



Observational behaviors and emotions to assess welfare of dogs: A systematic review

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ABSTRACT

Observing dogs' behavior to assess their welfare is relevant in various applied settings, such as veterinary clinics and animal-assisted interventions. Yet, no field-wide consensus or complete overview of observable behaviors to assess dogs' welfare seems to exist. In this review, we carefully analyze and categorize observational measures of a) dog welfare and b) their emotional state as described in the literature. Adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines, we searched two major electronic databases (PubMed, ScienceDirect) between October and December 2021 and included peer-reviewed articles—published in the last 10 years—about observable indicators of the welfare and/or emotional state of dogs. We included 39 studies in total. Based on these studies, nine overarching themes of behavioral indicators could be formulated, of which vocalizations, stress-related behaviors, and interaction with the nonsocial environment were mostly mentioned in the literature. Most articles described observable indicators that were both positively and negatively framed. Only five articles mentioned some form of validity assessment, while 23 studies mentioned inter-rater reliability measures. We conclude that having more validated observation instruments would be valuable for both research and practice. Although a clear and simple way of observing dog welfare without complicated tools is of great importance, the field would also benefit from instruments using combinations of physiological parameters and observable behaviors to assess dogs' welfare.

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Introduction

Animal welfare has received increasing attention over the last decades (Mellor, 2012; Kremer et al., 2020). This applies to several areas or settings, from farm animals to companion animals, and from animals performing a particular task (tracking dogs, police dogs, etc.) to animals used within animal-assisted interventions. The role of domestic animals, such as dogs in our lives, has changed accordingly. Whereas previously a dog was “just an animal,” many dogs are now seen as full family members (Meehan et al., 2017), and this has resulted in a greater focus on their welfare.

The scientific fields concerned with the lives and behaviors of animals—such as veterinary science and ethology—still lack a

generally accepted definition of (good or bad) animal welfare. Often the terms well-being and welfare are used interchangeably, without consensus on the exact meaning, and the definitions vary (McMillan, 2020). As long as there is no uniformity on the concept of welfare, measuring welfare remains a challenge.

In literature, good welfare is often associated with the absence of exposure to chronic stressors. After all, exposure to chronic stressors may lead to an animal's inability to accurately adapt to the situation at hand. Although this affects welfare more than acute stress, most studies deal with acute stress and do not specifically address the response to exposure to chronic stressors in dogs (Beerda et al., 1997). Therefore, in many studies, the mapping of dogs' welfare is related to the measurement and analysis of stress-related behaviors

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(Palestrini et al., 2017; Kartashova et al., 2021), such as lip-licking, whining, yawning, and paw lift or trembling. The literature traditionally considered the absence of animals' physical and behavioral symptoms of stress as an indication of good welfare (Hall et al., 2019). Yet, recent articles focus more on the specific positive aspects of animal welfare (Panksepp, 2005; Boissy et al., 2007; Serpell, 2008; Hemsworth et al., 2015; Lawrence et al., 2019; Csoltova and Mehinagic, 2020). These studies emphasize that welfare encompasses more than the absence of negative aspects—such as fear, pain, stress, hunger, and thirst—by stating that positive behaviors, such as playing, exploring, showing affiliative behavior, and tail wagging, are also important to measure (Boissy et al., 2007; Ohl and van der Staay, 2012; Polgár et al., 2019).

In addition to observations of stress signals and body language (Ng et al., 2014), several physiological methods have been used for animal welfare mapping. The body of research on dog welfare based on the physiology and biology markers is rapidly growing. However, the main focus of this literature review is on observational ways of assessing dog welfare and emotions. Many professionals who are working in animal-assisted interventions have a background in human care or dog handling, without the specific expertise or tools to examine the dog's physiology associated with welfare. Similarly, veterinarians and vet nurses may lack time or equipment during standard consultations to examine welfare physiologically and will also need to rely on observational methods. Indeed, the research of Palestrini et al. (2017) shows that continuous observation of dog welfare is desirable and that observations are a practical, noninvasive method (Palestrini et al., 2017; Corsetti et al., 2019). A reliable and validated observation tool for measuring welfare in dogs is, however, still lacking (Kiddie and Collins, 2014). In addition, even though many studies link observational measures to animal welfare, there is still no field-wide consensus on what behaviors should be observed to fully assess animal welfare. Therefore, this article presents an overview of the observational ways of assessing dog welfare as indicated in the literature. To give a broad overview of the observational characteristics that are studied when it comes to dogs' welfare, we not only focus on behaviors that indicate the presence or absence of stress but also on emotions.

Emotions could be defined as “a form of mental activity that emerges during the activations of specific brain functions” (Miklosi, 2015) and can be seen as a process which gave animals the ability to either avoid unpleasant experiences or seek valuable resources and rewards (Konok et al., 2015). Emotions are a central concept when it comes to animal welfare (Špinka, 2012) because they are closely related to positive or negative experiences (Konok et al., 2015). Emotions affect health, and thus welfare, through several pathways. Negative emotions directly affect physiological processes, such as the sympathetic and parasympathetic nervous systems, and thus may deregulate the immune system. Indirectly, both negative and positive emotions also affect behavior through changes in motivation and decision-making (Barrett et al., 2016). Animal emotions have eluded science for many years because we simply do not know what and how animals feel (De Waal, 2011) and we lack the method of self-report, so we have to use indirect measures instead. However, Bekoff (2000) has advocated a more open attitude to the study of animal emotions. In line with this, De Waal (2011) has also argued that if animals respond similarly under similar circumstances, it is plausible that similar emotions underlie their reactions, and that there is no a-priori reason to assume that animal emotions are fundamentally different from human emotions. The link to specific brain circuits responsible for emotion has now been established in several species (Briefer, 2012).

Despite the value of studying emotions to assess animal welfare, the categorization of emotions in animals remains a major challenge (De Waal, 2011). The expression of emotions in humans and animals occurs by means of facial expressions, vocalizations, and postures

(Barrett et al., 2016). Emotions can be placed along two axes, those of arousal (degree of activity) and valence, in the sense that emotions fall on a range from positive to negative experiences (Travain et al., 2015). Both the duration and intensity of emotions, however, are individual-specific, and the cognitive, neurobiological, and behavioral components likely differ for each emotion (Barrett et al., 2016). The analysis of concrete facial movements based on muscle contractions, including the ears and eyes, is increasingly unraveling emotional expressions across animal species and offers the perspective of a reliable coding system (Dalla Costa et al., 2014; Wathan et al., 2015; Bennett et al., 2017; Kremer et al., 2020). Yet, most studies of facial expressions in animals conclude that more research and validation are needed (Waller et al., 2013; Finlayson et al., 2016; Bennett et al., 2017; Cátia et al., 2017; Dalla Costa et al., 2017). Furthermore, vocalizations of animals are also linked to emotions (Briefer, 2012; Kremer et al., 2020), and different vocalization types can be linked to either a positive or negative emotional valence. For instance, dogs have a wide range of barks, whines, and mixed sounds that they use to communicate positive as well as negative emotional states (Yin, 2002; Pongrácz et al., 2006; Csoltova and Mehinagic, 2020).

Observing dogs' behavior to assess their welfare and emotions is—when having the necessary background knowledge—often possible and especially relevant in applied settings, such as the veterinary clinic and animal-assisted interventions, as we pointed out above. Yet, no field-wide consensus or complete overview of observable behaviors to assess dogs' welfare and emotions seems to exist. In addition, it is often unclear whether and to what extent existing observational instruments are validated. This article, therefore, focuses specifically on identifying the observational ways of assessing dog welfare and emotions as described in the literature and categorizes them into meaningful overarching constructs. The following questions guided this literature review:

1. Which concrete observable behaviors are used to assess the welfare and/or emotions of dogs and can these be classified in overarching constructs (themes) to guide further study?
2. What can be said about the valence of these concrete observable behaviors and/or emotions indicating the welfare of dogs, that is, to what extent are these behaviors positively or negatively evaluated in the literature?
3. What can be said about the methodological quality of the included studies, as well as the conclusions drawn about the welfare and/or emotions of dogs based on the observed behaviors?

Method

Search procedure

Study identification, screening, and determination of in- and exclusion criteria were done according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (McInnes et al., 2018). For this review, two electronic databases, PubMed and ScienceDirect, were accessed from the 14th of October until the 30th of December 2021. In both databases, we first searched using terms related to the welfare of dogs and then terms related to the emotions of dogs (see Table 1). Because the search for terms related to welfare produced too many hits in both databases, the term “measurement” was added. For the same reason, we specified a selection of journals in ScienceDirect based on the most relevant search results. That is, we purposefully selected journals from relevant fields. Other extra filters we applied were that articles should have been peer-reviewed and published in the last 10 years and that a full text in English should be available (see Table 1 for an overview).

