than shelter dogs from unknown backgrounds (Fig. 25.4). We offered expert witness testimony in a hoarding situation where, among other transgressions, the breeder kept two or three adult Labrador Retrievers in cages sized for a single dog. The breeder argued that his dogs needed to touch each other constantly. Almost half of the dogs were so fearful of people that they needed several weeks of behavior modification before they could be adopted (which is consistent with the 60% of dogs from our other hoarding cases exhibiting moderate to severe fear), compared with only 9% of Labrador Retrievers and Labrador mixes that were seized from sanctuaries. The defendant was found guilty of several misdemeanor counts and banned from owning animals for 5 years (Wisconsin Court of Appeals, 2018).



Fig. 25.4. Dogs in hoarding situation exhibiting fear. (Photograph courtesy of the American Society for the Prevention of Cruelty to Animals.)

25.5.2 Cognitive bias

The cognitive bias paradigm has been proposed as an objective, scientific means for identifying potential psychological harm in animals (Paul *et al*., 2005; Chapter 23, this volume). The paradigm originates from human studies that show a person's affective state can influence judgment, memory, and attention. People experiencing negative emotions better remember negative events, pay more attention to threatening stimuli, and judge ambiguous stimuli more pessimistically (Nguyen *et al*., 2020). The paradigm has been modified for animals, and chronically stressed animals tend to view the world from a 'glass half empty' perspective (Burman, 2014).

The cognitive bias test is intended to assess an animal's emotional state by measuring their responses to ambiguous cues to determine whether they exhibit optimism (positive bias) or pessimism (negative bias). Animals are first trained to associate two distinct stimuli (e.g., bowls placed in specific locations) with positive (a treat) and negative (no treat) outcomes. After the training, the bowl is placed in an intermediate location and the animal's response – approaching the ambiguous cue or hesitating – indicates its cognitive bias. For instance, optimistic dogs are more likely to approach ambiguous cues quickly, expecting a reward. In contrast, pessimistic dogs (dogs that suffer from separation anxiety: Mendl *et al*., 2010; or dogs exposed to the odor of a stressed person: Parr-Cortes *et al*., 2024) are more hesitant or avoidant, interpreting the cue as likely negative.

To date, no cognitive bias studies have been conducted on dogs with a history of adversity. However, McGuire *et al*. (2018) found horses and donkeys that had suffered abuse and neglect were actually more optimistic than those without an adverse history. Given the instrumental learning required for the task, highly fearful animals may be too inhibited to participate. In addition, trauma can impair learning and cognition, so traumatized animals might be less able to learn the task. Finally, cognitive bias can be induced by short-term emotional states as well as enduring moods, so parsing an acute effect due to hunger, anger, etc., from an enduring affective disorder brought about by trauma is impossible. More research is needed to ascertain whether this paradigm can be a helpful tool for identifying animals suffering psychological harm.

25.5.3 Biomarkers

The term 'biomarker' refers to any of a range of biological indicators consistently associated with a type (or types) of trauma. Such indicators serve as a 'mark' of the trauma in the animal's physiological functioning. Biomarkers are considered, especially by non-scientists, to be more objective and credible compared to behavioral indicators. As such, they hold great promise for supporting the prosecution of psychological trauma in animals.

Because of their link to biological functioning, physiological indicators are frequently used to assess animal welfare (Appleby *et al*., 2018). Recent efforts to determine processes unique to specific subjective experiences of animals have evaluated a variety of markers with endocrine, oxidative stress, non-coding molecular, and thermobiological functions, which lend themselves to peripheral measurement while also being associated with emotional processing/regulation, or psychiatric and/or stress-related disorders (reviewed by Babington *et al*., 2024). Common physiological indicators of animal welfare include the primary mediators of the stress response (e.g., epinephrine, glucocorticoids) as well as secondary metabolic, immune/inflammatory, and cardiovascular markers (see Polgár *et al*., 2019 for a review of dog-specific research; see Wolfe and Edes, 2023 for a general overview of important mediators).

While widely studied and commonly used to infer welfare, interpretation of physiological indicators is challenging because, in many cases, the same change can be associated with positive or negative situations or experiences (e.g., Hennessy, 2013; Babington *et al*., 2024). This is because all animals respond to stressors by activating physiological pathways that prime the animal to respond adaptively; activation of a pathway, e.g., an increase in cortisol from activation of the HPA pathway, reflects a preparatory response to support behavior and does not necessarily convey information about the valence or intensity of the eliciting stimulus (Koolhaas *et al*., 2011). Many of the physiological indicators used in general animal welfare assessments are not, therefore, useful biomarkers of psychological trauma because they reflect acute, adaptive changes to accommodate 'ordinary' stressors and are transient responses rather than enduring effects (Wolfe and Edes, 2023).

The use of biomarkers to confirm psychological trauma in animals currently lags behind such research

in humans, which itself is in its early stages. Abi-Dargham *et al.* (2023) recently reviewed the current status of PTSD biomarker research, presenting data for the current methods of neuroimaging, i.e., heart rate variability and respiratory sinus arrhythmia, fear potentiated startle response, cortisol levels, inflammation markers, and proteomics. All measures demonstrated weak links to PTSD, leading the authors to conclude that, 'to date, the overwhelming majority of these measures have not been proven sufficiently reliable, valid and useful to be adopted clinically'. Because chronicity of psychological disorders is more difficult to confirm in animals than in humans (who can verbalize the duration of their impairment), investigating the usefulness of biomarkers for psychological trauma in animals requires that indicators must more specifically reflect enduring changes caused by either highly aversive events of an intensity rising to the level of trauma and/or ongoing chronic aversive events with which the animal is unable to cope. They also must be parametrized in such a way as to distinguish them from adaptive preparatory responses (Koolhaas *et al.*, 2011). Without such a composite metric, biomarkers must be repeatedly measured to establish a sustained perturbation or dysregulation (McEwen and Wingfield, 2003) because the ability to recover from stress distinguishes adaptative response from distress and dysregulation (Koolhaas *et al.*, 2011).

Experimentally, markers are measured before, during, and after a stressor to assess baseline, response, and recovery, but such an approach is not practicable in the real world (Babington *et al.*, 2024). Absent the ability to repeat measures, sampling markers from specific tissues can provide information on a longer timescale. For example, hair cortisol reflects deposition across weeks rather than minutes or hours, allowing inferences about the individual's experience across a longer time frame (e.g., van der Laan *et al.*, 2022). Another long-term marker is telomere length, with relatively shorter telomere length reflecting the accumulation of damage from oxidative stress over the animal's life (relative because telomeres erode over time regardless of life history; telomere erosion is sometimes referred to as 'biological age' to distinguish it from chronological age (Bateson and Poirier, 2019)). Samples of saliva have been validated to assay telomere length in dogs, providing a non-invasive and inexpensive long-term biomarker (Dutra *et al.*, 2020). In adult humans, telomere erosion rates are inconsistent across different types of childhood trauma (Li *et al.*, 2017), but such distinctions have yet to be investigated in dogs.

The concepts of 'allostasis' and 'allostatic load' have recently been found to have potential. Allostasis, which means 'achieving stability through change', reflects an adaptive response to environmental perturbations via glucocorticoids, catecholamines, and cytokines, while allostatic load is an ongoing dysregulation of these systems stemming from the magnitude of or sustained exposure to stressors (McEwen and Wingfield, 2003). The 'allostatic load index' (ALI) is a composite measure that translates the allostatic loads across systems into impacts on the individual's mental and physical health (Wolfe and Edes, 2023). It does this by including measures of multiple biomarkers from different systems (e.g., cardiovascular, immune, etc.) and temporal effects (acute, chronic). ALI was developed in human medicine but has recently been extended to captive animals (Edes *et al.*, 2018), with ALI scores accurately reflecting stressful life events and predicting morbidity and mortality in captive primates (Seeley *et al.*, 2022). At this time, domestic dogs are yet to be represented in the ALI literature. However, there is a large body of work on individual biomarkers in dogs (Polgár *et al.*, 2019), which makes the development of a canine ALI realistic in the near future.

Another approach is to use between-subjects studies to compare the group means for a given biomarker between dogs with a history of trauma and their matched-pair conspecifics undergoing 'normal' stress (i.e., shelter dogs). Averaging over multiple subjects accounts for individual differences while matching group composition accounts for effects due to age, sex, breed, etc. Using this approach, Buttner and Strasser (2022) found significantly higher salivary cortisol concentrations during structured human interaction in shelter dogs from an adverse background compared to matched controls without that background. On the other hand, no difference was found between dogs of adverse background and their non-adverse-background shelter-matched controls when assessing oxidative stress, though both groups had greater oxidative stress compared to client-owned pet dogs (Jiménez and Strasser, 2024). These studies are early and important works that aim to establish biomarkers associated with psychological trauma in dogs.

More work is needed to determine how individual markers vary across the population and over

time (Seeley *et al*., 2022), such as recent work to establish serum concentration normal ranges for multiple inflammatory markers in healthy dogs of different ages and weights (Jiménez, 2023). Additionally, refining inclusion criteria and phenotyping of animals used in studies is critical for identifying behavioral indicators and biomarkers associated with particular types of trauma (Cussen and Reid, 2024a). For example, dogs from hoarding situations have pronounced elevations in coefficients of inbreeding (COI) and genetic risk factors for deleterious conditions compared to the published values for purebred and mixed-breed dogs (V. Cussen and P. Reid, 2024, unpublished results). It is illogical to think that this pattern would extend to victims of dogfighting, though both groups have experienced trauma. Large samples comprising individuals with known histories of trauma type and severity are needed (Brenhouse and Bath, 2019).

The complexity of biological organisms and trauma's effect on function represent challenges, especially as they relate to single individuals and/or single markers. Humans and animals are incredibly resilient to acute and chronic stress, leading some authors to label resilience as 'ordinary magic' because it is the rule rather than the exception (Masten, 2001). This holds true even for trauma. Conversely, a minority of individuals are at greater risk for deleterious physiological and psychological effects (Wu *et al*., 2013; Hennessy *et al*., 2020). In both humans and animals, for example, exposure to traumatic contexts results in PTSD (or PTSD-like symptoms in animals) in 20–30% of individuals (Koolhaas *et al*., 2011); in a rodent model of PTSD, individuals with dampened cortisol responses to stress also showed an impaired ability to extinguish learned fear responses (Reznikov *et al*., 2015). Susceptibility to trauma may be governed by gene-by-environment interactions (Plomin *et al*., 2016) and/or epigenetic effects (McEwen, 2018), among other factors. Furthermore, the number and intensity of stressful or traumatic experiences are related to the severity of deleterious physiological consequences (Agorastos *et al*., 2019), as are the predictability and controllability of the stressors (Koolhaas *et al*., 2011).

Yet, it is indisputable that trauma results in deep, at times indelible, alterations of animals' physiology. While the nuances above represent current challenges, they also hold promise for future applications. When the specific mechanisms and exposure functions are better elucidated, biomarkers may then become useful as scales that show not only the presence or absence of trauma, but also the frequency and severity. Until then, risk ranges and prevalence data for biomarkers from populations of animals seized during cruelty investigations can be compared to normal ranges and prevalence values for owned pets; such contrasts may provide additional objective evidence of psychological trauma in victims of animal cruelty.

