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Assessing the Welfare of Kennelled Dogs - A Review of Animal-Based Measures

Zita Polgár¹, Emily J. Blackwell¹, Nicola J. Rooney¹*

¹Animal Welfare and Behaviour Group, University of Bristol, Langford, United Kingdom

*Corresponding author. Tel.: +44 0117 928 9469; Fax: +44 0117 928 9582; E-mail address: Nicola.Rooney@bristol.ac.uk (N.J. Rooney)
Abstract

Hundreds of thousands of dogs are housed in kennels worldwide, yet there are no standard protocols for assessing the welfare of dogs in these environments. Animal science is focusing increasingly on the importance of animal-based measures for determining welfare states, and those measures that have been used with kennelled dogs are reviewed in this paper with particular focus on their practicality and validity. From a physiological standpoint, studies using cortisol, heart rate and heart rate variability, temperature changes, and immune function are discussed. Behavioural measures are also of great relevance when addressing canine welfare, thus studies on fear and anxiety behaviours, abnormal behaviours like stereotypies, as well as responses to strangers and novel objects are reviewed. Finally, a limited number of studies attempting to use cognitive bias and learning ability are also mentioned as cognitive measures.

The literature to date provides a strong background for which measures may be useful in determining the welfare of kennelled canines, however more research is needed to further assess the practicality and validity of using these methods, particularly in regard to the large degree of individual differences that exist between dogs.

Key words: animal welfare, assessment, dogs, kennels, animal-based measures
1. Introduction

The study of animal welfare is a constantly evolving field. Historically, there have existed two views on the nature of animal welfare: one based on how the animal is doing (i.e. its physical functioning and fitness) and another based on how it is feeling (i.e. its mental state in experiencing the world around it) (Broom 1986; Veissier & Boissy 2007; Mills 2010b). Today, it is often argued that a true measure of welfare incorporates both elements and is not only a measure of the absence of negative states, but also the presence of positive ones (Boissy et al. 2007). It is from this idea that the Five Freedoms were born, detailing five essential areas that must be met for an animal to be considered to have good welfare, and on which UK animal welfare laws are based (FAWC 2009). Standard protocols based on these principles have been created for a variety of farm animals, including cattle, poultry, and pigs (Welfare Quality® 2009) however, no such protocols exist for measuring the welfare of dogs in kennels.

Around the world, dogs are kept in kennels for a variety of reasons. Abandoned and stray dogs are kennelled in rehoming centres until they are either adopted or euthanised. In the UK alone, approximately 27,000 dogs go through the three largest rehoming organisations and over 81,000 stray dogs pass through kennels in local authorities each year (RSPCA 2016; Battersea Dogs and Cats Home 2016; Dogs Trust 2017). At any one time, the number of dogs in shelters in the USA is as high as 3.3 million (ASPCA 2017). Working dogs, such as police dogs, military dogs, and sled dogs, are also generally kennelled when they are not on duty (Gaines et al. 2008). Greyhounds kept for racing are housed in kennels, with over 15,000 in just the UK (Environment, Food and Rural Affairs Committee 2016). Laboratories also breed dogs which are kept in cages or kennels for research purposes (Hubrecht 1993). Even pet dogs, who may not normally reside in kennels, may be left at kennels for short periods where they are exposed to reduced social contact, limited space, excessive noise, and altered daily routines, while their owners are on holiday, or if the dogs are in quarantine, receiving veterinary care, or have been seized due to breed-specific legislation. Thus, it is clear that a large population of dogs are housed in a kennel environment at some point in their lives, some for extended periods. While the kennels may vary in their sizes, set-ups and features, the welfare implications of keeping dogs in housing conditions
that are often so restricted - both spatially and socially - are substantial and deserve consideration (for a detailed review, see Taylor & Mills 2007).

Although individual organisations that house dogs in kennels tend to have their own welfare assessment procedures, there is no consensus on what measures should be included in these assessments, nor on the reliability and validity of those measures. Indeed, the differences in housing environments as well as differences in past experiences (for example the rearing of kennelled racing greyhounds is likely to be very different to the early life experiences of police dogs, which again would be different to those of pet dogs waiting for rehoming) mean that certain welfare indicators that might be valuable in one context may not be relevant in other contexts or with different groups of dogs.