All records were transferred to Rayyan (<https://www.rayyan.ai/>, April 2023) for further (title) screening by the first author and removing duplicates. Six additional articles found by screening the

Table 1
Overview databases, search terms, and used filters.

Database	Search terms	Extra filters
ScienceDirect	(Wellbeing OR Welfare OR Quality of Life OR Cope OR Stress) AND Dog AND Measuring (Emotion OR Mood OR Feeling OR Sentience OR Affect OR Subjective State OR Facial Expression) AND Dog	Published in last 10 years, research articles, <i>Applied Animal Behavior Science</i> / <i>Journal of Veterinary Behavior</i> / <i>Animal Behavior</i> / <i>Behavioral Processes</i>
PubMed	(Wellbeing OR Welfare OR Quality of Life OR Cope OR Stress) AND Dog AND Measuring (Emotion OR Mood OR Feeling OR Sentience OR Affective state OR Facial Expression) AND Dog	Published in last 10 years, research articles, <i>Applied Animal Behavior Science</i> / <i>Journal of Veterinary Behavior</i> / <i>Animal Behavior</i> / <i>Behavioral Processes</i> Other animals and English and full-free text Other animals and English and full-free text

Table 2
Identified themes.

Theme	Observed behaviors and/or emotions
1 Body posture	Submission, dominance, muscle tension, tail high/low, freeze, etc.
2 Vocalization behavior	Audible behaviors, such as growling, barking, howling, whining, etc.
3 Oral behavior	Lip-licking, grooming, yawning, etc.
4 Observational physiological response to stress	Salivation, urinating, defecation, dilated pupils, trembling, penis protrusion, etc.
5 Other stress-related behavior	Repetitive behavior, redirected behavior, body shaking, paw lifting, scratching, panting, etc.
6 Interactions with nonsocial environment	Exploring, hiding, alertness, attention, restlessness, activity, etc.
7 Interactions with social environment (human/other animals)	Greeting, fixating, avoidance, accepting treats, gaze, etc.
8 Expression of emotions	Signs of basic emotions, facial expressions
9 Holistic observation of the dog's state	Mental/emotional state: score calculated based on the general picture, taking the context into account

reference lists of relevant articles were added because they clearly focused on observational measures of welfare or emotions. After the initial title screening, the abstracts and full texts ($n = 125$) were manually screened by the first and sixth authors and independently by the fourth author to determine inclusion based on the criteria below. Any ambiguities were solved by consensus. The main reason for the exclusion was that the abstract did not mention an observational method or concrete observable behaviors to measure the welfare of dogs. The second main reason for excluding articles was when the abstract did not mention welfare or emotions of the dogs. The third and fourth reasons for excluding articles were that articles were either not applicable to dogs or used observations of dogs in very specific laboratory settings.

Inclusion and exclusion criteria

The in- and exclusion criteria were defined before the screening to prevent bias. The first inclusion criterion we applied was that the welfare and/or emotions of dogs within the study were—at least partly—deduced based on the dog's appearance or observable behaviors and not by using physiological instruments only (such as cortisol or heart rate measurements). That said, studies using physiological instruments *in addition to* observations were included. In relation to this, we excluded studies using instruments that could only be applied in specific laboratory settings, such as eye-tracking, and studies that only used second-hand observations, such as questionnaires for dog owners about their dog's behavior at home. We also excluded studies that did not operationalize indicators into concrete observable behaviors, for example, studies using the term “stress signals” without specifying this further. Last, we excluded reviews and meta-analyses.

Coding and data analysis

After the selection process, our study consisted of three phases. In the first phase, general information was extracted from the included articles, such as the concrete behaviors used to observe the welfare and/or emotions of dogs, the valence of these behaviors (i.e., whether the behaviors were positively or negatively framed), the

medium used (live observation, video, etc.), and the unit of analysis (frequency of behaviors, duration, etc.).

In the second phase, inductive thematic analysis was performed (Braun and Clarke, 2006). Nine themes were deduced from the articles to integrate and present the findings coherently (see Table 2 for the themes and examples). Some of these themes are well-known and often referred to in the literature on dogs' welfare, such as body posture (theme 1) and vocalizations (theme 2) (Deldalle and Gaunet, 2014; Epstein et al., 2021). Because we used concrete observable behaviors as a starting point, our themes were formulated as descriptive as possible. For instance, instead of one overarching theme related to stress signals, we deduced three different, more concrete, themes: oral behavior (theme 3), physiological signs of stress (theme 4), and other stress signals (theme 5). Some articles observed dogs' behaviors while they interacted with the environment. Such observations were grouped in theme 6 (interactions with the nonsocial environment) or theme 7 (interactions with other animals or humans). The overt behaviors linked to specific emotional states of dogs were grouped in theme 8 (emotion expression). Last, in theme 9, we grouped holistic indicators used to assess dogs' welfare or emotions that were not further broken down into distinct behaviors by the authors but were instead presented as a purely overall assessment of the dog's state. These studies often used a specific method or scoring system.

After the determination of the nine themes, we followed a specific procedure in our inductive thematic analysis. When reading the full text of the articles, all relevant phrases and concrete behaviors were assigned to one of the nine themes by assessing if these fit the description of the theme and were in line with the theme's example behaviors. For the first five themes, we first checked whether the behaviors fit the description and examples of theme 1, if not, we looked at theme 2, etc. If an article explicitly mentioned interaction with the environment, it was examined whether it fit best under theme 6 (nonsocial environment) or theme 7 (social environment). The first and second authors discussed the behaviors mentioned in articles that could potentially be classified under multiple themes until they reached a consensus about the classification. For instance, when an article mentioned urination and defecation as a negative sign of welfare, it was placed in theme 4. Yet, when this was specifically described as an odor marker for other dogs, it was placed in

theme 7 (interactions with the social environment). Similarly, we chose to position panting in theme 5 (other stress-related behaviors) and not in themes 3 or 4 (oral behavior and physiological responses, respectively), because this is commonly described in the literature as a signal of stress and sometimes as signal of fear (McMillan, 2020). The more static postural behaviors grouped in theme 1 were separated from motor behaviors such as walking in theme 6.

In the third and last phase, the quality of the included studies was investigated by looking explicitly for characteristics that are considered exemplary for reliable scientific research, such as a considerable sample size, validity, and reliability measures. We noted whether the validity and/or (inter-rater) reliability were covered in the study. When authors are very explicit about which specifically observable behaviors they study, the criteria for reliable scientific research are more accurately met. The most common way to describe these behaviors is by using an ethogram, or, in the case of facial expressions, by describing specifically which facial muscles were studied. Therefore, we checked whether the studies mentioned a clear description of behaviors and/or the use of facial muscles. If a precise description of these behaviors was missing, we noted this.

Results

Search results

The initial search generated 3891 articles ($n = 1917$ from PubMed, $n = 1974$ from ScienceDirect). Six additional records were added by screening the references of relevant articles. After removing duplicates ($n = 525$), the titles of 3372 articles were screened, of which 3247 were excluded (based on the title). From the remaining 125 articles, the abstract was screened, resulting in 101 articles of which the full text

was read. This led to a total of 39 articles that met the eligibility criteria and were therefore included in this review (see Figure).