25.6 Recommendations for Legal Change

In conceptualizing moral duties to animals, the philosopher Jeremy Bentham famously stated: 'The question is not, can they reason? nor, can they talk? but can they suffer?' (Bentham, 1789). Our goal in this chapter has been to establish that animals are sentient beings that do suffer psychologically when abused or neglected, sometimes to the point of irreparable harm. How do we propose bringing the legal system in line with popular thought and scientific evidence?

First, animal welfare professionals, especially behaviorists, can help educate prosecutors and courts on the psychological harm that animal cruelty victims can sustain because of abuse and neglect. Even where charges are brought, in part, on physical injury, prosecutors should be encouraged to introduce relevant and credible evidence of psychological harm to bolster those charges and help establish precedent for the admission of behavioral evidence in animal cruelty cases. If bringing charges based solely on psychological harm, we advise doing so based on the strongest and clearest evidence to increase the likelihood of success and establish precedent for future cases.

Ledger and Mellor (2018) describe how expert opinions that have included details of negative affective states have been well received by Canadian courts in the past decade and note how such evidence has been allowed to bolster cases where there was physical evidence of harm. For instance, Ledger testified in a case in which a defendant left six dogs in a locked vehicle until they died of hyperthermia. She argued that the dogs would have experienced significant emotional suffering and distress as a direct result of the heat in the vehicle – specifically, anxiety, panic, nausea, and thermal and physical discomfort (Ledger and Mellor, 2018). As a result, the judge dealt the perpetrator a harsher sentence. Similarly, in a 2018 case (Commonwealth

of Massachusetts v. Donovan, 2018) involving the hanging of two juvenile dogs, in which the first author testified, the judge imposed a stricter sentence on the defendant because of the unnecessary suffering the defendant inflicted upon the dogs as they struggled to breathe.

Second, lobbying for amendments to existing cruelty laws to include psychological harm explicitly is undoubtedly a possibility, at least in theory, and would obviate the need to argue that current cruelty statutes already encompass psychological harm. In the USA, this would require a state-by-state approach, and historically, efforts to strengthen existing animal cruelty laws have faced fierce opposition, especially from agricultural interests.

There are, of course, practical challenges as well. Despite improvements in law enforcement's knowledge about and response to crimes against animals, with some agencies in larger jurisdictions even having designated investigators and prosecutors, under-enforcement of cruelty laws persists, whether because of a lack of knowledge, resources, or prioritization. This is particularly true when it comes to forms of neglect, the most common type of animal cruelty. In addition, in cases involving multiple animals, there will often be animals that have sustained physical injuries, which are easier to prove and less vulnerable to challenge, with prosecutors often making strategic decisions only to bring charges based on animals that sustained the most severe and visible physical harm. As is the case with many larger-scale neglect cases, such as those involving sanctuaries and rescue hoarders, other evidentiary challenges include being able to establish that the animal's injuries, whether physical or psychological, were sustained while the animal was in the custody of the owner or custodian and not before the animal came into their possession or guardianship. In the case of psychological harm, the fact that some animals may display clear signs of trauma or acute distress while others do not will be a hurdle to overcome.

25.7 Summary and Conclusions

Acts of abuse and neglect perpetrated against animals frequently leave damage that cannot show up on the forensic veterinarian's radiographs or physical examination. The harm is psychological and, unlike most physical injuries, is often beyond repair, even with intensive, specialized behavioral rehabilitation. Yet, psychological harm is not explicitly specified in any animal cruelty statutes, and no US court has interpreted its state cruelty law to address psychological harm in a published decision. Fortunately, many statutes refer to 'unnecessary suffering', 'torment', and other potentially applicable terms without defining their meaning, thereby leaving open the possibility of successfully prosecuting a case based on psychological harm. For that to happen, scientists and subject-matter experts must educate prosecutors and courts about the wealth of compelling evidence that adverse experiences cause animals to suffer psychologically. Promising new research, particularly on biomarkers, is advancing our ability to document psychological harm objectively. As our understanding of animals' emotional lives evolves, we become increasingly better prepared to fight for the justice that animal victims of cruelty deserve and work toward a more humane and compassionate society for people and animals. As we know better, we should do better.

Note

[1] Many cases of animal hoarding and other forms of abuse or neglect occur in facilities where the owner/operator misleadingly labels the facility a sanctuary or rescue.

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26 Treatment Options for Emotional Distress in Animals

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26.1 Emotional Distress

Emotional distress refers to a state of psychological discomfort or suffering that affects an animal's behavior, well-being, and/or physical health (Broom, 1993; Grandin and Deesing, 2002; see also Chapter 11, this volume). Emotional distress in animals can be caused by experiences such as separation from a caregiver, loss of a companion, mistreatment, or chronic health issues, all of which disrupt an animal's normal emotional balance. Emotional distress may be associated with a wide range of behavioral responses, summarized in Table 26.1.

Behavior problems associated with emotional distress are common in companion animals (Voith, 1985; Dinwoodie *et al.*, 2019), and can be harmful to pet–owner relationships, sometimes leading to euthanasia or relinquishment of otherwise healthy pets (Patronek *et al.*, 1996; Casey *et al.*, 2009). For working animals, emotional distress may hinder training (Murphy, 1995; Batt *et al.*, 2010), interfere with job performance (Caron-Lormier *et al.*, 2016), or impede the learning of new skills (McEwen and Sapolsky, 1995).

Stress is a normal biological response triggered when an animal perceives a threat to homeostasis (Moberg, 2000). This response, designed for survival, can be activated, even without a real threat being present, as long as the animal perceives one. Stress responses may be transient and adaptive, a type of beneficial or neutral stress known as eustress (Selye, 1975) or neutral stress (Breazile, 1987).

The stress response is physiologically mediated through the autonomic nervous system (via norepinephrine) and the hypothalamic–pituitary–adrenal (HPA) axis, releasing cortisol (Karaer *et al.*, 2023). Acute stress effects include mobilized energy, increased blood flow to muscles, bronchodilation, and decreased pain perception, while functions like digestion, reproduction, and immunity are suppressed (Moberg, 2000).

Chronic stress, however, can harm animals in multiple ways. The immunosuppressive effects of chronic stress may weaken an animal's resistance to infectious diseases and slow wound healing. Shelter cats showing chronic stress symptoms have a higher risk of upper respiratory infections (Tanaka *et al.*, 2012). Idiopathic cystitis, an inflammatory bladder disorder, has also been linked to chronic stress in cats (Westropp *et al.*, 2006; Stella *et al.*, 2011). In dogs, chronic stress and anxiety are associated with increased disease risk and a shortened lifespan (Dreschel, 2010).

26.2 Treatment: Health, Nutrition, Physical Needs

Physical and mental health are interconnected (Chapter 3, this volume), and optimal health should be a foundation for any behavior modification program (Mills, 1995; Griffin *et al.*, 2023). Before starting behavioral interventions, a veterinary evaluation may be necessary, as some medical conditions – like osteoarthritis (Asmundson and Katz, 2009; Mills *et al.*, 2020), endocrine issues (Beaver and Haug, 2003; Dodman *et al.*, 2013), and neurological disorders (Shihab *et al.*, 2011; Levitin *et al.*, 2019) – can impact behavior and learning. Addressing or ruling out these conditions is essential before behavioral therapy.

Animals have physical and emotional needs, which should be met through play, exercise, social interaction,

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Table 26.1. Behavioral signs of emotional distress.

Anxiety and fear	Animals experiencing emotional distress may develop chronic anxiety or specific fears, resulting in heightened startle responses, avoidance of certain environments or stimuli, or excessive vigilance (Bain, 2024)
Withdrawal or escape behavior	Distressed animals may attempt to withdraw from or escape situations or environments they perceive as threatening. This can include hiding, fleeing, or avoiding certain places, objects, or people (Moberg, 2000)
Aggressive behaviors	Emotional distress can result in aggressive behaviors, often as a defense mechanism. Animals under stress or experiencing fear may become more irritable or unpredictable, leading to increased incidences of biting, growling, or other forms of aggressive behaviors (Summers and Winberg, 2006)
Displacement behaviors	Displacement behaviors in animals refer to actions or activities performed out of context, often in response to situations that trigger conflicting motivations, anxiety, or frustration. These behaviors, such as grooming, scratching, excessive vocalization, yawning, or licking, serve as an emotional outlet, helping the animal cope with stress or conflicting desires (Tinbergen, 1952)
Compulsive behaviors or stereotypies	Animals under emotional distress may develop repetitive or compulsive behaviors, such as excessive grooming (which can lead to self-harm), pacing, or vocalizing. These behaviors are often attempts to cope with stress (Mason, 1991)
Learned helplessness or depression	In situations where animals are unable to escape or avoid stressors (such as in cases of prolonged confinement or abuse), they may exhibit a condition known as learned helplessness. This is a psychological state in which the animal stops attempting to escape negative situations because it believes it has no control over the outcome (Seligman, 1972; see also Chapter 8, this volume)
Cognitive impairments	Chronic stress and emotional distress can impair cognitive functions in animals, such as problem-solving abilities or memory. This can reduce their ability to adapt to new environments or challenges and can negatively affect their overall welfare (McEwen and Sapolsky, 1995)

and spaces for natural behaviors. Enrichment items like toys, puzzles, and chew objects stimulate animals mentally and physically, helping prevent boredom, a common cause of behavioral issues in captive or indoor animals. Enrichment should be varied and target senses like smell, taste, and sound.

Providing social interaction is also crucial (Chapter 9, this volume). For social animals, isolation can lead to distress, while exposure to incompatible companions may cause anxiety. Careful management of these interactions can reduce stressors.

A behavior modification plan should meet animals' needs for physical activity, mental stimulation, social contact, and nutrition. Environmental enrichment is essential, especially for captive and companion animals.

26.3 Treatment: Environmental Management

Identifying and mitigating stressors in the environment is vital for managing behavior. Loud noises, chaotic surroundings, or lack of privacy can provoke anxiety for many animals. Providing quiet, safe spaces where animals can retreat is critical for emotional health. Recognize that aversive stimuli can vary between individuals; if a treatment consistently triggers fearful body language, avoidance, or escape attempts, it may be aversive to that specific animal.

Environmental modification through antecedent arrangement involves adjusting surroundings to prevent undesired behaviors by addressing triggers before they arise. By managing antecedents – events or conditions leading to specific behaviors – animals can experience less stress and more positive experiences. Removing or altering conditions that prompt unwanted behaviors is key. For instance, blocking a dog's view of a busy street can reduce barking and prevent the dog from rehearsing aggressive responses to people or dogs outdoors. Environmental modifications must be customized to each animal's needs, considering species, breed, and temperament for long-term success.

Additionally, providing a predictable routine is critical, as lack of predictability and control is a significant stressor for confined or captive animals (Mineka and Kelly, 1989; Morgan and Tromborg, 2007; Chapter 8, this volume). Animals are better

equipped to cope with aversive events when they can anticipate them (Gliner, 1972; Seligman *et al*., 1979). Predictable schedules for feeding, handling, and enrichment reduce anxiety. Introducing choice and control, where feasible, enhances welfare.

26.4 Treatment: Behavior Modification

Behavior modification is the principal means of changing or controlling undesirable behavior and therefore it is critical for practitioners to understand species-typical behavior and the basic principles of learning and motivation.