Some attempts have been made to create evidence-based welfare assessment tools specifically for rehoming centre dogs. Barnard et al. (2014) developed the Shelter Quality Protocol, which uses 26 indicators of welfare – including management, resource, and animal-based measures, as well as an ‘Emotional State Profile,’ measured through a visual analogue scale – to identify areas of welfare concern in long term shelters. Kiddie and Collins (2014) developed a quality of life assessment too based on behavioural indicators of both positive and negative emotional states where a binary scoring system was used for each indicator to produce an individual quality of life score for each animal. When discussing each measure within this review, we will mention which are included in either of these tools.

Although encouraging progress has been made, it is timely to also review additional potential measures that may be more relevant and practical indicators of welfare in kennelled dogs. Ideally, these measures should be applicable to all kennelled dogs, and not just those in rehoming centres. Most early assessments of animal welfare focused on measuring the animals’ conditions and the resources that were provided to it, rather than the animal’s perception of those conditions (Whay et al. 2003; Whitham & Wielebnowski 2009). Admittedly, measuring management practices as potential indicators of welfare is infinitely simpler than attempting to discern well-being from animal-based measures. Unfortunately, management practices only give an indication of an animal’s “potential” for good welfare (i.e. good
welfare cannot be achieved without appropriate housing, but appropriate housing does not guarantee
good welfare) and thus animal-based measures are still needed for a full assessment. This does not mean
that management level measures are not valuable however, as meeting an animal’s basic needs is still
essential. Taylor and Mills (2007) have summarised the effects of different aspects of the kennel envi-
ronment and management (i.e. space allowance and furniture, visual, olfactory and auditory enrichment,
exercise, social contact, predictability of routine, etc.) on canine welfare in their review.

As it has now been established that welfare is not something that is given to an animal but rather a
characteristic that it has (Broom 2007), greater emphasis needs to be placed on animal-based measures
that are able to quantify how an individual animal is coping with the conditions that it is in. In this
review, the different physiological, behavioural, and cognitive measures that are being used to assess
canine welfare at the animal-level will be discussed, with specific emphasis placed on novel procedures
that are being developed, as well as the feasibility of applying the methods to a range of kennel envi-
ronments. This review will discuss whether measures have been validated against each other, however,
whilst in the case of laying hens and some other production species there have been true validation
studies in which potential welfare indicators are compared to preference/choice (e.g. Nicol et al 2009),
for dogs, no such studies exist. Therefore, we review the extent to which each indicator has been vali-
dated against others. The goal of this review is not to identify a single catch-all welfare indicator, but
to identify which measures would be most useful in a welfare assessment that incorporates the most
practical and reliable measures. Table 1 provides a summary of the measures discussed, as well as their
feasibility and potential confounds.

2. Physiological Measures

2.1 Cortisol

Cortisol is one of the most commonly used biomarkers of stress as it is indicative of the level of activity
within the hypothalamic-pituitary-adrenal (HPA) axis, the body’s primary physiological stress-response
system. Cortisol levels increase in response to arousal regardless of valence, but when examined to-
gether with behavioural responses, this increase can be a useful indicator of distress (i.e physical stress
that occurs in response to negative experiences, as opposed to eustress, which would occur in response to positive experiences (Mills 2010a). Cortisol measurements have become a cornerstone in animal welfare research and have been used to measure stress responses across a wide selection of species (for a review, see Mormède et al. 2007).

As can be seen in Table 1, in studies of dogs, a variety of methods have been used to measure cortisol levels, each with different confounds and degrees of feasibility. Early studies tended to rely on plasma cortisol found in blood samples, however, since the process of taking blood is quite stressful in itself, concerns have been raised about the confounding effects of the procedure (Beerda et al. 1996). As a number of studies both in dogs (Vincent & Michell, 1992; Beerda et al. 1996) and other mammals (Fell et al. 1985; Parrott et al. 1989) have now demonstrated that salivary cortisol levels are highly correlated with plasma levels, blood cortisol sampling has largely been abandoned in favour of less invasive measures, although they are still used if blood is being taken for other purposes or measures (Dudley et al. 2015). Urinary and faecal cortisol have also proved to be popular non-invasive measures used to measure stress in dogs as both provide an indication of cortisol production over a slightly longer period of time than either saliva or plasma (Mormède et al. 2007; Accorsi et al. 2008; Rooney et al. 2009; Bryan et al. 2013; Titulaer et al. 2013).