Literature overview

The number of articles about measuring the welfare and/or emotions of dogs published in the period 2011–2021 ($n = 39$) shows no clear trend. Many articles were published in the years 2014 ($n = 7$) and 2017 ($n = 8$), whereas only one paper was published in 2012 and 2018. In the other years, the number of articles was stable ($n = 3$ on average). With regard to the valence of observed behaviors (i.e., to what extent the behavioral indicators of dogs' welfare or emotions were positively or negatively framed in the articles), most articles had a mixed focus. Only one article had a sole focus on positive valence (Lind et al., 2017); 20 of the 39 included articles focused on behaviors that were both positively and negatively framed, while 18 focused only on negative behaviors. Twenty-five articles combined observable concrete behaviors with other nonobservational methods. Of these, the most frequently used method was a questionnaire for the dog owner or veterinarian ($n = 8$) and measuring cortisol in saliva ($n = 9$). Three studies measured heart rate and/or heart variability in addition to the observations. Most articles used videos to observe the welfare and/or emotions of the dogs ($n = 27$), followed by live observation ($n = 8$). One study used photographs ($n = 1$). More differences were seen with regard to the units of analysis. Most articles ($n = 18$) used the duration and/or frequency of behaviors; others focused on the occurrence or nonoccurrence of certain behaviors (binary system; $n = 4$) or used a scale ($n = 6$). Other studies specifically developed a new unit of analysis ($n = 9$), for example, the use of free-choice profiling and marking on a visual analog scale or the DOG FACS manual in articles that studied the facial expressions of dogs. One article combined the use of duration

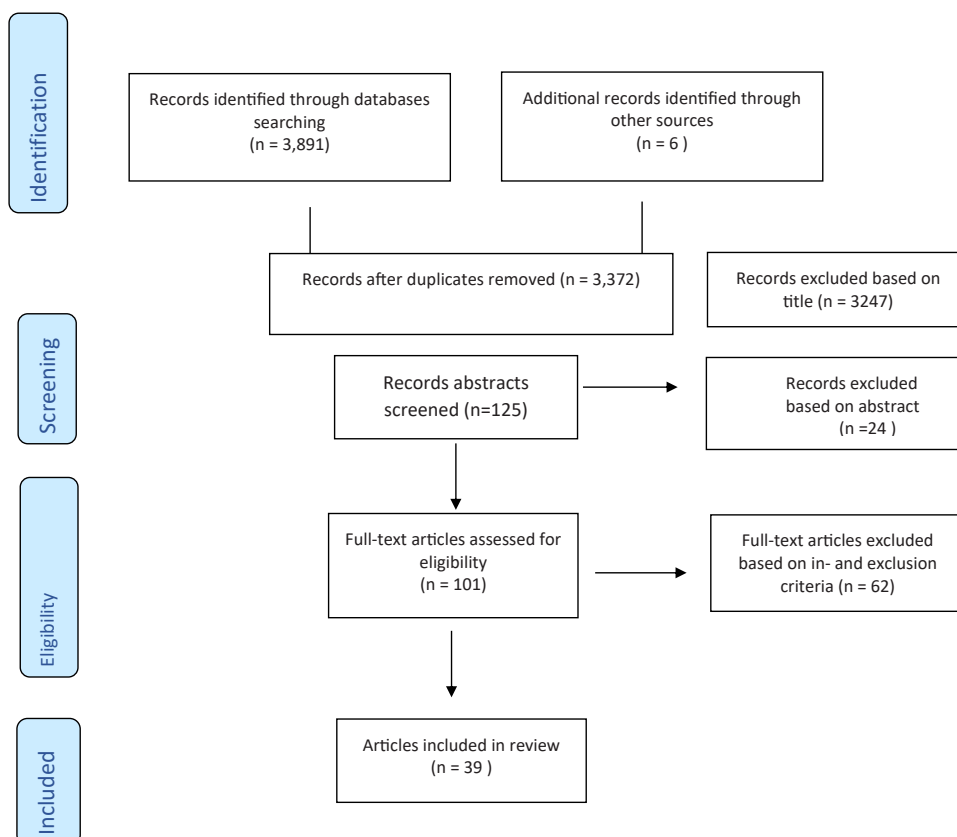


Figure. Preferred Reporting Items for Systematic Reviews and Meta-Analysis 2009 flow diagram.

and/or frequency of behaviors with a scale to define their intensity (Gähwiler et al., 2020). For an overview of the general characteristics of the included studies, see Table 3.

Results per theme

Overall, the most used themes to observe the welfare and/or emotions of dogs were vocalizations (60.5% of the articles), other stress-related behaviors (64.1% of the articles), and interactions with the nonsocial environment (66.7% of the articles). Interestingly, most articles investigated a combination of several of these themes (range of 2–6 themes, on average three themes). Below, the results are discussed for each theme. Table 4 lists the specific behaviors that were placed in the nine themes, categorized per article.

Theme 1: Body posture

In total, body posture was observed in 56.4% of the articles ($n = 23$). The most frequently mentioned behaviors within this theme were tail wagging ($n = 15$), the position of the tail ($n = 7$), or ears ($n = 6$), and crouching ($n = 3$). For tail wagging, the position of the tail was considered important (high, neutral, low, or tucked between the legs), but also whether it wagged or not. None of the articles explicitly specified whether the tail's position or wagging was seen as a positive or negative sign of welfare. Some articles mentioned body posture ($n = 7$) as a specific observable behavior, without specifying this further (e.g., Grigg et al., 2017). Other articles were more specific, for instance, by indicating a high or low body position, crawling on the ground, or rolling on the back. A specific (full) body posture, freeze, was mentioned once (Travain et al., 2015), as was full-body stiffness (Jones et al., 2014). The position of the head (resting or upright) was also mentioned once (Hekman et al., 2012).

Theme 2: Vocalization behavior

Vocalization was mentioned in 51.3% of the articles as a concrete observable behavior of the dog's welfare or emotions. Interestingly, these vocalizations were, without exception, interpreted as signs of the negative welfare of dogs. Overall, there was a striking similarity in the vocalization behaviors observed in studies, namely growling, barking, whining, and howling. Yelping was only named twice (Walker et al., 2016; Jeong et al., 2020). Finally, a few articles mentioned vocalization as an umbrella term without specifying it further (e.g., Kuhne et al., 2014; Ng et al., 2014). Concerning this, Bauer et al. (2017) mentioned “continuous vocalization” and Dalla Villa et al. (2013) used the term “prolonged vocalization,” whereas in the article by Jeong et al. (2020), “low-frequency vocalization” was seen as a behavioral indicator.

Theme 3: Oral behavior

Oral behavior was mentioned in 64.1% of the articles as an indicator for studying welfare and/or emotions of dogs. Compared to the previous theme, the oral behavior category focuses on the silent movements or behaviors around the dog's snout or mouth, and the behaviors that fall into this category are more diverse. Most articles did not mention explicitly if the observed behavior was seen as a positive or negative sign of welfare, although some did (Kiddie and Collins, 2014). Although some oral behaviors mentioned in the articles can be seen as positive, such as eating and/or drinking (Dalla Villa et al., 2013; Bauer et al., 2017; Lind et al., 2017), several behaviors could be associated with a more negative view on dog welfare, such as yawning, lip-licking, showing teeth, self-mutilation, biting compulsively, smacking without eating, and vomiting (Kiddie and Collins, 2014; Palestini et al., 2017; Corsetti et al., 2019). Bauer et al. (2017) described yawning and lip-licking as calming signals, without further specification.

Theme 4: Observational physiological response to stress

Physiological responses to stress were named in 33.3% of the studies. These responses are controlled through the autonomic nervous system and involve behaviors that are hard to “consciously influence.” Among the behaviors grouped in this category were shivering/trembling, raising fur, urinating/defecating, sweaty paws, sneezing, and lack of appetite, which were often negatively associated with the welfare of dogs. It was notable that relatively many articles looked at only one of these behaviors (Deldalle and Gaunet, 2014; Kiddie and Collins, 2014; Kuhne et al., 2014; Ng et al., 2014; Corsetti et al., 2019; Jeong et al., 2020), for example, trembling/shivering (Deldalle and Gaunet, 2014; Ng et al., 2014; Jeong et al., 2020), which is described by Ng et al. (2014) as “body shaking with small, high-frequency movements, clear shivering of the body.” Although some behaviors within this theme are relatively easy to measure, such as urination and defecating, some are more difficult to assess. For example, sweaty feet are not always visible on every surface, and it might be hard to determine whether a dog has less appetite. Notably, Kiddie and Collins (2014) specifically determined “lack of appetite” as a dog eating less than half of its food.

Theme 5: Other stress-related behavior

This theme includes stress-related behaviors that were not covered in the other themes because they are not considered to be postural, vocalization, oral, or physiological behaviors. Instead, most of these behaviors, mentioned in 64.1% of the included articles, referred to specific locomotor patterns. Repetitive behaviors were often mentioned, such as pacing, chasing own tail (Jones et al., 2014; Walker et al., 2016; Bauer et al., 2017; Grigg et al., 2017), paw lifting (Glenk et al., 2014; Stellato et al., 2017; Jeong et al., 2020), scratching (Deldalle and Gaunet, 2014), shaking off (Dalla Villa et al., 2013; Kuhne et al., 2014), panting (Hekman et al., 2012; Döring et al., 2016), and stretching (Rehn and Keeling, 2011; McCullough et al., 2018; Corsetti et al., 2019; Epstein et al., 2021).