A complete review of learning theory is beyond the scope of this chapter. Rather, several behavior modification techniques that are the most helpful for the most common types of emotional distress suffered by companion animals will be highlighted.

While the basic principles of learning and motivation apply broadly across species, it is also important to understand the species-specific natural history and behavioral characteristics of the animal learner. Cats for example are more likely than dogs to show behaviors characteristic of prey species when they feel threatened. A skilled trainer will keep this in mind when designing a behavior modification plan for a cat, perhaps avoiding unfamiliar environments, or always providing feline learners with an opportunity to hide/withdraw when they feel insecure.

Research in dogs has also shown that breed clade is a significant predictor of learning and behavioral response (Junttila *et al*., 2022; Azadian and Protopopova, 2024), although considerable behavioral variation exists for individual dogs with common genetic history (Morrill *et al*., 2022). Some breeds (e.g., herding breeds) may be more motivated by opportunities to play or chase than by food rewards.

26.5 Emotional State and Learning

Emotional state has an interconnected relationship with many aspects of learning such as cognition, attention, judgement / decision making, and social cognition (Harding *et al*., 2004; Paul *et al*., 2005; Massen *et al*., 2019; Csoltova and Mehinagic, 2020). This is a two-way relationship: emotional state affects learning, and in turn learning can affect emotional state (Mendl *et al*., 2009; Burman *et al*., 2011). In most cases, a calm but alert emotional state is considered ideal for learning.

Therefore, ensuring the animal is in an emotional state conducive to learning is a crucial first step to any behavior modification program. For pet animals, this typically means they have had sufficient rest, exercise, nutrition, social interaction, and that they are comfortable with their surroundings (people, animals, and environment). In some cases, anxiety-reducing medications may be helpful to reduce fear, anxiety, or panicked emotional reactions (see Section 26.6).

26.5.1 Habituation

Habituation is a basic form of learning seen in all animals, including invertebrates (Harris, 1943; Eisenstein and Peretz, 1973). It occurs when an animal's response to a stimulus decreases after repeated, non-consequential exposure. The classic example is a person living near a train track who initially notices the train's sound but eventually ignores it over time. In animals, a dog new to car rides might initially be stressed but gradually becomes comfortable after repeated uneventful trips.

This process occurs naturally over time without intervention and can be a useful tool for introducing animals to non-threatening, novel stimuli. However, if a stimulus evokes fear, anxiety, stress, or aggression, repeated exposure without proper guidance can worsen the response through a process called sensitization rather than habituation.

In contrast to habituation, sensitization involves an increasing response to a stimulus with repeated exposure (Harris, 1943). For example, a dog that shows signs of fear or stress during car rides may become more nervous with each subsequent trip, exacerbating the fear response. Why some animals sensitize while others habituate remains unclear, but factors such as the intensity of the stimulus, individual genetics, and arousal levels likely play a role.

When an animal shows signs of sensitization, removing them from the stressful situation and seeking professional help is crucial. Continuing exposure without intervention can exacerbate the problem, making it more challenging to resolve.

26.5.2 Systematic desensitization

Systematic desensitization is a gradual process similar to habituation, but using controlled intensity of the fear-inducing stimulus (Wilson and Davison, 1971). This is often used to either prevent or address sensitization. It involves exposing the animal to the

fear-inducing stimulus at a very low, non-threatening level, then slowly increasing the intensity as the animal becomes more comfortable. This helps the animal learn to cope with the stimulus without triggering a fear response. For instance, if a dog is fearful of car rides, systematic desensitization might begin with the dog simply sitting in a parked car without it moving, gradually progressing to turning on the engine without the car moving, and then short drives around the block.

26.5.3 Counterconditioning

Counterconditioning is a technique that pairs the previously fear-inducing stimulus with a positive experience, such as treats or praise (Shnookal *et al*., 2024). There are two types of counterconditioning:

- *Classical Counterconditioning*: This involves changing the emotional response to a stimulus by associating it with something positive. For example, if a dog fears the sound of the vacuum, every time the vacuum is turned on, the dog is given a high-value treat. Over time, the dog associates the vacuum with the treat, replacing fear with positive anticipation.
- *Operant Counterconditioning*: This method uses positive reinforcement to change the animal's behavior in response to a stimulus. For instance, many dog owners teach their dogs a recall cue (e.g., 'come', or 'here') by encouraging their dog to come towards them, and giving them a treat once they are within reach. With repetition, the dog learns that approaching their owner in this context will lead to positive outcomes, so in the future, they will choose to engage in this behavior more often.

26.5.4 Positive reinforcement

Positive reinforcement is a type of operant conditioning used to encourage desired behaviors by rewarding them with something the animal finds valuable, such as treats, toys, or praise. When the animal performs the desired behavior, the positive consequence reinforces the likelihood of that behavior occurring again in the future. This approach builds trust and fosters a cooperative relationship between pet and handler, encouraging the pet to willingly participate in learning and behavior change (Haug, 2024).

Positive reinforcement can be used to treat many types of emotional distress. For example, teaching dogs to perform nose targeting behavior to people's hands can help reduce fear of people (Collins *et al*., 2022). Using positive reinforcement to teach cats to enter their carriers helps reduce stress during transportation to a veterinary practice (Pratsch *et al*., 2018).

Positive reinforcement training has been associated with improved pet–owner bond (Deldalle and Gaunet, 2014; de Castro *et al*., 2019), improved animal welfare during and after training (Hiby *et al*., 2004; de Castro *et al*., 2020), and high levels of effectiveness for a wide range of behavior problems (Fernandes *et al*., 2017; Ziv, 2017). Due to these benefits and more, positive reinforcement is often recommended as the first-line treatment option for a wide range of behavior conditions (Friedman, 2009; American Veterinary Society of Animal Behavior, 2021).

One aspect of positive reinforcement particularly relevant in the context of treating emotional distress is the long-held, but highly mistaken, notion that rewarding distress – such as fear – reinforces the fear. This belief can still be found in books on behavior and training, but is without merit. Social support – if agreeable to and effective for the learner – can be helpful when treating emotional distress. Emotional support through comforting social interactions is a very effective method for alleviating psychological distress (see Chapter 9, this volume, for more on the benefits of social support).

26.5.5 Differential reinforcement

Differential reinforcement focuses on reinforcing desirable behaviors while ignoring or redirecting undesirable ones. By reinforcing alternative behaviors that are incompatible with the unwanted action, animals learn to choose more appropriate responses. For example, reinforcing a dog for sitting or standing calmly when visitors arrive, rather than jumping, helps the dog learn a new, more desirable behavior. Over time, the dog will opt for the calm behavior because it results in rewards.

26.5.6 Relaxation training

Relaxation training focuses on shaping calm behavior and promoting relaxation as a core element of behavior modification. Commonly used in companion animal training, relaxation protocols teach pets to lie down and relax on a specific mat or pet bed. The goal is to have the pet associate this mat with calmness, regardless of location, making it a portable tool to help pets remain composed in various situations.

Unlike standard 'go-to-bed' or 'lie down' cues, mat relaxation exercises aim to create a deeper state of calm, helping pets learn better coping strategies when facing stressful stimuli. These exercises are especially useful for dogs with separation-related disorders, helping them feel more comfortable when left alone. Similarly, they can assist in reducing anxiety during car rides, vet visits, and introductions to new people or animals, especially in pets with territorial tendencies. An example of relaxation training for a dog is presented in Figs 26.1 and 26.2.

26.6 Treatment: Psychoactive Medications

Psychoactive medications can be an important component of treatment plans for emotional distress in animals. Used appropriately, they can help improve welfare in the short term or facilitate learning as part of behavior modification plans. Long-term anxiety-reducing medications can also be useful in the treatment of chronic conditions such as generalized anxiety disorder.

A common concern with psychoactive medications is that animals may become dependent on them to cope with stressors, making it difficult to wean them off while maintaining positive behavior. However, this is not the case. Medications do not erase learned behavior. Instead, they facilitate learning by helping the animal develop more desirable emotional and behavioral responses to triggers. Once substantial positive progress has been made, medications can usually be gradually reduced without losing the improvements in behavior and welfare.

It is inappropriate to rely on medications as a monotherapy for treating behavioral conditions. It is important that psychopharmacology is considered *in addition to* enrichment, environmental management, and behavior modification treatment plans.

26.6.1 Legal and ethical considerations

Prescription medications require a consultation with a primary care veterinarian or board-certified veterinary behaviorist. Typically, the veterinarian gathers a behavioral and health history for the patient and performs a physical examination. Baseline blood and urine tests may be recommended to ensure the patient is healthy and able to metabolize medications safely. In some cases, additional information, like video recordings of problem behaviors, may be required for diagnosis.

A veterinarian with expertise in behavior will use the clinical and historical information to make a diagnosis, and will likely make recommendations including environmental management and behavior modification treatments. Medications and/or alternatives are typically recommended alongside (not as substitutes for) behavioral strategies, although there are rare exceptions.

A few veterinary medications have on-label indications, such as Reconcile™ (fluoxetine) for treating separation anxiety in dogs. However, most psychoactive medications are prescribed off-label. In the United States, this means the medication has not been FDA-approved for use in the species or condition being treated. This practice is common in veterinary medicine, where the costs of obtaining on-label approval often exceed potential profits for pharmaceutical companies.

26.6.2 Nutraceuticals, pheromones, and supplements

Common options include calming supplements like L-theanine, tryptophan, cannabidiol (CBD), and S-adenosyl methionine (SAMe), as well as pheromone products such as Adaptil™ for dogs and Feliway™ for cats. These over-the-counter products are mild in effect and may be most effective for low-level anxiety or mild stress, or as a supplement to other treatments. While typically safe, they should still be discussed with a veterinarian. They often work best when used alongside behavior modification and/or medication.

26.6.3 Cannabinoids

Cannabinoids, especially CBD, are gaining popularity for managing anxiety and stress in pets. CBD products have shown promising effects in the treatment of travel stress in dogs (Hunt *et al.*, 2023; Flint *et al.*, 2024), or separation anxiety in dogs and cats (Masataka, 2024). However, results are mixed, as CBD products have failed to show effectiveness in the treatment of noise phobia (Morris *et al.*, 2020), and stress and aggressive behaviors in shelter dogs (Corsetti *et al.*, 2021). It also has potential anti-inflammatory effects, which may benefit pets with arthritis or chronic pain, as reducing

Relaxation Training Example (for a Dog)

Step 1: Introduce the Mat

1. Pick a comfortable mat, blanket, or bed that will be the dog's designated 'relaxation spot'. Some good options are bath mats, towels, or yoga mats. You'll also need some high or medium-value treats and a low-distraction environment where the dog feels comfortable. It may be best to start practicing relaxation training at a time of day when the dog is already in the habit of relaxing, for example after a meal or a walk.
2. Place the mat on the floor and let the dog investigate it. Reward any interest in the mat (e.g., sniffing or touching it). Keep the frequency of treat delivery high at this point, for example every 2–4 seconds (positive reinforcement).
3. Scatter a few treats on the mat to create positive associations. Allow the dog to eat them without expecting them to stay on the mat. When the dog walks off the mat, stop dispensing treats.