There has been some research into the use of hair and nail samples to potentially measure chronic distress (see Mesarcova et al. 2017 for a review). One major advantage of these is that they may eliminate the confounding effects that natural fluctuations of cortisol levels throughout the day have on the other sample types (Accorsi et al. 2008; Mesarcova et al. 2017). It is well established in humans and some other mammals that cortisol fluctuates in a diurnal pattern, with levels being the highest shortly after waking (Mormède et al. 2007). This pattern is not as distinct in dogs, with some studies finding evidence of cortisol levels being highest in the morning, others suggesting that the pattern may not exist at all, and one study finding differences in whether diurnal patterns exist depending on the usual routine of the dog (see Kolevská et al. 2003 for a review). Regardless of whether the fluctuations are diurnal or not, there is ample evidence to suggest that fluctuations do occur - in response to normal hormone
releases, altered rates of blood flow through the adrenal system (for example due to exercise or other physical exertion), or even cold temperatures (Beernaert et al. 1996; Hennessy 2013; Protopopova 2016) - the effects of which would be cancelled out when measuring long-term stress through hair or nail samples.

Another significant advantage of using hair samples in particular is the potential to measure chronic stress and baseline cortisol levels over time (Accorsi et al. 2008; Bryan et al. 2013; Grigg et al. 2017; Mesarcova et al. 2017). Other measures of cortisol like plasma, urine, and saliva, assess the levels currently circulating within the animal’s body. This makes them potentially useful measures of acute stressors that have affected the animal in the time (minutes to hours) before the measurement was taken but may not be reflective of the level of chronic stress that the animal is experiencing long term (see Table 1). Because the cortisol amounts in hair are bound to it over time, both as the hair follicle grows and as the sweat and sebum excreted from skin glands comes in contact with it, it gives a more precise picture of long-term cortisol elevation (Mesarcova et al. 2017). Indeed, it has been found to give more stable measurements than either faeces or saliva, with four faecal samples being needed to reach the same level of repeatability as a single hair sample (Bryan et al. 2013). In the as-of-yet only study using hair cortisol to measure the long-term welfare of kennelled dogs, Grigg et al. (2017) found that hair cortisol levels were significantly lower in dogs eight weeks after being switched from solitary housing to social housing than they were prior to the intervention. The same study also found reductions in repetitive behaviours and barking, although no statistical analysis was performed to assess the association between hair cortisol and these behaviours.

When looking at studies of dogs that have analysed relationships between cortisol and behaviour, hair samples have been one of the only measures that have found strong associations between the levels of the steroid and stress behaviours such as running away, hiding, panting, lowering body posture, and attention seeking, following a period of being exposed to stressful stimuli – although it should be noted that these associations were only significant with samples taken in the morning and not samples taken in the afternoon, despite there being no significant difference between the two samples (Siniscalchi et
al. 2013). Other studies which have attempted to correlate behavioural indicators of stress with cortisol levels in either saliva or urine, have found few significant associations (Beerda et al. 1998, 1999b; Hennessy et al. 2001; Hibi et al. 2006; Jones et al. 2014; Part et al. 2014).

While it appears that hair samples may be a practical and effective way to quantify basal cortisol levels, more research needs to be done to gain a better understanding of their use. For example, some studies have suggested that there may be differences in cortisol level based on hair colour, with darker hairs having less cortisol than lighter hairs, sometimes even within the same dog (Bennett & Hayssen 2010; Svendsen & Sondergaard 2014). However, other studies have not found such differences (Nicolson & Meredith 2015; Rosen 2016). It is also unclear what effect external factors, such as sunlight exposure or excessive brushing may have on cortisol concentration in hair (Mesarcova et al. 2017). It has also been found that different methods of preparing the hair for analysis, for example powdering compared to chopping, can cause over a three-fold difference in the amount of cortisol that can be recovered from the sample (Mesarcova et al. 2017). Furthermore, although hair samples seem to be promising potential measures of chronic stress in dogs, only one study as of yet (Grigg et al. 2017) has used cortisol concentrations in hair to assess the welfare of kennelled dogs specifically.