Theme 6: Interactions with nonsocial environment

Interactions with the nonsocial environment were mentioned in 66.7% of the articles. This theme refers to all behaviors that indicate interaction with the material, nonsocial environment. The position of the dog in the room was frequently used as a characteristic, as well as its activity (e.g., lying, standing, sitting, or resting) (Epstein et al., 2021; Part et al., 2014; McCullough et al., 2018). In addition, exploring and sniffing were often mentioned (Ng et al., 2014; Palestini et al., 2017; Stellato et al., 2017). Walking, jumping (against objects), and playing with objects were three other behaviors found within the literature (Kuhne et al., 2014; Jones et al., 2014; Stephan et al., 2021). Avoidance of objects was also mentioned (Travain et al., 2015).

Theme 7: Interactions with social environment

In 56.4% of the studies, interactions with the social environment (other living beings) were included. Within this theme, the exact observed behaviors varied widely but could be summarized in four main characteristics, namely engaging in interaction with the observer/owner (eye contact, playing, accepting treats, or physical contact) (Glenk et al., 2014; Lind et al., 2017), ignoring invitations to interact (Jones et al., 2014; Stellato et al., 2017), interaction with another dog (Dalla Villa et al., 2013; Kiddie and Collins, 2014), and physical approach or avoidance behaviors of the dog (i.e., moving toward or away from the observer within the room; Travain et al., 2015; Bauer et al., 2017; Huber et al., 2017). In some studies, Corsetti et al. (2019), for example, considered a combination of these interaction characteristics.

Table 3
Overview included articles and used methods.

Article (author, year)	Title article	Main focus of valence (neg/pos aspects welfare) ^a	Combined with nonbehavioral indicators?	Used medium for observation	Unit of analysis (behavior and/or emotions)
Arena et al. (2017)	Application of free-choice profiling to assess the emotional state of dogs housed in shelter environments	Mixed	No	Video recorded	Developed for QBA: a set of descriptive terms (on three axes) generated by free-choice profiling and rating it on a visual analog scale
Arena et al. (2019)	Development of a fixed list of terms for the qualitative behavioral assessment of shelter dogs	Mixed	No	Video recorded	Developed for QBA: a set of 20 descriptive terms (on four axes) generated by a fixed QBA rating scale
Bauer et al. (2017)	Evaluating FIDO: developing and pilot testing the field instantaneous dog observation tool	Negative	Physical health and cleanliness	Live	Developed for FIDO: categories with rating codes red, yellow, or green
Bloom and Friedman (2013)	Classifying dogs' (<i>Canis familiaris</i>) facial expressions from photographs	Negative	No	Photographs	Each basic emotion was scored by a Likert-type scale 0–4
Bremhorst et al. (2019)	Differences in facial expressions during positive anticipation and frustration in dogs awaiting a reward	Mixed	No	Video recorded	Developed for DogFACS: coding based on DogFACS manual
Bremhorst et al. (2022)	Evaluating the accuracy of facial expressions as emotion indicators across contexts in dogs	Mixed	No	Video recorded	Developed for DogFACS: coding based on DogFACS manual
Cátia et al. (2017)	Dogs and humans respond to emotionally competent stimuli by producing different facial actions	Mixed	No	Video recorded	Rate of facial actions
Corsetti et al. (2019)	Evaluating stress in dogs involved in animal-assisted interventions	Mixed	Canine Behavioral Assessment and Research Questionnaire (C-BARQ)	Live	Acts/hour
Dalla Villa et al. (2013)	Behavioral and physiological responses of shelter dogs to long-term confinement	Mixed	Saliva cortisol	Video recorded	Proportional duration or frequency in 180 min
Deldalle and Gaunet (2014)	Effects of two training methods on stress-related behaviors of the dog (<i>Canis familiaris</i>) and on the dog-owner relationship	Negative	Questionnaire about demographic information and background dog and owner	Live	1–0 sampling of behavior
Döring et al. (2016)	Behavior of laboratory beagles: assessment in a standardized behavior test using novel stimuli and situations	Negative	No	Video recorded	0–3 score of behavior. Body language and behavioral indicators were analyzed separately
Epstein et al. (2021)	Addressing stress in dogs in shelters through a novel visual and auditory enrichment device	Mixed	Salivary cortisol	Video recorded	Occurrence (counts) or duration (number of seconds) in a 10 min period
Gähwiler et al. (2020)	Fear expressions of dogs during New Year fireworks: a video analysis	Negative	Questionnaire about dogs behavior during fireworks and about their welfare	Video recorded	Proportional duration or frequency per minute, posture scale 1–5
Glenk et al. (2014)	Salivary cortisol and behavior in therapy dogs during animal-assisted interventions: a pilot study	Negative	Salivary cortisol	Video recorded	Duration and frequency
Grigg et al. (2017)	Evaluating pair versus solitary housing in kennelled domestic dogs (<i>Canis familiaris</i>) using behavior and hair cortisol: a pilot study	Negative	Hair cortisol	Video recorded	Occurrence and duration within continuous sampling and instantaneous sampling (1 min interval)
Hekman et al. (2012)	Salivary cortisol concentrations and behavior in a population of healthy dogs hospitalized for elective procedures	Negative	Saliva cortisol samples	Video recorded	Duration (% of total time) or frequency (number of events per 20 min)
Huber et al. (2017)	Investigating emotional contagion in dogs (<i>Canis familiaris</i>) to emotional sounds of humans and conspecifics	Negative	No	Video recorded	Duration or frequency
Jeong et al. (2020)	Evaluation of salivary vasopressin as an acute stress biomarker in healthy dogs with stress due to noise and environmental challenges	Negative	Blood pressure, rectal temperature, pulse rate, respiratory rate, salivary vasopressin concentration, and serum cortisol level	Video recorded	Proportional duration or frequency during recorded time (30 min)
Jones et al. (2014)	Use of accelerometers to measure stress levels in shelter dogs	Negative	Urinary and salivary cortisol Activity levels	Live	Stress score from 1 (mild) to 5 (severe/extreme) stress
Kiddie and Collins (2014)	Development and validation of a quality of life assessment tool for use in kennelled dogs (<i>Canis familiaris</i>)	Mixed	Physical measurements (body condition score, scarf, and eye discharge)	Live	Binary system (1–0 scoring)

(continued on next page)

Table 3 (continued)