Step 2: Reward Calm Behavior on the Mat (see Figure 26.2)

1. When the dog sits or lies down on the mat, reward them with treats and praise. If the dog doesn't settle, try encouraging them by gently luring them into a lying position with a treat.
2. Every time the dog chooses to lie down on the mat, calmly reward them. This step teaches them that the mat is a place for calm behavior.
3. Allow the dog to get up and walk away from the mat if desired; just stop giving treats when this happens. Over time, they will learn through trial and error that treats happen on the mat, and this behavior will become more common (differential reinforcement).
4. Start with short periods on the mat (10–15 seconds) and gradually increase the time as the dog gets comfortable. Continue rewarding periodically as they stay relaxed. Periodically toss a treat off the mat to 'rest' the training session. Keep sessions short at first (3–5 minutes). Pick up the mat in between sessions.
5. Optional – add a verbal cue such as 'relax' or 'go to your mat' once the dog seems to be catching on the game. Say the cue, then use a treat to guide your dog to the mat. When they lie down, reward and praise. Verbal cues are often not required for this type of training, as the presence of the mat itself becomes the cue. But there is no harm in adding one if desired.

Step 3: Practice Relaxation and Stay on the Mat

1. Gradually increase the time the dog stays on the mat. Start rewarding them less frequently as they learn to relax on the mat.
2. Practice having the dog lie on the mat in various locations around the house or outdoors to reinforce the relaxation behavior in different environments.
3. Introduce light distractions (like moving around the room) while encouraging your dog to stay relaxed on the mat. Reward them for remaining calm.

Step 4: Generalize the Mat as a Relaxation Space

1. Once the dog is comfortable, bring the mat with you on outings to reinforce its use as a calm, safe space in new environments. This is the time to start using the mat in real life situations, such as in the car, or at a café. It will be more difficult for your dog to focus and voluntarily relax in new and distracting environments, especially for nervous or high-energy dogs. Be patient and choose situations where you expect your dog will likely be successful at first (e.g., start at a training class or a friend's house, not a food court in a busy mall).

Fig. 26.1. Relaxation training example (for a dog).



Fig. 26.2. This puppy is learning to relax on cue on his mat. (Photograph courtesy of Nita Hynes, DVM, used with permission.)

discomfort can improve behavior (Gamble *et al.*, 2018; Verrico *et al.*, 2020; Patikorn *et al.*, 2023).

The pet CBD market is largely unregulated, so quality and concentration vary. Choosing a reputable brand with third-party testing is essential (Henion *et al.*, 2023). Research on CBD for behavioral issues in pets remains limited, with more promising results found in studies focused on treating pain and inflammation. CBD may aid mild anxiety but is unlikely to be effective for severe behavioral problems, which often require prescription medication.

Always ensure CBD products are THC-free, as THC is toxic to pets. Consult a veterinarian before using CBD to ensure safe and effective dosing for the patient.

26.6.4 Additional considerations: cost, ease of administration

The prices of anxiety-reducing medications can vary significantly. Generic, off-patent medications are often affordable, although veterinary-specific formulations with approved on-label indications may provide certain benefits. For pets covered by a health insurance plan, behavioral health treatments, including veterinary consultations and prescribed pharmaceuticals, might be included in the coverage.

Medications are only effective if they are administered successfully to the patient. Most anxiety-reducing medications come in the form of tablets or capsules, but unfortunately, many have strong, bitter tastes if they are not swallowed whole. A common method pet owners use is to grind the tablets and mix them with highly palatable wet food. However, this method often fails with bitter medications, as the unpleasant taste can easily overwhelm the flavors of the food.

Enclosing tablets in something relatively solid, like small morsels of cheese, hot dog, or commercial products such as Pill Pockets™, is often effective. Feeding three or more small treats in a row can also help. The pet quickly swallows the first few treats in anticipation of more, which helps them consume the tablet hidden in one of the treats once they are used to this sequence. See Fig. 26.3 for tips on this process.

Some psychoactive medications are designed specifically for the veterinary market, including flavored options like Reconcile™ (flavored chewable tablets). Additionally, it is possible to have most medications compounded into chewable tablets or flavored liquid formulations. Although this customization is typically more costly, and the resulting formulations may have shorter shelf lives, it can be beneficial for certain pets.

Transdermal medication delivery has been tested for fluoxetine, unfortunately with poor results (Ciribassi *et al.*, 2003; Eichstadt *et al.*, 2017). Transdermal delivery of mirtazapine has been shown to be effective for cats (Benson *et al.*, 2017; Buhles *et al.*, 2018; Poole *et al.*, 2019; Quimby *et al.*, 2020; Spano *et al.*, 2023). The transdermal bioavailability of other anxiety-reducing medications has not yet been established for veterinary patients.

26.6.5 How do psychoactive medications work?

Psychoactive medications exert their effects by modulating neurotransmission along key pathways in the central nervous system (CNS). These medications affect the activity of one or more neurotransmitters. Common targets are monoamine neurotransmitters (serotonin, dopamine, norepinephrine), GABA, and glutamate. Neuropathways containing target neurotransmitters extend to areas of the CNS responsible for emotional regulation (e.g., limbic system) and decision making (e.g., pre-frontal cortex), resulting in broad effects on emotional state and behavioral control.

Behavior is complex, driven by physiologic state, genetics, epigenetics, learning history, early life experiences, environmental conditions, and more.

Tips for Getting Dogs or Cats to Accept Bitter-Tasting Pills

1) Find your pet's favorite flavors and textures that can be wrapped around a pill – Some pets like Pill Pockets™, while others may prefer special canned food or treats like tuna.

2) Prepare several small balls or morsels of the chosen food – Take a small amount of the food and form several small, treat-sized balls. Practice giving your pet 3 or 4 of these morsels by hand, one at a time. Timing is essential here: offer morsel #2 as soon as your pet eats morsel #1. The goal is to encourage quick swallowing, as they will anticipate the next treat arriving right away.

   a. *Tip*: Tossing treats, or offering them from an overhead angle, can sometimes help encourage pets to swallow quickly without chewing.

   b. *For finicky pets who prefer wet treats like Churu*: Try coating the tablet in Churu or butter and freezing it before offering it. (Check with a veterinarian or pharmacist to ensure freezing doesn't affect the medication's effectiveness.)

3) Introduce a crunchy texture inside the morsels – After your pet is comfortable with the routine, try adding a small crunchy piece (like a Temptation or piece of kibble) in the middle of the morsels. This helps teach them not to be suspicious of hard or crunchy textures.

4) Add the medication – Once your pet is confident with the routine, replace the crunchy piece in morsel #2 with the actual pill, then offer all 3 or 4 treats in sequence as usual. Hopefully, your pet will swallow the medicated treat without noticing any difference!

5) Continue to deliver medications with this routine. Do not reduce the number of treats delivered over time, and continue to deliver the treats in rapid succession to encourage immediate swallowing.

Fig. 26.3. Tips for getting dogs or cats to accept bitter-tasting pills.

Psychoactive medications can indirectly affect behaviors by modulating underlying motivational states.

26.6.6 When are psychopharmaceuticals indicated?

Determining whether an animal may benefit from psychoactive medications is a collaborative process between, at a minimum, the veterinarian and the animal's owner(s) or caretaker(s). Individual responses to emotional distress are highly variable, depending on the individual animal's personality, learning history, and coping style. Animals may respond to stress by displaying active behaviors (e.g., pacing, hypervigilance), passive behaviors (e.g., hiding, lack of exploratory behavior), or both. Lack of progress with behavior modification treatment plans may be another sign that the animal is experiencing ongoing distress.

As mentioned previously, stress activates the HPA axis and autonomic nervous system, causing behavior-relevant changes such as decreased pain sensitivity and increased urination. Physiologic signs of high sympathetic tone include high heart rate, dilated pupils, and increased sweating (through paw pads in dogs and cats, potentially leaving footprints from moisture).

26.6.7 Are psychoactive medications safe?

The majority of commonly used anxiety-reducing medications in veterinary medicine have good safety profile within recommended dose ranges. However, veterinary assessment is critical as patients with underlying disease states (e.g., liver disease) can be at increased risk for side effects, and drug interactions can occur if the patient is taking medications for other conditions. Behavioral signs may also be due to or associated with underlying medical conditions, which may require diagnosis and/or treatment (Mills *et al*., 2020; Amat *et al*., 2024).

26.6.8 Are medications necessary?

Not all cases of emotional distress require treatment with psychoactive medications. In situations where

the triggering factor can be avoided, complete resolution of symptoms can often be achieved through simple environmental management strategies. For instance, kennel stress in a shelter dog often resolves entirely once the dog is adopted or placed in a foster home. Another example is a pet experiencing severe fear of a particular individual dog or cat; in such cases, avoiding contact with the problematic animal can effectively prevent distress.

Even when it is not possible to consistently avoid triggers, mild-to-moderate cases of emotional distress can frequently be managed efficiently using behavior modification techniques, as described above. Mild instances of confinement anxiety, noise phobia, and fear of people or other animals can often be improved quickly with desensitization and counterconditioning (DS/CC). These are often cases where medication alternatives such as nutraceuticals, pheromones, or cannabinoids can be helpful.

Psychoactive medications are commonly indicated for animals in cases where:

- The animal's welfare needs improvement within a given environment where certain triggers are unavoidable.
- The frequency and/or intensity of behaviors related to anxiety, fear, stress, or excessive arousal need reduction, complementing environmental and behavioral treatments.
- Enhancing the feasibility or effectiveness of behavior modification interventions is necessary.
- There's a need to minimize the impact of unavoidable stressful events, such as a medical procedure or necessary travel.

26.7 Evidence-based Medicine

The Oxford Centre for Evidence-Based Medicine (OCEBM Levels of Evidence Working Group, 2011) ranks research types by their value for clinical decision making. The highest value (level 1) goes to well-designed, blinded randomized controlled trials (RCTs), or ideally, systematic reviews of multiple such studies. Other evidence types – such as lower-quality RCTs, non-controlled trials, and expert opinion – can still be useful, but clinicians and behavior professionals should be mindful of the high potential for bias in these forms.

The importance of blinding and control groups cannot be underestimated in veterinary clinical trials. In 2014, Gruen *et al.* (2014) conducted an open-label trial adding trazodone every 12 hours to the post-operative care plan for dogs under strict rest after orthopedic surgery. Results appeared promising: 89% of owners reported 'moderately or extremely' improved tolerance with trazodone. However, in a later blinded, randomized trial with a placebo, Gruen *et al.* (2017) found no significant difference between trazodone and placebo groups, with over 70% of owners in both groups reporting improvement. This highlights the strong placebo-by-proxy effect in medication studies.

The placebo effect can be avoided with well-designed randomized controlled clinical trials, where participants and researchers are blinded to treatment conditions. For instance, Landsberg *et al.* (2008) found that oral fluoxetine (1–2 mg/kg, Reconcile™) improved separation anxiety treatment outcomes compared to placebo, even without behavior modification.

In another RCT, Eagan *et al.* (2023) studied fearful cats from hoarding environments, comparing gabapentin every 12 hours to placebo during behavioral treatment aimed at building trust for adoption. Cats receiving gabapentin not only showed lower stress scores but also completed the program an average of 1 week sooner than those receiving the placebo.