There have however been several studies assessing the welfare of kennelled dogs using the other measures (primarily salivary and urinary) of cortisol concentration. When looking at the impact of moving dogs into kennels, most of the research suggests that dogs tend to have an initial increase in cortisol levels when entering kennel environments that are more challenging than those they are used to, but this is modulated by past experiences. For example, when dogs were transferred to indoor kennels after having been housed in outdoors areas during favourable weather, their cortisol levels increased far more than dogs that had been brought to kennels from areas that typically have stormy, unpleasant weather, despite their levels being comparable previously (Beerda et al. 1999b). Similarly, dogs that were brought into kennels after having been strays or having been previously in kennels showed declining cortisol levels over their first ten days, whereas dogs surrendered from homes showed increasing levels
(Hiby et al. 2006). Indeed, Rooney et al. (2007) found that, when housed in kennels, if dogs were previously habituated to the kennel environment, their urinary cortisol levels increased significantly less than if the dogs had not been habituated. In contrast, another study that conducted a direct comparison between urine samples taken in a home environment and on the first days in a kennel found that cortisol was significantly higher in the kennel than at home regardless of past kennelling experience, however these dogs had not gone through a specific habituation programme as in Rooney et al. (2007), but had simply had a history of kennelling (Part et al. 2014).

Some studies suggest that cortisol first increases, then levels out with time (Hennessy et al. 2013; Protopopova 2016). One study found that dogs newly admitted to shelters had higher plasma cortisol levels than dogs that were sampled in homes, however, their levels were comparable after just five days (Hennessy et al. 1997). Another found that, on average, urinary cortisol peaked around the seventeenth day, after which levels steadily declined and were not significantly different from baseline levels taken from dogs in homes by Day 31 (although the authors did note large individual variations between the dogs) (Stephen & Ledger 2006). When looking at plasma cortisol levels, Dudley et al. (2015) found that, on the first day, cortisol levels in newly kennelled dogs were significantly higher than those of control dogs, however these levels significantly decreased over the next ten days (but were still higher than control dogs on Day 10). A study on laboratory beagles looking at cortisol levels immediately after being transferred to small, single steel cages from outdoor, social pens, found that levels were highest on the first day and gradually decreased and stabilised over the next 77 days (Clark et al. 1997).

Other studies however, have not found evidence of such a change over time. Titulaer et al (2013) noted that dogs housed in kennels for six months did not have significantly different urinary cortisol levels from dogs that had been housed in kennels for between one week and three months, and that levels for all groups were “relatively high,” although the initial levels upon first entering kennels were not measured. Beerda et al. (2000) found that dogs housed in the most severe living conditions tended to have higher urinary cortisol levels than dogs housed in more enriched environments even after being kept in those conditions for multiple years. A meta-analysis of 31 studies found no difference between the
salivary cortisol levels of dogs living in shelters for less than two weeks compared to more than two weeks (Cobb et al. 2016). To complicate matters further, there are also some studies which have found that cortisol levels decrease to significantly lower than baseline in kennels. The same meta-analysis of over 30 studies found that dogs that have been living in rescue shelters for over two weeks had significantly lower salivary cortisol levels than dogs in working/training kennels or private homes (Cobb et al. 2016). Gaines and Rooney (unpublished data 2007; as cited in Hewson 2007) also found that dogs that had been kennelled for more than one year had urinary cortisol levels that were below the levels of dogs in homes. Although Denham et al (2014) found that the majority of kennelled working dogs still had normally functioning HPA systems even after years of living in kennels, they also noted that the small group of dogs that showed the most atypical behavioural responses (engaging in repetitive behaviours under minimal stimulation) had opposite responses to novel stressors, where their cortisol levels decreased after the challenge. These results provide some evidence that dysregulation of the HPA axis may occur in dogs in response to chronic stress of kennelling.