Article (author, year)	Title article	Main focus of valence (neg/pos aspects welfare) ^a	Combined with nonbehavioral indicators?	Used medium for observation	Unit of analysis (behavior and/or emotions)
Kuhne et al. (2014)	Emotions in dogs being petted by a familiar or unfamiliar person: validating behavioral indicators of emotional states using heart rate variability	Negative	Heart rate and heart rate variability	Video recorded	Frequency and duration of behavioral responses based on continuous sampling
Lind et al. (2017)	Assessing stress in dogs during a visit to the veterinary clinic: correlations between dog-standardized tests and assessments by veterinary staff and owners	Positive	Questionnaires by owner and veterinary employees	Live	Scale 1–5
Littlewood and Mellor (2016)	Changes in the welfare of an injured working farm dog assessed using the five domains model	Mixed	No	Evaluation of a fictitious scenario	Welfare compromise grade (A = none; F = severe) and welfare enhancement grade (0, +, ++, +++)
McCullough et al. (2018)	Physiological and behavioral effects of animal-assisted interventions on therapy dogs in pediatric oncology settings	Mixed	Demographic form, C-BARQ, self-report survey, salivary cortisol	Video recorded	Frequency stress-related behavior summed to one score versus affiliative behaviors summed to one score
Mellor et al. (2020)	The 2020 Five Domains Model: Including human-animal interactions in assessment of animal welfare	Mixed	No	Evaluation	Welfare compromise grade (A = none; F = severe) and welfare enhancement grade (0, +, ++, +++)
Mellor (2012)	Animal emotions, behavior, and the promotion of positive welfare states	Mixed	No	Not mentioned	Not mentioned
Menchetti et al. (2019)	Multi-operator qualitative behavioral assessment for dogs entering the shelter	Negative	No	Video recorded	Qualitative score for overall stress level (score 0–5) and score for 5 descriptors of dog behavioral traits (score 0–5)
Mornement et al. (2014)	Development of the behavioral assessment for rehoming K9's (B.A.R.K.) protocol	Mixed	No	Live	0–10 scale
Ng et al. (2014)	The effect of dog-human interaction on cortisol and behavior in registered animal-assisted activity dogs	Mixed	Salivary cortisol	Video recorded	Frequency and duration
Palestrini et al. (2017)	Stress level evaluation in a dog during animal-assisted therapy in pediatric surgery	Mixed	Heart rate	Video recorded	Proportional duration or proportional frequency
Part et al. (2014)	Physiological, physical, and behavioral changes in dogs (<i>Canis familiaris</i>) when kenneled: testing the validity of stress indicators	Mixed	Physiological (urine and saliva), physical (whole body condition, sclera, temperature, skin, amount of food)	Video recorded	Proportional duration or frequency per minute
Pastore et al. (2011)	Evaluation of physiological and behavioral stress-dependent indicators in agility dogs	Negative	Salivary levels of cortisol	Live	Yes or no recording of behavior
Rehn and Keeling. (2011)	The effect of time left alone at home on dog welfare	Mixed	Heart rate and heart rate variability	Video recorded	Instantaneous sampling (15 s) or continuous sampling/one to zero sampling
Scaglia et al. (2013)	Video analysis of adult dogs when left home alone	Negative	No	Video recorded	Duration or frequency
Stellato et al. (2017)	Assessment of fear-related behaviors displayed by companion dogs (<i>Canis familiaris</i>) in response to social and nonsocial stimuli	Negative	Questionnaire by the owner	Video recorded	Frequency
Stephan et al. (2021)	Pet dogs at home alone: a video-based cross-sectional study comparing behavioral, cognitive, and physiological indicators of welfare between short- and long-term kenneled domestic dogs	Mixed	C-BARK questionnaire	Video recorded	Percentage of time
Titulaer et al. (2013)	Assessment of fear-related behaviors displayed by companion dogs (<i>Canis familiaris</i>) in response to social and nonsocial stimuli	Mixed	Bias test, urinary cortisol: creatinine, questionnaires	Video recorded	Number of occurrences of total observation time (frequency) or % of total observation time (duration)
Travain et al. (2015)	Hot dogs: thermography in the assessment of stress in dogs (<i>Canis familiaris</i>)—A pilot study	Negative	Infrared thermography	Video recorded	Proportional duration or frequency per minute
Walker et al. (2016)	Qualitative behavior assessment of dogs in shelter and home environment and relationship with quantitative behavior assessment and physiological response	Negative	Salivary cortisol	Video recorded	Quantitative score of behavior: Behavior occurring less than three times was excluded from the analysis

FIDO, field instantaneous dog observation; QBA, Qualitative Behavioral Assessment.
^a If more than 60% of the indicators about positive welfare indicators: main focus positive. If more than 60% of the indicators about negative welfare indicators: main focus negative. If 40%–60% of the indicators positive and 40%–60% negative: main focus mixed.

Table 4
Results classified in nine themes.

Article (author, year)	Body posture	Vocalization behavior	Oral behavior	Observational physiological response to stress	Other stress-related behavior	Interactions with nonsocial environment	Interactions with social environment	Expression of emotions	Holistic way of looking to welfare/emotions
Arena et al. (2017)									Free-choice profiling and rating on an analog scale 20 fixed QBA terms
Arena et al. (2019)									
Bauer et al. (2017)	High wag, neutral wag, low wag, tail tuck, crouch	Growl, bark, continuous vocalization	Eat, drink, lip lift, yawn, lip lick	Tremble, hard body, hackles raised	Circling, pacing, paw lift, shake off	Wall bouncing, start in front of kennel, start in back of kennel, move from front to back repeatedly, rest	Approach, play bow, lean near, solicit, nonresponsive, hide, lunge, avert gaze, move forward to front of kennel, move toward back of kennel, frantic, play with waterer/feeder	Recognition of six basic emotions and one neutral condition 11 DOGFACS 20 DOGFACS	
Bloom and Friedman (2013)								Four categories of emotional arousal	
Bremhorst et al. (2019)									
Bremhorst et al. (2022)									
Cátia et al. (2017)									
Corsetti et al. (2019)	Raising ears, raised tail, wagging with tail held high, pointer, lowering head, cringing, tail between legs, lying down on back, waving tail	Growling, barking, whining, howling, snorting	Muzzle licking, yawning, auto-grooming, drooling, licking/biting compulsively, self-mutilation, catching flies, curling lip, showing teeth	Raising fur	Scratching, repetitive pacing in circles, panting	Sniffing environment, sniffing air, urinate with raised leg, sitting, lying, dozing	Looking at conductor/patient/observer/other operator, no attention, sniffing people, sideway glance, avoiding physical contact, hiding behind conductor, inviting to play, giving the foreleg, licking hands, requesting attention, playing		
Dalla Villa et al. (2013)	Rigid/high posture, tail wagging, tail low/curled	Barking, prolonged vocalizations	Auto-grooming, drinking, chewing, coprophagy	Urinating, defecating	Pacing, circling, tail chasing, shaking off, stretching,	Walking, trotting, jumping, hind legs, lying, sitting, standing, resting, wall bouncing, digging, out of sight, shade, visual exploration, olfactory	Social pacing, amicable, play, threat, mount dog, sniffing dog, social look		
Deldalle and Gaunet (2014)	Low posture	Whining	Mouth licking, yawning	Shivering	Scratching	Sniffing	Gaze to owner, avoidance of gaze, avoidance body		
Döring et al. (2016) ^a	Tail wagging erect, relaxed or between, cowering or between relaxed and		Muzzle licking	Shivering/trembling, urination, defecation	Paw lifting				

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Table 4 (continued)

Article (author, year)	Body posture	Vocalization behavior	Oral behavior	Observational physiological response to stress	Other stress-related behavior	Interactions with nonsocial environment	Interactions with social environment	Expression of emotions	Holistic way of looking to welfare/emotions
Epstein et al. (2021)	cowering, submissive or between submissive and cowering Crouching, rolling on back, tucking tail, wagging tail	Barking, howling, whining	Grooming, lip-licking, yawning, drinking	Trembling, urination, defecation	Pacing, chasing tail, circling, paw lift, shake off, shaking head, stretching, panting Blinking, panting Paw lifting, body-shake, panting Spinning, pacing	Facing back of kennel, in back of kennel, in front of kennel, jumping, running, walking, lying down, paws up on kennel, sitting, standing, pawing kennel, playing with toy, sniffing Sleep, move, hide			
Gähwiler et al. (2020)	Ear, tail, and body position	Whine/howl, bark	Snout lick, lip smack, yawning						
Glenk et al. (2014)	Tail wagging		Lip-licking, yawning				Takes a treat, obey to command		
Grigg et al. (2017)	Body posture	Barking					Social behavior: physical contact/playing/aggression		
Hekman et al. (2012)	Head resting or up, tail wagging	Barking, whining	Lip-licking, yawning		Panting	Sitting (lateral, half sternal, full sternal), location in run (front/middle/back), standing, walking, changing position, facing, jumping, pawing/manipulating the door, sniffing			
Huber et al. (2017)	Immobility/freezing, tail wagging	Barking, whining	Yawning, lip-licking		Scratching, body shaking, stretching, panting Paw lifting	Look at loudspeaker, approach loudspeaker	Look at owner, approach owner		
Jeong et al. (2020)		Whining, barking, growling, low-frequency vocalizations	Tongue out, snout licking, swallowing, smacking, yawning	Shivering					
Jones et al. (2014)	Tail lowered, full-body stiffness, ears back/to head, tail tucked	Whining, growling	Lip lick, yawn	Sneeze, trembling, sweaty paws	Paw lift, stretch, scratching, spinning/circling/weaving, panting (with or without drooling)	Jumping on cage	Cautious/reliant approach, avoidance of eye contact or interaction, staring, vocalization while making constant eye contact		
Kiddie and Collins (2014)	Low posture, ambivalent posture, erect ears, high body posture, tail wagging	Whine, growling	Snapping, biting, chewing bedding, drink excessively, tongue out, lip-licking, snout licking, swallowing, lip smack,	Lack of appetite	Pace repetitively, tail chasing, circling, paw lift, body-shake, panting	Wall bouncing, play bouncing, escape attempt, hide, chewing bars, change movement, sit, stand, nose, startle, walk, high level of activity, changing behavior from one to another, alert,	Listless, play with other dog, lick other dog's muzzle, lick, initiate physical contact, play with assessor		

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Table 4 (continued)