26.7.1 What type of therapy should be tried first?

Psychoactive medications are one of several tools for enhancing psychological welfare and addressing problem behaviors in animals. Some interventions that might be worth attempting before medication include:

1. Environmental management (e.g., placing a visual barrier for a dog that barks at people or other dogs passing by).
2. Changing housing type (e.g., moving a fearful shelter cat to a foster home).
3. Enrichment (e.g., providing extra walks or nose-work sessions for an understimulated dog).
4. Behavior modification plans.

If an animal's welfare continues to suffer from ongoing stress despite environmental and behavioral interventions, medications should be considered sooner rather than later. Typically, it is possible to assess within 24–48 hours whether environmental and behavior modification strategies will significantly improve welfare.

In some cases, immediate initiation of psychoactive medication is warranted. Examples of cases requiring urgent medication include behaviors causing

harm to self or others, severe phobias such as separation or noise phobia, profound inactivity ('shut-down' or severe behavioral inhibition), among others.

26.8 Medication Considerations

26.8.1 Fast- versus slow-acting medications

Psychoactive medications are generally categorized as either fast acting or slow acting (see Table 26.2).

Fast-acting medications work within about 30 minutes and their effects are typically strong but short-lived, lasting 2–12 hours depending on the medication. Sedation is a common side effect, especially at high doses or when combining these medications. Fast-acting medications often show 'peak and trough' effects, with the strongest impact occurring 1–2 hours after administration and gradually wearing off until the next dose.

These medications are commonly used for predictable, unavoidable stressors, such as travel for a dog with car anxiety or a vet visit for a fearful cat. They can also be useful for acute emotional stabilization to improve quality of life, like for a dog showing kennel stress in a shelter.

Another use for fast-acting medications is as a 'bridge' while waiting for long-term medications, like selective serotonin reuptake inhibitors (SSRIs), to take effect. A fast-acting medication provides immediate relief and can be gradually tapered off after 4–6 weeks once the slow-acting medication starts working.

Tapering the dose is recommended for fast-acting medications if used daily for more than 2 weeks. Common examples in this category include trazodone, gabapentin, pregabalin, clonidine, dexmedetomidine, and benzodiazepines.

Slow-acting medications require longer to take effect, usually 4–6 weeks. Their impact is generally more subtle, without the 'peak and trough' fluctuations seen in fast-acting medications. They provide all-day effects without noticeable highs and lows, and sedation is less common and generally undesirable if it occurs. Side effects, if present, often appear in the first 1–2 weeks and are frequently transient (resolve within 1–2 weeks without treatment).

Slow-acting medications are ideal for animals experiencing consistent, day-long anxiety, fear, or arousal, especially when triggered by unpredictable or unavoidable factors. They are commonly prescribed for chronic issues like generalized anxiety, compulsive behaviors, severe separation anxiety, and intense noise phobia.

When discontinuing slow-acting medications, tapering is strongly recommended, especially if used for 2 months or more. Examples commonly used in veterinary medicine include fluoxetine, clomipramine, and selegiline.

Dose adjustment frequency depends on the time of onset: fast-acting medication doses can be increased at 8–48 hour intervals, while slow-acting medication doses should not be increased for the first 4 weeks of treatment (and every 2 weeks thereafter).

26.8.2 Behavioral disinhibition

Behavioral disinhibition, especially concerning aggressive behaviors, is a common consideration when prescribing psychoactive medications. In veterinary medicine, benzodiazepines are the class of medications most frequently associated with disinhibition of aggressive behaviors (Miczek and Fish, 2005; Herron *et al.*, 2008). However, the risk of this side effect appears very low with other commonly used medications, and psychoactive drugs are often

Table 26.2. Fast- versus slow-acting medications.

	Fast acting	Slow acting
Time to effect	30–120 minutes, depending on the medication	Usually 4–6 weeks (sometimes faster)
Duration of effect	<24 hrs (depends on medication, some last 2 hours, others may last 12–18 hours)	24 hours or longer
Sedation common side effect?	Yes, usually dose-dependent	Possible but not common
Taper prior to discontinuation?	Recommended if patient has been taking daily for >2 weeks	Strongly recommended if patient has been taking for >2 months
Common medications in this category	Trazodone, gabapentin, pregabalin, clonidine, dexmedetomidine, benzodiazepines	Fluoxetine, paroxetine, fluvoxamine, venlafaxine, clomipramine, amitriptyline, selegiline

successfully employed to manage aggressive behaviors driven by fear, excessive arousal, and/or impulsivity.

Nonetheless, caution should be exercised when introducing any new psychoactive medication, and the animal's behavior should be closely observed for any changes. If sudden-onset aggressive behavior occurs that is out of character for the animal and aligns with starting or increasing the dosage of a psychoactive medication, this should be promptly reported to the prescribing veterinarian.

26.8.3 Trial and error

Optimal use of psychoactive medications often requires an initial trial and error period. As well described in humans, individual animals respond best to different medications or doses, likely due to differences in emotional state, genetics, neurophysiology, metabolism, etc. It can take weeks, months, or sometimes years to find the right medication(s) and the right dose for the individual animal.

Dosing for psychoactive medications is highly variable. Higher doses do not always equate to greater effects with these medications. Some patients are more sensitive than others to lower doses, and experience more side effects at lower doses. Generally, the best strategy is to start at the low end of the therapeutic dose range and titrate up to desired effect, while closely monitoring the patient for potential side effects.

A desirable response to psychoactive medication typically includes remission or significant reduction of undesirable behaviors, changes in body language indicating an improved emotional state, and increases in desirable or healthy behaviors.

For long-term use, the patient should be maintained on the lowest effective dose that does not cause significant side effects.

26.8.4 Discontinuing psychoactive medications

Modern psychopharmaceuticals are not considered to be addictive (defined as causing intense cravings or severe physiologic symptoms with withdrawal), with the notable exception of benzodiazepines. However, milder 'discontinuation symptoms' are possible with all psychoactive medications that have been given chronically.

Discontinuation symptoms reported by human patients include nausea, lethargy, dizziness, ataxia, 'brain zap' sensations, anxiety, insomnia, and vivid dreams, among others. There are currently no studies on discontinuation symptoms in veterinary patients, but anecdotally rebound anxiety is common with fast weaning or abrupt withdrawal of chronic medications. Withdrawal symptoms are usually not medically dangerous in veterinary patients, but it can be an uncomfortable and unpleasant experience for the animal and their caregivers.

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Index

Note: Page numbers in **bold** type refer to **figures;** Page numbers in *italic* type refer to *tables*

abnormal behaviors 407
  and maladaptive behaviors 158–159, *357*
  in zoo animals 325
abnormality 225
Actinobacteria 54
active fear-inhibitory process 105
acute stress 423
adaptive fear responses 183–184
adversity 124–125
  early life adversity (ELA) 158, 199, 409–411
  lesser states of 159–160
affect balance model 6
affective (mood) disorders 196
  comorbidity with 249–250
affective experience, of extreme aversiveness 156–158
affective states 369–381, *377*, 400
affective valence 378–380
affordance theory 232
agency 299–300
aggregation problems 398–399
aggression
  fear 343–344
  human-directed 343
  intraspecific and interspecific 343
  play 344
  problems 343
  redirected 344
  territory 343
aggressive behavior 344
aggressive dogs 53
aging pets 243–254
allostasis, concepts of 415
allostatic load 415
allostatic load index (ALI) 41, 415
altricial mammals 138
Alzheimer's disease (AD) 246
Amazon parrots *(Amazona amazonica)* 339–341
American College of Veterinary Behaviorists (ACVB) 53
American College of Veterinary Internal Medicine (ACVIM) 53
American Veterinary Society for Animal Behavior 141
amplification function 167–168
amygdala 35
ancestral traits 354–355
anesthesia 10, **11**
anhedonia 297
animal-based (AB) indicators 388–389
animal cruelty laws 403–404
animal emotion
  assessment, concepts to 373–374
  concept 369
  consciousness and concepts 370–372
  emotional states 369–370, **370**
  expressive and cognitive indicators 374–378
  terminology 372–373
Animal Liberation (Singer) 19
Animal Machines (Harrison) 22
animal models
  of human psychiatric disorders 408–409
  of learned helplessness 408
animal rights 19–20
animal welfare 8, 354, 387
  concept of 6
  definition of 23
  determinant 380
  professionals 416
  science of 20–24
Animal Welfare Act (AWA) 309
Anolis sp. **353**
anticholinergic drugs 253
anxiety 105, 121, 136, 233, 249, 316
  in captive birds 338
  concept of 232
  in dogs 295
  frustrations and 282–285
  and mood disorders 158
anxiolytic drugs 204
Apis meliffera see honeybees
Applied Behavior Analysis 227
approach-approach conflict 282
approach-avoidance conflict 282
aquarium animals 323–331
artificial-intelligence-based approach 235
artificial lighting 341
artificial weaning methods 267
Asiatic black bear 190
Association of Zoos and Aquariums (AZA) 323
asymptomatic disease 12
attachment disorders 197
attention-deficit/hyperactivity disorder (ADHD) 54–57
autism spectrum disorder (ASD) 50, 56

autonomic nervous system (ANS) 50, 188, 423
avian caregivers 342, 345–346
avoidance-avoidance conflict 282, 283

Bacteroidetes 57
battery cages 24
Beagle puppies 40
bear bile 190
bears 190–191, **191**
beef cattle 266
behavior
  aggressive 344
  anticipatory 297
  change 254
  modification 425
  patterns 24
  responses 183
  tradition 227
behavioral abnormality 225–227
behavioral cause **229**
behavioral complexity 219
behavioral disinhibition 432–433
'behavioral engineering' approaches 299–300
behavioral feather picking 341
behavioral health
  definition 135
  development and mental welfare 137–138
  environmental influences on 138–142
  routine assessments of 146
  of sheltered animals 294–301
  welfare and concept of needs 136–137
behavioral needs 136–137
  emotional states and meeting 142–143
behavioral phenotyping 299
behavioral research 3
behaviorism 21–22
benzodiazepines 254
Bifidobacterium longum (BL999) 56
Bifidobacterium pseudolongum 54
big data 91
biological age 415
Biological Functioning School 23
biomarkers 40–41, *41*, 414–416
birds
  emotional well-being in 337
  frightened 345
  and mammals 356
  mammals and 136
  pet 345–346
  seasonal nesting behavior 352
  wild-caught 191
birth-to-death welfare inventory 312, *313*
Blautia 54
blood brain barrier (BBB) 51, 52
blue fox *(Alopex lagopus)* 138
boredom 286
brain 30
  function 50
  micro-architecture 281
brain-blood biomarkers 189
Brambell Committee 22
Brambell Report, The 22, 312
breast feeding 51
brown capuchin monkeys *(Sapajus apella)* 71