Indeed, there is other physiological evidence that dysregulation occurs in some kennelled dogs, namely the dissociation of ACTH and cortisol levels over time (Hennessy et al. 2002a, 2002b, 2006, 2013). Dysregulation may also provide a reasonable explanation for why many studies have not found direct associations between cortisol levels and the majority of behavioural measures considered indicative of distress in canines, although individual differences in behavioural responses is likely also a factor (Beerda et al. 1999b; Hennessy et al. 2001; Hiby et al. 2006; Jones et al. 2014; Part et al. 2014). Down-regulation and decreased HPA reactivity in response to chronic stress has also been observed in a number of farm animal species (cows, sheep, horses), wild animals (European startlings), and even humans (see Pawluski et al. 2017).

Thus, the overall picture of the usefulness of cortisol as a measure of the welfare of kennelled dogs remains unclear and convoluted. Idealistically one may aspire to determine set cut-off levels to identify
whether an individual’s welfare is unacceptably poor. Unfortunately, due to the myriad of factors that
may influence measures (sex, age, neuter status, time of day, etc. - see: Cobb et al. 2016 and Mormède
et al. 2007); the limited understanding of when and how dysregulation of the system occurs; the lack of
correlation with behavioural measures; and the fact that levels increase in response to arousal regardless
of its valence, it is not possible to determine such a cut-off value for acceptable welfare. These factors
also suggest that the measures of cortisol that have been used thus far are unlikely to be the most reliable
measures of distress in kennelled dogs, particularly for those kennelled long-term. Indeed, no cortisol
sampling measures of any kind were used by Kiddie and Collins (2014) nor Barnard et al (2014) in their
assessment tools. Nevertheless, there exists compelling evidence that novel measures of cortisol, such
as in hair or nail samples, could provide valuable data relating to chronic distress. Future research should
aim to assess the usefulness and relevance of such novel measures, and to gain a better understanding
of the ambiguity of results when compared to commonly used measures.

2.2 Heart Rate and Heart Rate Variability

Heart rate and heart rate variability are also frequently used indicators of potential distress in the study
of animal welfare (von Borren et al. 2007). Activation of the sympathetic nervous system causes an
increase in heart rate to facilitate any impending ‘fight or flight’ response. While heart rate (HR) simply
measures the average number of beats per minute, hear rate variability (HRV) measures the changes in
time between heart beats. HRV has been suggested as a particularly useful non-invasive measure of
activity in the autonomic nervous system, with HRV tending to decrease in response to stressful events.
While HR and HRV have been used extensively to assess welfare in pigs, goats, cattle, poultry, and
horses (see von Borren et al. 2007 for a review), a number of recent studies have now also focused on
dogs (Craig et al. 2017; Wormald et al. 2016, 2017), although none have used HRV to examine the
welfare of kennelled dogs specifically, nor is it used as measure in either of the previously discussed
assessment tools (Barnard 2014; Kiddie and Collins 2014).

A study examining the relationship between HRV and aggression (which is commonly caused by
fear/distress, see Rooney et al. 2016) found that aggressive dogs had significantly lower HRV than non-
aggressive dogs when measured after the arrival of a stranger into their home, suggesting that they were
more distressed at the time of this event (Craig et al. 2017). Wormald et al. (2016) found a similar result
when taking HR, HRV, and salivary cortisol measures from greyhounds undergoing a blood donation
procedure. Afterwards, the dogs were tested for their reactions to approaching a small, unfamiliar dog.
Those dogs which displayed aggression towards the unfamiliar dog had significantly elevated initial
HR, significantly reduced HRV, and significantly increased cortisol levels during the blood donation
than dogs that did not show aggression. In another study by the same authors (Wormald et al. 2017),
dogs diagnosed with anxiety-related behaviour problems had significantly lower HRV after a manual
restraint procedure than dogs without such problems. Interestingly however, the restraint procedure in
this study did not increase cortisol levels in either group, and reactivity during the procedure was not
related to HRV measures, making it unclear whether the dogs in the anxious group had a lower baseline
HRV to begin with or if this was influenced by the procedure.