Article (author, year)	Body posture	Vocalization behavior	Oral behavior	Observational physiological response to stress	Other stress-related behavior	Interactions with nonsocial environment	Interactions with social environment	Expression of emotions	Holistic way of looking to welfare/emotions
Kuhne et al. (2014)	Wallowing, freeze	Vocalization	Salivation, vomiting, drinking, licking own body, yawning, nose/lip-licking, flicking tongue	Elimination	Scratching own body, body shaking, stretching, lifting paw panting	scan, explore, orientation toward where food is presented, play bow, time at front of kennel, lie down, object play Sniffing/licking on the floor, playing with inanimate objects, digging, visual scanning, excessive activity	Seeking out human contact, gazing at human, sitting/lying next to human with body contact, mounting, blinking, looking elsewhere, closing both eyes, averted head, sitting, lying down, averted body/going backwards		
Lind et al. (2017)			Eat treat			Grabbing	Greeting, cooperation, handling, interest in play, tug of war		Mental/emotional state: score calculated based on domains 1–4
Littlewood and Mellor (2016)									
McCullough et al. (2018)	Raising ears, rolling over, tail wagging, crouching, ears pinned back	Barking, yelping, yipping, whining, whimpering, growling	Oral behavior/lip-licking, self-directed behaviors (such as grooming, biting, etc.), yawning, baring teeth, drooling excessive		Body shaking, panting	Leaning/resting body or head against object, escape, restlessness	Leaning/resting body or head against person, licking a person, pawing, play bow, pushing snout/seeking pet, walking/approach, looking at/to handler, looking away, stare gaze		Mental/emotional state: score calculated based on domains 1–4
Mellor et al. (2020)									
Mellor (2012)								Seeking, fear, rage-assertiveness, bonding (panic), care/play/lust	
Menchetti et al. (2019)									Stress level and five descriptors of behavioral traits (main behavior, occasional behavior, posture, pen (continued on next page)

Table 4 (continued)

Article (author, year)	Body posture	Vocalization behavior	Oral behavior	Observational physiological response to stress	Other stress-related behavior	Interactions with nonsocial environment	Interactions with social environment	Expression of emotions	Holistic way of looking to welfare/emotions
Mornement et al. (2014)								Anxiety Fear Compliance Friendliness Activity level	area, distance to tester)
Ng et al. (2014)	Crouching	Vocalizing	Mouth opening, neutral, lip-licking, licking person, licking object, self-grooming	Trembling	Paw lifting, scratching, body shaking Stretching repetitively, moving head, panting Panting	Sitting, standing, recumbent, alert, ambulant, rest/sleep Jumping exploring	Jumping		
Palestrini et al. (2017)			Lip-licking, grooming, yawning			Exploration, passive behavior, oriented to environment	Oriented to environment, interaction with child, interaction with people, withdrawal		
Part et al. (2014)	High tail, level tail, low tail, wag tail	Bark, whine	Drink, feed, auto groom, yawn, lip licks		Scratch, body-shake, paw lifting, panting	Alert, sleep/rest, sit, stand, lie, travel, kennel rear, circling before lying down, sniff object, object play			
Pastore et al. (2011)	Tail wagging	Whining, barking, growling	Yawning, tongue out, snout licking	Trembling, urination	Paw lifting, circling, body shaking, panting	Restlessness, looking away, turning of the head	Looking away, turning of the head		
Rehn and Keeling (2011)	Tail wagging	Barking, growling, howling, whining	Grooming, chewing, yawning, lip-licking		Body stretching, body shaking, panting	Lying alert, lying resting, sitting, standing, walking, running, location, exploring, attention toward something, play	Following owner, physical contact, attention toward owner, inviting play		
Scaglia et al. (2013)		Barking, whining, howling	Grooming, lip-licking, yawning			Exploration, locomotion, passive behavior, oriented toward environment, play, scratching	Passive behavior, oriented toward environment		
Stellato et al. (2017)	Reduced body posture, freeze, low tail wag	Barking, whining	Yawning, lip/snout licking, licking paws, chewing/nibbling on body		Body shaking, paw lift, scratching body	Retreat, evade, nosing/sniffing, digging	Retreat, evade, hiding		
Stephan et al. (2021)		Barking, growling, howling, whining				Locomotion, standing, sitting, lying with raised head, lying on elbow or curled up, lying on the side or back, located on berth, located on sofa/bed, at exit door, elsewhere, interacting with food, interacting with toy, interacting with other objects	Interacting with other pet		
Titulaer et al. (2013)							Sniffing, play bouncing		(continued on next page)

Table 4 (continued)

Article (author, year)	Body posture	Vocalization behavior	Oral behavior	Observational physiological response to stress	Other stress-related behavior	Interactions with nonsocial environment	Interactions with social environment	Expression of emotions	Holistic way of looking to welfare/emotions
	High, neutral, half low, low, or very-low body posture, tail wagging	Growling, barking, howling, or whining	Licking lips, drinking, grooming		Pacing, circling, tail chasing, scratching, paw lifting, body-shake, panting	Walking, trotting, standing, standing on hind legs, sitting, lying down, bouncing, sniffing, object investigation (including play), front of kennel, back of kennel, startling, digging at walls/floors/doors, chewing bars of kennel			
Travain et al. (2015)	Freezing		Nose/lip-licking, mouth opening/closing, yawning		Paw lift, shake off, panting	Avoidance, posture change (from lying to sitting or standing and vice versa)	Avoidance		
Walker et al. (2016)	Tail wag	Bark, howl, whine, yelp	Eat, drink, lip lick, yawn, groom	Urinate, defecate,	Circle, paw lift, stretch, shake, pant	Walk, run, stand, rest, sit, jump, bite kennel wire, dig, sniff			Qualitative scoring: free-choice profiling behavior

QBA, Qualitative Behavioral Assessment.
^a The test category also contains integrated behavior but cannot be used without the testing situation and is therefore not included in this table.

Theme 8: Expression of emotions

Although stress signals in dogs have been assessed to determine welfare for decades, the study of emotions has only emerged in the last 10 years. Indeed, only 15.3% of the articles explicitly referred to emotion in their observations, and these observations were seldom coupled with the behaviors of the other themes. One specific article used the six basic emotions: happiness, sadness, surprise, disgust, anger, and fear, which were ranked by observers from photographs of dogs (Bloom and Friedman, 2013).

Within this theme, the system of DOGFACS (Bremhorst et al., 2019, 2022) is interesting, because of its scientific way of analyzing facial muscles, based on 11 different facial codes. Two articles used this method as a basis to analyze emotions (Bremhorst et al., 2019, 2022). One other focused on emotional arousal by making use of DOGFACS, formulating four categories of arousal: happiness, positive anticipation, fear, and frustration (Cátia et al., 2017). The article by Mellor (2012) is based on the emotional system developed by Panksepp (2005) and Mornement et al. (2014), which takes anxiety, fear compliance, friendliness, and activity level into account.

Theme 9: Holistic observation of the dog's state

Instead of concrete behaviors, the five articles grouped in this theme (12.8%) used holistic, overall observations to assess the dog's welfare or emotions. This was often approached in a qualitative way, although Walker et al. (2016) combined this holistic view with other quantitative behavioral observations. Most articles used a specific method to arrive at their conclusion about the welfare of the dog, such as Qualitative Behavioral Assessment (QBA; Walker et al., 2016; Arena et al., 2017, 2019). QBA involves several specially trained observers watching multiple video clips of a dog and then freely describing the dog, which is followed by statistical analysis to generate the results. The idea is that dogs show their internal subjective state through qualitative changes in their behavior (McMillan, 2020). Another specific method used was the Five Domains Model (Littlewood and Mellor, 2016; Mellor et al., 2020). This method involves getting information about nutrition, environment, health, behavior, and mental state to reach an overall conclusion about the dog's welfare. The fifth domain (mental state), described as “the subjective emotional experience,” follows from the other four domains (Littlewood and Mellor, 2016). Later modifications of the model also included human-animal interactions (Mellor et al., 2020). Last, the way Menchetti et al. (2019) observed welfare may, at first glance, seem similar to themes 3, 4, or 5. However, these authors did not separate the different (body) parts of the dog that could indicate stress responses but instead described stress responses by picturing a holistic image of the dog. In this way, five descriptors of dog behavioral traits are formulated, and the overall stress level is qualitatively determined.