Cacatuidae family 337
'calming signals' 283
Canine Behavioral Assessment & Research Questionnaire (C-BARQ) 54, 74, 298
Canine Frustration Questionnaire (CFQ) 298
canine idiopathic epilepsy (IE) 54–55
cannabinoids (CBD) 427–429
captive animals **101**
captive psittacine birds 337–346
Case for Animal Rights, The (Regan) 19, 20
cats 39, **430**
  adolescent phase in 141
  behavior **147**
  clinical signs in 243
  cognitive dysfunction in *250*
  depression 197
  dogs and 90
  hyperthyroid 249
  socialization phase for 139–140
  species 105
  VISHDAAL in 243
cattle 265–267
cattle dogs 129
causal indicators 397
central nervous system (CNS) **31**, 35, 51–52, 161, 429
central threat response system (CTRS) 30, 34, 36, 38, 40
  behavioral parameters *41*
  physiological parameters *40*
cephalopod molluscs 261
cephalopods 25
chemical biomarkers 41
chickens 269–271
chicks 340
child-parent relationship 217
chimpanzees *(Pan troglodytes)* 65, 82
  happiness 67–70, **68**
  object-play in **81**
China Bear Rescue Center (CBRC) 191
choice 102
chronic conditions 40
chronic diseases 37
chronic enteropathy (CE) 53, 58–59
chronic pain 285–286
chronic progressive disease 246
chronic stress 214, 409, 423
classical brain neuroanatomy 351
classical conditioning 283

classical counterconditioning 426
client-owned dogs 54
Clinical Practice Guidelines for Military Working Dogs 409
Cntnap2$^{-/-}$ mice 50
cockatiels *(Nymphicus hollandicus)*, 344
cockatoos *(Cacatua galerita)* 340
cockatoos *(Cacatua goffiniana)* 338, **342**
coefficients of inbreeding (COI) 416
cognitive ability 227
cognitive and emotional disorders 243–254
  evaluation 246–250
  nutraceuticals and prescription diets 252–253
  treatment for 250–254
cognitive barriers 182
cognitive behavior therapy (CBT) 203–204
cognitive bias 378–380
  tests 73, 414
cognitive dysfunction syndrome (CDS) 243–244
  and associated problems 288
  characteristics 244
  comorbidity with affective disorders 249–250
  diagnosis 247–249, **251**
  in dogs and cats *250*
  pathophysiology 246–247
  prevalence of 244–246
  progression 246
  risk factor for 246
cognitive functioning 173
cognitive impairment 252
cognitive markers 378–380
Cognitive Processing Therapy 202
cognitive stimulation 324
commensal domestication 260
Committee on Pain and Distress in Laboratory Animals 158
communicative human patients 88
comorbid disorders 33
companion animal mental health
  chronic enteropathy and 58–59
  dysbiosis 52
  gastrointestinal microbiome and microbiota 51
  gut microbiota 51–52
  microbiota-gut-brain axis 51–52
    and canine idiopathic epilepsy 54–55
    comparative 52–53
    human diet research and 57–58
    nutritional strategies and whole diets effects on 57
  nutrition and 55–57
comparative personality 298
compliance-focused assessments 389, 391
compulsive disorders 286
computational modeling 379–380
concept of disorder 225–227
conflict-induced displacement behaviors 342
conscientiousness 70
consciousness 10, **11**, 21, 25
  animal emotion 370–372
Conserved Transcriptional Response to Adversity (CTRA) 34
contingent suffering 309
contrafreeloading 300
control/controllability 106
  in animals 105
  behavioral need 137
  beneficial effects 105–106
  concept of 101
  defining and characterizing 102
  desirability of 103–104
  and distress 169–170
  enhancing *see* enhancing control
  event-specific *vs.* general 109–110
  learned helplessness 107–108
  locus of 102–103
  to mental health and well-being 104–106
  perception of **102**, 200
  predictability 106–107, *111–112*
  secure hiding place **109**
  sense of 169–171
  and suffering 170–171
  types of 103
convolutional neural network (CNN) 376
cooperative feeding 327
coping 136
  ability 7–9
  and mental health 280–282
  styles 297–299
corkscrew tails 37
corticotropin-releasing hormone (CRH) 408
counterconditioning 143, 344, 426
  exercises 283
COVID-19 pandemic 294
  population reductions 294
cow 266, **266**
curiosity 36
Cushing's disease 288
cynomolgus macaque *(Macaca fascicularis)* **317**

Decapods 25
decision-making theory 380
depression 34, 121
  and 'learned helplessness' 196–197
Descent of Man, The (Darwin) 21
desensitization 143, 343
desensitization and counterconditioning (DS/CC) 233, 343, 344
desirability of control 103–104
development
  of altricial mammals 138
  genetic predispositions 137
  mental welfare 137–138

Diagnostic and Statistical Manual of Mental Disorders (DSM-III) 181
diagnostic biomarkers 40
dietary fibers 55
diet change 59
diet research 57–58
differential reinforcement 426
dimensional emotion 371
direct catecholamine action 35
direct connections 72–73
discontinuing psychoactive medications 433
discrete emotions 159, 370–372, 375
distress 136, 155–174
  adversity leads to abnormal and maladaptive behaviors 158–159
  affect and motivation 161
  affective experience of extreme aversiveness 156–158
  amplification function for 167–168
  causes 162–163
  conception of 157
  definitions and concept 155–160
  emotions 168
  fear and 244
  laboratory animal 311
  learned experience 168
  lesser states of adversity 159–160
  low-motivation form of 164
  measurement 158, 171–173
  nature of 160–168
  negative affect 156, 164–167, **166**
  personality traits 168
  proposed definition of 171
  psychophysical and existential 160
  responses lead to pathologic changes 158
  sense of control 169–171
  social support 168–169
  specific, discrete or basic emotion 159
  and suffering, comparisons between 156
  threshold and moderating 168–169
  unspecified intensity 157–158
Doberman Pinschers 37
docosahexaenoic acid (DHA) 246
Dog Aging Project 252
dogfighting yard **410**
Dog Impulsivity Assessment Scale (DIAS) 298, 299
dog-owner relationship 217–218
dogs *(Canis familiaris)* 39, 73, 406–407, **430**
  adolescent phase in 141
  aggression in 53
  attachment style 36
  behavior **147**
  and cats 90
  cognitive dysfunction in *250*
  cognitive dysfunction syndrome (CDS) 244
  depression 197
  emotional expressions in 297
  exhibiting chronic signs 204
  fear and anxiety 295
  fearfulness in 214
  female 406
  fetal development in 138
  focus on 213–219
  in hoarding situation **411, 413**
  in kennel environment 108
  personality and mental tests 219
  with plentiful canine companionship **129**
  posttraumatic stress disorder 192, **193**
  resilience in 215
  in shelters 298
  socialization phase for 139
  special case of 128–129
  with storm phobia 125
  in stressful circumstances **129**
  well-being and health 214
domestication 260
dominance, in psittacine birds 344–345
dominate attention 162
dopamine (DA) 126
drift-diffusion models 380
drug-refractory epilepsy (DRE) 57
drug-sensitive epilepsy (DSE) 57
DSM-5 diagnostic criteria 186, *187,* 194
dust-bathing behavior 25
dysbiosis 52

early life adversity (ELA) 158, 199, 409–411
early life threats 32
ectothermy 355
education 35, 145–146
effect indicators 397
elastic demand 25
electric shock 109, 124
electroencephalogram (EEG) 249
emotion 86, 168
  concept 234
  as conscious subjective experiences 370
  dimensional model of **371**
  discrete 370–371
  experience 370
  of fear 183
  feelings 230
  functional analysis of 234–235
  functional categorization of 230
  motivation and 228–234, **231**
  multiple components of *231*
  problem behavior evaluation 234–235
  separation 230
emotional communicative signals 235
emotional contagion 411
emotional disorders and problem behavior 224–237

emotional distress 128, 423–433
behavioral disinhibition 432–433
behavioral signs of *424*
behavior modification 425
counterconditioning 426
differential reinforcement 426
emotional state and learning 425–427
environmental management 424–425
evidence-based medicine 431–432
fast- *vs.* slow-acting medications 432, *432*
habituation 425
health, nutrition, physical needs 423–424
medications necessary 430–431
positive reinforcement 426
psychoactive medications 427–431
psychopharmaceuticals 430
relaxation training 426–427
systematic desensitization 425–426
trial and error 433
emotional feelings 371
emotionally competent stimuli (ECS) 232
'emotionally expressive' behavior 369
emotional processing 3
emotional responses *233*
emotional states 142–143, 230, 232, 235, 369–370, **370**
and learning 425–427
emotional well-being 4, 101, 337
emotion in animals 235
endorphins 126
energetics 355
enhancing control 108–110
adverse effects of uncontrollability 110
in early life 110
and predictability 106–107, *111–112*
specific and general control 110–112
therapeutic considerations 112–113
'The Enlightenment' 18, 19
enrichment 145–146, 251–252, 424
environmental enrichment (EE) 37, 41, 42, 145, 299, 318–319, 424
investigate physiological responses to *42*
National Library of Medicine publications of **42**
zoo animals 328–329
environmental factors 215–217
environmental influences 138–142
environmental management 424–425
environmental modifications 252, 424
environmental stimulus **31,** 136
environmental threats 34, 39
environment, sheltered animals 295–297
epigenetic factors 218
epinephrine 408
eudaimonia 87
Eureka effect 300
European Association of Zoos and Aquariums (EAZA) 323
eustress 136
event-specific control 103
vs. general control 109–110
evidence-based medicine 431–432
evolutionary perspective 281
ewe-lamb bond 267
excessive vocalization 342–343
excess licking of surfaces (ELS) 53
exercises
counterconditioning 283
and enrichment 252
pets energy level and 36
on resilience 216–217
existential distress 160
existential suffering 160
experimental psychology 224
Expert Knowledge Elicitation 397
exposure therapy 203
Expression of the Emotions in Man and Animals, The (Darwin) 21, 375
expressive behavior 375–378
external locus of control 103
eye movement desensitization and reprocessing (EMDR) 203, 204

facial behaviors 375–378
machine learning to detect 376–378
facial expressions 359
Faecalibacterium prausnitzii (ATCC 27766) 56
Farlex Partner Medical Dictionary's (2012) 156
farm animals 20
domestication 260
future 272
'Good Life Frameworks' 265
history of 260–261
intensive systems 271–272
mental well-being in 261
positive experiences 264
positive welfare opportunities for 265
principles of good life for 263–265
scale of suffering 261–263
species, good life for **262,** 265–271
cattle 265–267
chickens 269–271
pigs 268–269
sheep 267–268
value of choice 264–265
Farm Animal Welfare Council (FAWC) 265
fast- *vs.* slow-acting medications 432, *432*
fear
aggression 343–344
conditioning 188–189
and distress 244
in dogs 295
responses 139

fearfulness 214
fear-inducing stimuli elicit 124
fear-related disorders 106
fear-related responses 233
fear structure, concept of 183
feather-damaging behavior 341–342
feather picking 341–342
fecal microbial transplant (FMT) 50, 56–57
Federal Emergency Management Agency (FEMA) 54
feelings 17–26
  subjective nature of 23–24
  of subjective well-being 285
Feelings School 23
female dogs 406
fetus 38, 39
Five Domains Model 295, 387–400
  applications of 392
  assessments 395–396
  challenges 396–399
  defining feature of 392
  for laypeople **395**
  mental experiences 392–394
  overview of 388–392
  structure 393
  for welfare assessment 387, **388,** 396–399
Five Freedoms (Farm Animal Welfare Council) 387, 393
Five Freedoms of Animal Welfare 41, 42
flourishing 87
frustrations 282–285
fun animals, what and why of 79–82, **80, 81**
functionality 226, 227
Fusobacteria 54