Katayama et al. (2016) found that HRV is reduced in response to separation from a caregiver, but also
found reduced HRV in response to being gently petted by their caregiver (which they assumed to be a
positive interaction), suggesting that changes in HRV may occur when aroused regardless of the valence
of emotional change. In agreement, Zupan et al. (2016) also demonstrated that HRV decreases in re-
response to positive emotional states like being rewarded with high-value food or being petted by a fa-
miliar person. These results suggest that HRV should not be used as a measure on its own, but rather
should be interpreted together with other behavioural or cognitive information that can determine the
emotional valence of the physiological stress the dog is experiencing.

Although HR and HRV are relatively straight-forward, non-invasive measures, as shown in Table 1,
there are some considerations that need to be taken into account when using them to assess welfare.
Firstly, not only does the potential effect of the dog’s body movement need to be taken into account,
but there is also evidence to suggest that body posture and even orientation can have an effect, where
HR is lowest when lying down, and orienting towards a favourite toy causes a significant increase in
HRV (Maros et al. 2008). Secondly, whilst wearing a heart rate monitor does not seem to adversely
affect most dogs (Vincent & Leahy 1997; Essner et al. 2015), individual differences in their sensitivity to this still needs to be taken into consideration and habituation carried out. Furthermore, although HRV seems to be a promising measure of physiological stress, the emotional state of the dog still needs to be determined through other measures for it to be relevant to a welfare assessment.

2.3 Temperature

Body temperature can be a useful physiological measure of stress in animals. In response to acute stress, the activation of the sympathetic nervous system generally causes an increase in core temperature accompanied by a decrease in the temperature of the peripheries, known as stress-induced hyperthermia (Ogata et al. 2006; Travain et al. 2015). In laboratory rodents, stress-induced hyperthermia has been demonstrated as being a direct physiological response to arousal rather than an increase in body temperature due to physical activity or ambient temperature (Long et al. 1990; Oka et al. 2001; Ogata et al. 2006; Part et al. 2014).

Ogata et al. (2006) studied the responses of dogs to a fear-conditioning protocol. Although the individual behavioural responses were highly variable, all the dogs showed a similar increase in core (rectal) temperature, suggesting that the dogs experienced stress during the protocol. Using infrared thermal imaging, Travain et al. (2015) also found that the internal eye temperature of dogs was significantly higher during a stressful veterinary exam than both before and after the exam. In contrast, Part et al. (2014) found that dogs who were moved to kennels from a home environment had no difference in their core temperatures (measured with a thermometer in the ear canal), but they did have significantly lower surface temperatures, as measured using an infrared camera recording nose temperature. Similarly, Riemer et al. (2016) used an infrared camera to measure surface temperature, specifically the temperature of the ear pinnae. The results showed that peripheral temperature decreased in response to separation and increased again upon reunion with the owner. Thermal imaging has also been studied in dogs in a clinical veterinary context to assess its usefulness in detecting pain (Vainionpää 2014).
Taking temperature measurements manually with a thermometer is generally a stressful experience for animals, as it typically involves inserting a thermometer either into the rectum or the ear canal. With the advance of technology, thermal imaging can now be used as a non-invasive measure of temperature, which greatly reduces the stresses involved. This is because thermal imaging requires no restraint and, in some cases, does not even require a person to be present, meaning that the animal is not even necessarily aware that the measurements are being taken (Riemer et al. 2016). Thermal imaging is a useful measure of welfare across a variety of species for both core and peripheral temperatures (for reviews, see: Nääs et al. 2014 and Redaelli et al. 2014), however few studies have used it to assess canine welfare specifically, as a standard methodology has not yet been developed and validated.

One major issue with using thermal cameras is that some studies have reported that the dogs show aversive behaviours towards the camera (Travain et al. 2015), suggesting that camera itself could be a source of distress for the animals. This could clearly influence the measures taken, however other studies have developed methods where the dogs are completely unaware of the camera, with measurements being taken from five to eight metres away (Riemer et al. 2016) or where the animals are habituated to the camera over time (Proctor and Carder 2015). Even in these cases however, there is still the possible confounding effect of the environment that needs to be taken into consideration, as the temperature, material, dimensions, and heat-reflecting ability of the animal’s surroundings could all influence the measurements (Telkänranta et al. 2016; Whitham and Miller 2016). There is also no standard procedure for using thermographic imaging in dogs, and thus these methods have not been validated for this species, nor have they been used in the mentioned assessment tools (Barnard et al. 2014; Kiddie and Collins 2014).