Methodological characteristics of included studies

To investigate the methodological characteristics of the included studies, we first looked at measures of validity and reliability (see Table 5). Only five of the 39 studies (12.8%) mentioned some form of validation, such as content validity, construct validity, or criterion validity (Diederich and Giffroy, 2006; Taylor and Mills, 2006). In all other studies, the term validity was not mentioned throughout the article. Sixteen of the 39 articles (42.0%) did not address inter-rater reliability in the study. We also compared the sample size used in the studies. These varied greatly (from just one single dog to 189 dogs), mostly because the study designs differed and were, therefore, not comparable. The number of observers was not explicitly mentioned in six of the articles, but the other articles indicated that 1–3 researchers observed multiple dogs or videos. In three studies, the number of observers that rated videos or photos was significantly higher (11–50 people) because a comparison of the results between the observers was one of the goals of the study.

We checked whether the studies defined the specific observable behaviors in an accurate way by giving a clear description of these behaviors and/or emotions. The best way to describe behavioral data is by using an ethogram, in which an “inventory of well-defined behavioral units is described on the basis of either a complete repertoire of a taxonomic unit or a set of behaviors used in a particular study” (Pierard et al., 2019, p. 118). So for example, when a study mentions “jumping” as a relevant observable behavior, it was included in our review above, but, in terms of quality, we checked if a clear description (e.g., an ethogram) like “motion with two or four paws from the ground” was given. In most of the studies, the observed behaviors and/or emotions were not only mentioned but also accurately described. Only five out of the 39 studies (12.8%) did not meet this criterion. In two studies, this was inherent to the chosen method because the design of the study was that the observers themselves had to name the dogs' emotions from the photos or videos. Overall, we can say that, despite the lack of validity measures, the quality of the described behaviors/emotions seemed accurately described by means of an ethogram in most studies.

Interestingly, although most studies aimed to say something about the welfare or emotions of dogs, only in six articles (15.4%) a concrete conclusion about the welfare or emotions of dogs was formulated (Glenk et al., 2014; Littlewood and Mellor, 2016; Bauer et al., 2017; Palestini et al., 2017; Menchetti et al., 2019; Mellor et al., 2020). This is because in most studies, two or more situations or groups of dogs were compared, and the conclusions were focused on this comparison. For instance, Grigg et al. (2017) compared the welfare of dogs housed alone versus dogs grouped together in shelters. In a similar vein, sometimes conclusions about emotions were drawn without a specific link to welfare (Bloom and Friedman, 2013; Cátia et al., 2017; Bremhorst et al., 2019, 2022).

Discussion

In this review, we assessed how dogs' welfare and/or emotions are observed and described in the literature. An overview of observable behaviors and emotions can be of great importance in settings where either the knowledge of animal physiological responses or the techniques to measure these responses are lacking. Therefore, we aimed to identify which concrete observable behaviors are used across the literature to assess dogs' welfare and/or emotions and whether they can be categorized into overarching constructs. We then looked at the valence of these observable behaviors and/or emotions, that is, whether they were seen as signs of a positive or negative state of welfare. Finally, we assessed the methodological characteristics of the included articles and the conclusions drawn within the articles about dogs' welfare and/or emotions.

When considering the results, the first thing worth noting is that there appears to be no unambiguous definition of what welfare—or a similar term, such as quality of life or well-being—exactly means. Similarly, authors have not always described what they exactly meant by terms such as “stress signals” or “calming signals,” and whether these should be seen as positive or negative signs of welfare. One could argue that such a description is not necessary, as stress signals are often negatively interpreted. Yet, on the other hand, stress signals can sometimes be seen as ways to release tension, which might be necessary in some cases and can be interpreted as a positive way to deal with the demands of a certain environment. Second, some articles describe in detail how separate dog behaviors can be scored or categorized, thereby contributing to the reliability of these measurements, but lack a final interpretation or conclusion based on a specific score, that is, it is often not mentioned how a specific behavior (e.g., lip-licking) contributes to the dog's welfare. Third, none of the articles covered longitudinal studies on dog welfare. This is noteworthy, as one could question whether a valid statement about a dog's (long term) welfare can be made when

Table 5
Methodological characteristics of included studies.

Article (author, year)	Explicit description of observed behaviors/emotions	Validated (yes/no/not applicable)	Inter-reliability or inter-observer agreement	Sample size	Conclusion to welfare (Y/N)
Arena et al. (2017)	No (inherent to method)	No	Yes	16 dogs in video clips (13 observers)	Only named as possible tool after validation
Arena et al. (2019)	Yes	No	Yes	13 video clips of dogs (11 observers)	Only named as possible welfare assessment tool in combination with others
Bauer et al. (2017)	Yes	No	Yes	79 dogs observed by two observers study 1, 38 dogs by two observers study 2	Yes, code red, yellow, and green
Bloom and Friedman (2013)	No (inherent to method: six emotions)	No	Yes	50 people rated 21 photographs	No, only to emotions
Bremhorst et al. (2019)	11 DOGFACS	No	Yes	29 dogs (one observer)	No, only to emotional states
Bremhorst et al. (2022)	Conform DOGFACS	No	Yes	28 dogs (one observer)	No, only to emotional states
Cátia et al. (2017)	Conform FACS and DOGFACS	No	Yes	50 humans on videos and 100 dogs (one observer)	No, only to emotional states
Corsetti et al. (2019)	Yes	No	No	Nine dogs in AAI (one observer)	Only named
Dalla Villa et al. (2013)	Yes	No	No	17 dogs (number of observers not mentioned)	Only in comparing different forms of housing
Deldalle and Gaunet (2014)	Yes	No	No	50 dogs (one observer)	Only in comparing two training methods
Döring et al. (2016)	Yes	No	Yes	90 dogs (one observer)	Only in comparing facilities
Epstein et al. (2021)	Yes	No	No	47 dogs (one observer)	Only in comparing the testing group with the control group
Gähwiler et al. (2020)	Yes	No	Yes	36 dogs (one observer)	Only compared the same dogs with a nonfirework evening
Glenk et al. (2014)	Yes	No	Yes	Five dogs (one observer)	Yes
Grigg et al. (2017)	No (behaviors only named without description)	No	No	12 dogs (number of observers not mentioned)	Only comparing two groups of different housing
Hekman et al. (2012)	No (behaviors only named without description)	Yes (study 2)	No	42 dogs (study 1) and 39 (study 2) (one observer)	Only prediction of behavior as marker of cortisol
Huber et al. (2017)	Yes	No	Yes	53 dogs (one observer)	Only named as possible contribution in future
Jeong et al. (2020)	Yes	No	Yes	28 dogs (one observer)	Only behavior in relation to acute stress
Jones et al. (2014)	No (behaviors only named without description)	No	No	13 dogs (one observer)	Only behavior in relation to stress, not to welfare
Kiddie and Collins (2014)	Yes	Yes	Yes	202 dogs (two observers for each dog)	Only within different groups of kenneled dogs
Kuhne et al. (2014)	Yes	No	No	24 dogs (number of observers not mentioned)	Only in that understanding behavior will prevent incidents
Lind et al. (2017)	Yes	No	Yes	105 dogs (four observers per dog)	Only in terms of stress in or outside veterinary clinic
Littlewood and Mellor (2016)	Yes	No	No	One dog (one assessor)	Yes, by scoring all the phases for five domains
McCullough et al. (2018)	Yes	No	Yes	26 dogs (one primary coder, two additional coders)	Only in that therapy dogs do not have significantly increased stress response
Mellor et al. (2020)	Yes	No	No	Not applicable	Yes, by scoring all the phases for five domains
Mellor (2012)	Yes	No	No	Not applicable	Only in naming positive and negative emotional states
Menchetti et al. (2019)	Yes	Yes	Yes	189 dogs (three observers)	Yes, but not instead of multidisciplinary approach
Mornement et al. (2014)	Yes	Yes (attempted in study)	Yes	48 dogs (two assessors)	Only in relation to the replacement of shelter dogs
Ng et al. (2014)	Yes	No	Yes	15 dogs (number of observers not mentioned)	Only stress in AAI compared to two other settings
Palestrini et al. (2017)	Yes	No	Yes	One dog (two observers)	Yes, in that AAT did not elicit stress-associated behavior so no welfare compliance
Part et al. (2014)	Yes	Yes (attempted in study)	No	29 dogs (number of observers not mentioned)	Only in comparing different stress indicators
Pastore et al. (2011)	Yes	No	No	17 dogs (one observer)	Only in effect of agility on stress levels
Rehn and Keeling (2011)	Yes	No	No	12 dogs (one observer)	Only in the way if left home alone has impact on welfare
Scaglia et al. (2013)	Yes	No	Yes	30 dogs (one observer)	Only compared to three groups of different age
Stellato et al. (2017)	Yes	No	No	31 dogs (one observer)	Only in to recognize fear
Stephan et al. (2021)	Yes	No	Yes	77 dogs (number of observers not mentioned)	Only in how far dogs can deal with being left alone