gabapentin 254
gamma-aminobutyric acid (GABA) 51
gastrointestinal (GI) microbiome 51
gene expression 37, 39
general control 103
generalized anxiety disorder (GAD) 196, 288
genetic disorder 39
genetic factors 218
genetic influences 37–38
genetic predispositions 137, 147
genetics 199, 297–298
good health management 268
'Good Life Frameworks' 265
gray parrots *(Psittacus erithacus)* 338, 340, 341
grazing/foraging behaviors 281
'The Greatest Happiness Principle' 19
grey areas 26
grooming 105
Groundwork of the Metaphysic of Morals (Kant) 18
Guide for the Care and Use of Laboratory Animals (the *Guide*) 309
guinea pigs *(Cavia porcellus)* 25, **120,** 260

gut microbiota 50, 51–52
  and behavioral issues 53
  similarities in 52

habituation 425
happiness 4, 12, 19, 65–75
  chimpanzee 67–70, **68**
  concept of 7
  direct connections 72–73
  emotional well-being and 101
  indirect connections 73–74
  in nonhuman primate 67
  in other species 70–72
  pet **144–145**
  psychological constructs and nomological networks 65–67
  pursuit of 65
healing psychological trauma 202–205
health 86–87
health disorders 92
health-related QOL (HR-QOL) 91
Health Research Extension Act of 1985 309
healthy microbiome 52
heart rate variability (HRV) 214
helplessness 297 (*see also* learned helplessness)
hens **270**
hip dysplasia 37
hippocampus 213
homeothermic animals 313
Hominoid Personality Questionnaire (HPQ) 70
honeybees 25, 73
horse
  box **284**
  mental health issues in 279–289
human activities 20
human-animal interactions 316–317
human-bird contact 346
human diet research 57–58
human-directed aggression 343
human emotion 371, **372**
humane treatment strategies 236–237
human medical resource allocation 93
human mental health 50
  research 52
human psychiatric disorders 408–409
human psychological research 103
hyperarousal symptoms 186
hyperthyroid cats 249
hypervigilance 186
hypothalamic-pituitary-adrenal (HPA) axis 37, 50, 51–52, 121, 122, 125, 138–139, 213, 408, 409
hypothalamus 66

idiopathic cystitis 109
improvement-focused assessments 391

impulse control 299
inadequate socialization 197–198
indirect connections 73–74
individual-centered approach 13
individuality 352–353
individual well-being 155
Industrial Revolution 19
'inelastic demand' 25
inflammatory bowel disease (IBD) 58
'inherent value,' concept of 20
instrumental value 87
intelligence 36
intensity 157, 167
intensive systems 271–272
intermittent punishment 285
internal episodic states 228
internal locus of control 102
intraspecific and interspecific aggression 343
isolation-related stress 123–124

'jingle jangle' problem 70
judgement bias 378
judgement bias task (JBT) 379, **379,** 380

kangaroos 25, 205
Keeper–Animal Relationships (KAR) 326–327
kennel-dog syndrome 39
killer whales *(Orcinus orca)* 71
kittens 140
Kumamoto Sanctuary 70

laboratory animal 308
  distress 311
  environmental enrichment 318–319
  human-animal interactions 316–317
  improvement of well-being in 311–319
  lights 314
  mice 312
  monkeys 312
  noise and vibration 314
  organizing framework for 312
  pain and 317–318
  physical environment 312–313
  regulatory and historical context 309
  social environment 314–316
  stress 311
  suffering 309
  temperature 313–314
  welfare and research data 309–311
Lactiplantibacillus plantarum PS128 56
Lactobacillus reuteri 50
Lactobacillus sp. 56
language and cognitive barriers 182
laypeople **395**
learned experience 168
learned helplessness (LH) 107–108, 112–113, 164, 171, 285, 297, 408
  depression and 196–197
learning 352
  emotional state and 425–427
  and motivation 425
  theory 301
Lemur catta 71
length of stay (LOS) 294
lesioned rats 66
Leviathan (Hobbes) 18
life stressors 214
'limited rights' 20
Lincoln Canine Adaptability Resilience Scale (L-CARS) 215, 298
livestock animals 124
lizards 352, **353, 358**
locus of control (LOC) 102–103
loneliness 121
longitudinal behavior assessments 298
Loriidae family 337
loss of control 225–226
loss of social support 285
low-motivation form, of suffering 164

macaques 316, 317
macaws **340, 346**
machine learning, to detect facial behaviors 376–378
maladaptiveness 226
mammalian brain 80
mammals
  and birds 136
  marine 25
  needs for 136
  restricted movement of 295
marine mammals 25
marmosets *(Callithrix jacchus)* 71
maternal care 216
mechanistic disruption 226
medical research 308
medium-chain triglycerides (MCT) 57, 253
memory 352
memory-modulating mechanisms 184
memory tests 54
mental and physical health
  in animals 41–43
  context of 32
  definition of 30
  environmental stimuli **31**
  evaluation 40–41
  overview 30–32
  risk and protective factors 32–40, *33*
    behavioral factors *33,* 35–37
    biological factors *33,* 37–40
    environmental factors *33,* 33–35

mental disorders 53, 158
and ultra-processed (UPF) 57–58
mental health 87
of adult companion animals 142–145
behavioral health and 135
concept of 30
coping and 280–282
definition 135
implications 113
in reptiles 350–360
and well-being 101–113, **108**
mental health issues
in captive psittacine birds 337–346
in horse 279–289
Boredom 286
circumstance 280
coping, adaptation, and 280–282
fears 282–285
frustrations and anxieties 282–285
loss of social support 285
novel domestic challenges impacting on 286–288
pain 285–286
separation anxiety 285
unmet evolutionary expectations impacting on 286
protocol for assessing and remedying 359
mental stimulation 136
mental tests 219
mental welfare 137–138
mental well-being
challenges and opportunities for 308–319
in farm animals 261
monitoring 295
of sheltered animals 294–301
metabolic rate 355
methylation 218
mice 50, 312, 314
and rats 315
microbial diversity 52
microbiome-gut-brain axis (MGBA) 50, 51–52
and canine idiopathic epilepsy 54–55
in companion animal mental health 53–54
comparative 52–53
human diet research and 57–58
nutritional strategies and whole diets effects on 57
in veterinary medicine 53
mild stressors 139
mirtazapine 429
mitochondria 34
moderate stress 216
monitoring welfare 295
monkeys 312
monoamine oxidase B (MAOB) 253
mood disorders 158
morbidity 355
motivational state 230
motivation function 162–163
motivations 86
animals 86
assessment 234
concepts 228, 234
and emotion 228–234, **231**
learning and 425
problem behavior evaluation 234–235
mouse 314
multiple diets 252
multiple traits **66**
musculoskeletal system 244

National Institute of Food and Agriculture 32
National Institutes of Health (NIH) 309
necessities 25
needs
concept of 136–137
for mammals 136
negative affect (NA) 156, 164–167, **166**
in animals 406–408
negative emotional states 136, 406
negative emotions 6, 25, 142–143, 214, 407
negative feelings 25, 261
negative reinforcement 282
negative social emotions 121
nervous system reflexes 354
neuroactive compounds 55
neurobiology of resilience 213–214
neurochemistry 35
neuroendocrine mechanisms 182
neuro-endocrinological state 228
neurogenic stress 406
neurohormones 126
neurological disorders 50
neuropeptides 125
neurophysiological changes 189
neuropsychological disorders 50
neuroticism 69, 214, 217
neurotransmitters 51
noise 296
and vibration 314
nomological networks 65–67
non-food products 260
non-human animals 84, 155, 369
behavior 224
nonhuman social species 118
nonhuman species 104, 110
non-isolation-related stress
isolation-related and 123–124
stress-related *vs.* 123
non-monetary methods, of valuation 94
non-social fearfulness 215
non-social-isolation stress 124–125
normality, concepts of 225
NOVA food classification system 57–58

novel domestic challenges 281
nuclear factor kappa beta (NF-κB) 34
numerous nonhuman primates (NHPs) 316
nutraceuticals 427
  and prescription diets 252–253
nutrition 55–57

obesity 36, 118
objective knowledge 155
object-play 81, **81**
Obligation and Extent of Humanity to Brutes, Principally Considered with Reference to the Domesticated Animal, The (Youatt) 21
observer discomfort 226
obsessive compulsive disorders (OCD) 288, 342
occasional behavioral scientist 22
occupational therapy 327
operant counterconditioning 426
opioids 126
optimism/pessimism 103
orange-chinned parakeets *(Brotogeris jugularis)* 342, **342**
Origin of Species, The (Darwin) 21
oxytocin (OT) 126
oxytocinergic system 50
oxytocin-opiate system 128

pain 86, 285–286, 406
  and laboratory animal 317–318
pain-related suffering 165, 167, 172–173
pair bonding 339
paired parrots 339
Panthera uncia 71
parakeets *(Aratinga canicularis)* 340
parrots **120**
perception of control 200
perception of threat 32
personal control 101–113
personality 65–75, 297–299, 352–353
personality traits 35, 65, 168, 214–215
pessimistic bias 74
pets
  adaptability influences 37
  aging 243–254
  behavior 53
  birds 339, 345–346
  CBD market 429
  curious and intelligent 36
  dogs *see* dogs
  energy level and exercise 36
  happiness **144, 144–145**
  owners 142, 243
  personality 35
  professionals 145–147
  unrealistic expectations for 142
  veterinarians 243
pharmacotherapy 204
pheromones 427
phosphatidylserine 252
physical and mental health 423
physical environment 42, 136, 312–313
  conditions 354
physical punishments 283, 346
physical well-being 10
Physignathus sp. **358**
physiological stress responses 105, 300, 409
Pictorial Representation of Illness and Self-Measure (PRISM) 171
pigs 268–269, **269**
  ground-truth categorization of 377
Pill Pockets 429
play aggression 344
pleasurable experiences 137
population attributable fractions (PAF) 37–38
positive animal welfare 369
positive emotions 6, 25, 142–145, 325
positive feelings 25
positive mental states *358*
positive psychological state 288
positive reinforcement 426
positive reinforcement training (PRT) 317, 327–328
positive social behaviors 105
positive social emotions 120
postbiotics 56
posttraumatic disorders 182
posttraumatic phobias 195
posttraumatic psychopathology 181–205
posttraumatic stress (PTS) **185,** 185–195, **195**
posttraumatic stress disorder (PTSD) 106, 146, 181, 183, 184, 408–409, 415
  in animals 189–195, **195**
  biomarker research, 202
  cognitive behavior therapy 203
  definition and diagnosis of 186
  depression and 'learned helplessness' 196–197
  in dogs 192, **193**
  DSM-5 diagnostic criteria for 186, *187*
  eye movement desensitization and reprocessing 204
  formal recognition of 184
  generalized anxiety disorder 196
  interindividual variability of 187
  neurobiology and pathophysiology 188–189
  pathophysiology 184–197
  pharmacotherapy 204
  posttraumatic phobias 195
  posttraumatic stress and **185,** 185–195
  prolonged exposure 203
  spectrum of 201–202
  subthreshold 201
  treatment 204–205
potentially traumatic event (PTE) 182
prebiotics 55–56
predators 324

predictability 106–107, 111, *111–112*, 136–137, 300–301
predisposing factors, mental and physical health 33
prescription medications 427
primary appraisal 280
probiotics 56
problem-solving 352
professionals 145–147
pro-inflammatory genes 34
prolonged exposure (PE) 203
propentofylline 253
proximity-promoting mechanism 119
Psittacidae family 337
Psittaciformes 337
psittacine birds 337–346
  aggression problems 343
  developmental factors 339–340
  dominance in 344–345
  excessive vocalization 342–343
  fear aggression 343–344
  feather picking and self-mutilation 341–342
  foraging opportunities 340–341
  intellectual capacity of 346
  lighting and 341
  mental states and experiences of 338
  pair bonding 339
  photoperiod 341
  play aggression 344
  poor mental health 341–345
  predictable environments 339
  quality of care for 345–346
  reproductive behaviors 344
  screaming 342–343
  sleep deprivation 341
  social interactions 338–339
  species diversity 337–338
  territorial aggression 343
psychiatric disorders 213
psychoactive medications 427–433
psychobehavioral problems 355–359
psychobiological approach 225, 228, 230, 232, 234, **237**
psychobiological perspective 224–237
  behavioral abnormality 225–227
  concept of cause 227–228
  concept of disorder 225–227
  concepts of motivation 228–234
  humane treatment strategies 236–237
  problem behavior evaluation 234–235
psychobiological philosophy 227
psychobiotics, concept of 56
psychogenic stress 406
psychological constructs 65–67
psychological disorders 415
psychological distress 159
psychological environment 295
psychological harm **201**, 411
psychological resilience 213–219
psychological suffering 406
psychological trauma 181–205
  adaptive fear responses 183–184
  animal cruelty laws 403–404
  approaches for 411–416
  biomarkers 414–417
  cognitive bias 414
  comparing humans and animals 182–183
  distinguishing and diagnosing 200–202
  early life adversity (ELA) 199, 409–411
  emotional contagion 411
  experiencer characteristics 199
  healing 202–205
  historical information 182
  indistinct concepts and terminology 181
  language and cognitive barriers 182
  legal change 416–417
  moderating factors for 198–200
  negative affect states 406–408
  perception of control 200
  posttraumatic psychopathology 184–197
  psychological conditions/states 197–198
  scientific evidence for 408–411
  social support (social buffering) 200
  stress and distress 405–406
  stress inoculation 199–200
  subjective experiences 182–183
psychological well-being 6, 50, 113
  zoo and aquarium animal 323–331
psychopharmaceuticals 430
psychophysical suffering 160
pterotillomania 341
puppies 139, **429**
  during COVID-19 restrictions 140
  owners 110
  socialization on 215
puzzle-feeding devices 352

qualitative aggregation technique 392
qualitative behavioural assessment (QBA) 265, 297, 373
quality adjusted life years (QALYs) 94
quality of life (QOL) *4*, 6–10, *84*
  applications 90–94
    assessment 90–91, *91*
    communication 94
    policy 93–94
    screening 90
    treatment decisions 93
  assessments 87–90
    evaluating multiple inputs 88–89
    measurement 89
    minimizing bias and error 89
    recognizing limitations 90

for specific health disorders 92
subjective and proxy 87–88
tool validation 89–90
concept of 84–87
components and related 84–86
emotions and motivations 86
health and welfare 86–87
as holistic and pluralistic 84
inputs influence **11**
motivations animals 86
pain 86
relationships and instrumental value 87
well-being and 79
Question of Animal Awareness, The (Griffin) 22, 23
quiescence 359

Rainbow trout *(Oncorhynchus mykiss)* 24
random variability 295
rats 34, 110
adolescent 142
lesioned and non-lesioned 66
mice and 315
neonatal 36
pigeons and 107
postnatal handling of 139
Reactive Attachment Disorder 201
redirected aggression 344
reduction 309
refinement 309
relaxation training 426–427, **428**
replacement 309
reproductive behaviors 344
reptiles 350–360, *358*
assessing and remedying in **360**
brain 351
cognitive processing 352
consciousness 351
ectothermy 355
individuality and personality 352–353
innateness and ancestral traits 354–355
metabolism and energetics 355
psychobehavioral problems 355–359
rest and sleep 359
self-awareness 351–352
sentience 353–354
sociality and play 352–353
space 356–359
stress 355, *356, 357*
thermoregulation 355
resilience 36–37
definition 213
in dogs 215
early life history 215–216
environmental factors 215–217
exercise on 216–217
to fear-provoking stimuli 139
genetic and epigenetic factors 218
measuring 219
neurobiology 213–214
protecting and predisposing personality 214–215
psychological 213–219
risk and 198–200
social relationships 217–218
training 146
rest and sleep 359
reward
sensitization 297
rewards 283
rhesus macaques *(Macaca mulatta)* 71
Rhesus monkeys 316
rodents 124–125
routine hemograms 41

scientific welfare assessment 387
screaming 342–343
search-and-rescue (SAR) 193
seasonal nesting behavior 352
secondary appraisal 280
selective serotonin reuptake inhibitors (SSRIs) 204
selegiline hydrochloride 253
self-awareness 352
self-injurious behavior 159
self-mutilation 341–342
senior canine behavior screening questionnaire **245**
sense of control 169–171
sensitization, reward 297
sensory self-recognition 352
sentience 353–354
separation anxiety 285
serotonin reuptake inhibitors (SSRIs) 432
'sham surgery' control 66
sheep 267–268
sheltered animals 294–301
agency/'behavioral engineering' approaches 299–300
anhedonia and helplessness 297
environment 295–297
predictability 300–301
psychological environment 301
reward sensitization 297
welfare in 294–295
short-chain fatty acids (SCFAs) 51
sickness behaviors 33–34
signals communicating 235
Skinner box 22
sleep deprivation 341
social affiliation **119**
mental health benefits of 119
physical health benefits of 118
types of 119

social-behavior phenotype 50
social buffering 122–125, 217, 285
effects 126–128
efficacy 127
neuroendocrine mechanisms 125–126
non-social-isolation stress 123–125
positive affect 119–120, 128
social partner and 127–128
social support and 122–125
special case of dogs 128–129
of stress 122–123
social companionship 136
social conflict 136
social connections 119–122
social contract theory 18
social enrichment 296
social environment 314–316
social housing 315
social isolation 217, 218, 315
sociality 36, 118, 352–353
socialization 139–141
history 406
inadequate 197–198
on puppies 215
social pain **121**
social partner
aspect of 127–128
emotional state of 127
familiarity 127
number 127
social relationships 118–130, 217–218
social resources 9
social species **120**
social stimuli 297
social support (social buffering) 122–125, 168, 200
loss of 285
sociological theory 9
soft-shelled turtle (*Trionyx* sp.) **354**
soft-wired reptiles 354
space 356–359
specific emotion 159
states of pleasure 23, 26
states of suffering 23, 24–26
stereotypies 286
steroid/immunosuppressant-responsive enteropathy (SRE/IRE) 58
stress 32, 101, 355, 409, 423
adverse effects of 214
behavioral responses 407
chronic environmental 297
definition of 136
indicators of 407–408
laboratory animal 311
neurobiology 213–214
neurogenic and psychogenic 406
physiological responses 407–408
reptiles 355, *356*, *357*
social buffering of 122–123
stressful stimulus 181
stress-induced behavioral models 196
stress-induced dishabituation 197
stress-induced phobias 195
stress inoculation 36, 199–200
stressors 101, 158, 294, 296, 311, 406
characteristics 198–199
definition of 136
stress-related *vs.* non-isolation-related stress 123
stress response 136, 423
Sturnus spp. 25
subjective assessments 87–88, 297
subjective well-being (SWB) *4*, 10, **11**, 12, 65, **66**
in chimpanzees **68**, 69–70
feelings of 285
personality and 71
variability 69
subthreshold PTSD 185, 186, 201, 202
suffering 23, 155–174, 226, 309
affect and motivation 161
amplification function for 167–168
causes 162–163
comparisons between distress and 156
conception of 157
control and 170–171
definitions and concept 155–160
emotions 168
extreme aversiveness, affective experience of 156–158
learned experience 168
low-motivation form of 164
measuring 171–173
and motivation 163
nature of 160–168
negative affect 156, 164–167, **166**
personality traits 168
proposed definition of 171
psychological 406
psychophysical and existential 160
sense of control 169–171
social support 168–169
states of 24–26
threshold and moderating 168–169
threshold concept 157
supervised training 378
supplements 427
survivor trauma 193
sympathetic nervous system (SNS) 122, 408
symptom-based anxiolysis 253–254
synbiotics 56
syringomyelia 37
systematic desensitization (SD) 203, 236, 425–426

Terrestrial Animal Health Code 9
territorial aggression 343
thermoneutral zone (TNZ) 313
thermoregulation 355
threat response systems 30
tolerable stress responses 32
tortoises (*Chelonoidis* sp.) 352
tortoises (*Testudo* sp.) **358**
training methods 35, 111, 145–146
transdermal medication delivery 429
trauma-related compulsive behaviors (OCD) 197
trauma-related cues (TRCs) 183
traumatic experiences 35
traumatic stress disorder 190
trazodone 254
treatment
  in animals 204–205
  for cognitive and emotional disorders 250–254
trial and error 433
trichotillomania, 342
Type 2 diabetes 118

ultra-processed food (UPF) 57–58
unconscious emotions 18
unnecessary suffering 417
unsupervised training 378
upbringing, fostering mental and behavioural wellness 135–146
utilitarianism 19–20

valence 370, 371
Varanus sp. **353**
ventromedial nucleus, of hypothalamus 66
vertebrates 23
  pest control methods 396
Veterinarian, The 21
veterinary behavior textbooks 146
veterinary medicine 13, 53
vibration 314
Vienna Dog Personality Test (VIDOPET) 298
visual self-recognition 352
vital organ 55
vivarium 312
voluntary behavior 102

welfare *4*, 7, 86–87
  categories 135
  and concept of needs 136–137
  improvement assessments **388**, 389–392
  laboratory animal 309–311
  science 263
  subjective concepts of 12
  and well-being 9, 135
welfare-alerting indicators 389, *391*
Welfare Quality 265
welfare-status indicators *391*
well-being 4–5
  concepts in animals 5–12
    bipolar continuum phenomenon 6–7
    coping ability 7–9
    general descriptions 8–9
    individual's perspective and perception 5–9
    meeting of needs 8
    methods of measurement 8
    philosophical frameworks 5–6
    pleasant *vs.* unpleasant affect 6
    summary 12–13
  distinctions between 9–12
    in animal literature 10–12
    in human literature 9–10
    objectivity 12
    temporality 10–12
  effects on **6**
  emotional 101
  feelings in 17–26
  influences on 369
  in laboratory animal 311–319
  mental health and 101–113, **108**
  in nonhuman species 104
  positive and negative aspects of **7**
  psychological 113
  and quality of life 79
  in reptiles 350–360
  welfare and 9, 135
  zoo animals 325–326
'whole animal' approach 297
wildcats *(Felis silvestris grampia)* 71
wild environments 101
'wild' species 323
World Association of Zoos and Aquariums 323
World Health Organization 30

zoo animals 323–331
  abnormal behaviors in 325
  assessing well-being 330
  challenges to 323–325
  environmental enrichment 328–329
  Keeper–Animal Relationships (KAR) 326–327
  positive affective states 325–326
  positive reinforcement training (PRT) 327–328
  well-being 325–326
Zoological Association of Australasia (ZAA) 323



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