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Table 5 (continued)

Article (author, year)	Explicit description of observed behaviors/emotions	Validated (yes/no/not applicable)	Inter-reliability or inter-observer agreement	Sample size	Conclusion to welfare (Y/N)
Titulaer et al. (2013)	Yes	No	No	54 dogs (number of observers not mentioned)	Welfare of short- and long-term kenneled dogs were compared
Travain et al. (2015)	Yes	No	Yes	14 dogs (one observer)	Only named as possible tool for stress measurement
Walker et al. (2016)	Yes	No	Yes	29 dogs (number of observers of quantitative analysis not named, qualitative 10 observers)	Only in comparing home and shelter environment

AAI, animal-assisted interventions; AAT, animal-assisted therapy.

considering only one or two measurements in time. In other words, our review indicates that researchers might need to make a distinction between short- and long-term measurements of welfare (Belshaw and Yeates, 2018). Last, the research circumstances or context of studies were often different, which makes an extrapolation and/or comparison of the findings difficult. The studies in this review observed the behaviors of dogs in varying situations, such as at home (Rehn and Keeling, 2011; Scaglia et al., 2013; Gähwiler et al., 2020), in shelters (Dalla Villa et al., 2013; Jones et al., 2014; Arena et al., 2017; Menchetti et al., 2019; Epstein et al., 2021), kennels (Titulaer et al., 2013; Part et al., 2014), during animal-assisted interventions (Glenk et al., 2014; Ng et al., 2014; McCullough et al., 2018; Corsetti et al., 2019), in the veterinary clinic (Hekman et al., 2012; Lind et al., 2017) or in a laboratory (Döring et al., 2016). This is important to point out, because observed behaviors are sometimes only relevant in specific situations, for example, measuring interactions with the social environment is only meaningful when there is another animal or human to interact with.

Of the 39 studies included in this review, 25 used a combination of observable behaviors and/or emotions with other measures, such as a questionnaire for the veterinarian or dog owner, or physiological parameters. Interestingly, no clear conclusions can be drawn from the 17 articles that used physiological parameters in combination with observable behaviors. Several of these studies explicitly mention a discrepancy between the physiological and behavioral measures (Pastore et al., 2011; Rehn and Keeling, 2011; Hekman et al., 2012; Glenk et al., 2014; Part et al., 2014; Walker et al., 2016; Jeong et al., 2020). This could be due to individual differences in physiological responses, the multifaceted role of hormones in the body (Part et al., 2014), the fact that hormone secretion can increase during both positive and negative arousal (Mills et al., 2013), and the time frame between the trigger and physical response (Kremer et al., 2020). Most articles use more than one theme (body posture, vocalizations, oral behavior, physiological reactions to stress, other stress-related signals, interactions with nonsocial environment, interactions with social environment, expression of emotions, and holistic interpretations of welfare) to assess dogs' welfare. On average, studies used behavioral indicators that fell within three different themes. So it seems that, for a reliable observation of welfare, the standard is to use a varied selection of observable behaviors. Exceptions to this were theme 8 (emotions) and theme 9 (holistic interpretations of welfare). Within these two categories, studies often used the holistic interpretation as a stand-alone measure. This is probably due to the fact that most studies within these themes developed specific measurement systems to observe behaviors, such as DOGFACs (facial expression) or QBA. Although the simplicity of a stand-alone measure of dogs' welfare or emotions might seem attractive for the (veterinary) field, note that these holistic methods often require additional and intensive training, which makes them less practical.

Within some themes, studies mostly focused on behaviors with a negative valence (e.g., theme 2, vocalizations), while in other themes, a varied picture of positive and negative signs of welfare was portrayed (e.g., theme 3, oral behavior). In some articles, the positive or negative valence of behavioral signals was not mentioned or specified. This seems like a vulnerability because some behaviors can be interpreted as negative as well as positive. For instance, tail wagging or raising of the head can be interpreted as a positive or negative sign, depending on the context and the specific moment. The sample applies to behaviors such as auto-grooming (which can be a sign of stress but also of caring) and drooling (which can be considered normal when the temperature is high but can otherwise be seen as a sign of severe stress). Importantly, when it comes to the valence of behaviors, there appears to be a gradation that is rarely mentioned in the included studies. For example, the behaviors included in theme 5 (other stress signals) all seem to indicate negative

signs of welfare, but some more than others. Repetitive (stereotyped) behavior, for instance, is generally interpreted as one of the most severe stress signals, while snout licking and paw lifting may be considered milder stress signals (Beerda et al., 1997). The included studies rarely mention this or take this into account.

Our review also shows that the general quality criteria (such as assessment of validity and reliability) for scientific research were not always met in the included studies. Only five of the 39 articles mentioned some form of validity and 23 studies mentioned inter-rater reliability. This is unfortunate, because we know from previous reviews (Haverbeke et al., 2015), that false negative or false positive results can have deleterious effects on long-term dog and human welfare. However, most studies *did* include an ethogram, which can be seen as a sign of good scientific conduct, as it means that authors were very explicit about which specific observable behaviors were studied, making it easier to replicate the study in the future. Yet, overall, we can conclude that the validation of the observational measures found in this study needs more attention to further advance this research field. Validated and tested observational methods of measurement are indispensable to reliably assess dog welfare.

Limitations

One limitation of this review is that only peer-reviewed articles present in PubMed and ScienceDirect were included. Although gray literature could be helpful to counterbalance a possible publication bias, we chose to only include peer-reviewed articles for replication purposes and to ensure a high-quality standard. In relation to this, we assume that there might be a gap between the peer-reviewed, scientific knowledge we present here and the more practical “hands-on” knowledge of practitioners in the field. This valuable knowledge, passed on between colleagues in the field (e.g., in veterinary clinics or between providers of animal-assisted interventions), is not part of this literature review. That said, we believe that we have provided quite a complete picture of the current state of research when specifically looking for observable behaviors to assess the emotions and welfare of dogs.

Another limitation of this review is that we chose the search terms in such a way that keywords such as fear, anxiety, and distress *only* came up if they were explicitly linked to dog well-being, welfare, quality of life, or stress. Similarly, with regard to emotions, articles were only included if they explicitly mentioned the word emotion or related terms, such as mood or affect. This means, however, that articles explicitly focusing on separate emotion (e.g., fear) or a specific behavior (e.g., barking) that did not use any of the keywords in the full text were excluded from this review.

In addition, studies with a more physiological (instead of a behavioral) focus were not part of this review but undoubtedly contain interesting and useful information regarding dogs' welfare and emotions (e.g., Mercier et al., 2023). Examples are studies in the area of physiological parameters, such as heart rate variability or cortisol in relation to canine welfare (Zupan et al., 2016; Kooriyama and Ogata, 2021; Squair et al., 2023), which were out of the scope of this review.

Note, however, that because many articles lack a clear definition of welfare or conclusions about the meaning of behavioral indicators, we run the risk of misinterpreting some of the findings of the included studies. A final limitation of this review is that we excluded instruments that could only be applied in specific laboratory settings, such as eye-tracking, and studies that only used second-hand observations, such as questionnaires for dog owners or veterinarians.

Conclusion and Future Directions

Observing dogs' behavior to assess their welfare is especially relevant in applied settings where specific or invasive instruments are not always available, such as during regular check-ups at veterinary

clinics. In this systematic review, we analyzed and categorized observational measures of dogs' welfare and their emotions as described in the literature. A total of nine themes could be distinguished, of which the most commonly used themes to observe the welfare and/or emotions of dogs were vocalizations (60.5% of the articles), other stress-related behaviors (64.1% of the articles), and dogs' interaction with their nonsocial environment (66.7% of the articles). Altogether, the included studies offer an extensive list of behaviors that we should consider when observing dogs' emotions or welfare. Yet, given that not all observation instruments were properly validated, this remains an important avenue for future research. Last, the articles in this review point to the advantage of a multidisciplinary combination of physiological and behavioral measures of dogs' welfare and emotions to further increase the understanding of dog welfare.

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Authorship statement

TdW created the framework of this review and performed the search. TdW and DG selected the papers. SvdS screened the abstract and full papers. TW and SvdS wrote the first draft of the manuscript. SvdS, KH, and ME supervised the work. TdW, SvdS, RG, KH, ME, and AH edited the manuscript. All the authors approved the final version of the manuscript to be published.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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