### 2.4 Immune Function

Activation of the HPA axis in response to stress requires a great deal of energy from the body, and thus leaves it in a more vulnerable state than normal. Therefore, it is not too surprising that compromised immune function may be another useful physiological measure of poor welfare, particularly of chronic stress (Protopopova 2016). Immune function is often studied by measuring the amount of antibodies
such as immunoglobulin-A (IgA) present or by white blood cell counts (WBC). Unfortunately, as with
cortisol, studies attempting to assess the immune function response to stress in dogs have found con-
flicting results.

One of the earliest studies to assess immune response as a measure of stress was by Skandakumer et al.
in 1995. This study examined kennelled police dogs (German Shepherd Dogs) who underwent stressful
training routines (including tracking, agility, retrieving, and searching for and recovering hidden objects
marked with specific scents), and kennelled army dogs (German Shepherd Dogs, English Springer
Spaniels, and a Labrador Retriever) who were exposed to a novel stressful environment (a veterinary
setting where a hip radiography was carried out). Their study found a significant negative correlation
between cortisol and salivary IgA and a positive relationship between salivary IgA and behavioural
scores (higher scores were associated with more positive states). This is in accordance with the hypoth-
esis that stress reduces immune function, and thus, the authors concluded that IgA could potentially be
used as a reliable stress-indicator in dogs. While some authors have argued against this, citing signifi-
cant intra-individual variations (German et al. 1998), there have also been studies which have demon-
strated similar results: Kikkawa et al. (2003) found that salivary IgA levels in laboratory beagles sig-
nificantly decreased in the 30 minutes following a stressful noise stimulus and did not return to baseline
until 60 minutes after. Also with laboratory beagles, Clark et al. (1997) found that the number of white
blood cells (which produce antibodies like IgA) significantly decreased over the 12 weeks following
the dogs’ transfer to the laboratory cages.

One study, examining the effects of kennelling specifically however, found contrasting results. Dudley
et al. (2015) compared dogs newly admitted to shelters to control dogs in homes, and found that not
only were leukocyte, neutrophil, monocyte, and neutrophil-to-lymphocyte ratios higher in shelter dogs,
the counts of these continued to increase significantly over the ten days studied.

While measuring antibodies and white blood cells is a straightforward way of assessing immune func-
tion, there are some potential confounds. Firstly, the stress involved with taking blood samples could
have an impact on the results, although this could be lessened by opting for saliva samples instead.

Secondly, there is some suggestion that certain immunological functions may follow diurnal patterns, meaning that the time of day the measures are taken could have a significant impact on the results (Kikkawa et al. 2003). There is also evidence to suggest that there are significant differences in IgA concentrations based on breed (with eight breeds now identified as being predisposed to low IgA concentrations) and based on age (Olsson et al. 2014). Finally, the level of individual differences and indeed intra-individual differences has been called into question, and thus needs more research to determine the level of variability (German et al. 1998). Antibody levels are not used by either assessment tool (Barnard et al. 2014; Kiddie and Collins 2014) as practical measures of welfare/quality of life.

To circumvent these potential issues, there are also several measures which can be used as indirect indications of suppressed immune systems. One such possible measure is weight loss/gain which can be calculated either through measuring the weight directly or through body condition scoring. Weight loss is generally considered an indication that an animal is struggling to cope, potentially due to stress causing a decreased appetitite, and is a significant welfare issue (Broom & Johnson 1993; Rooney et al. 2009). Both Barnard et al (2014) and Kiddie and Collins (2014) included body condition score as a measure in their protocols to assess kennelled dog welfare.

Incidence of disease can also give clues about immune function, as animals with compromised immune systems will be more susceptible to diseases than those with normally functioning systems. In one study of dogs in US shelters, the chances of a dog coughing increased by 3% for each day the dog was in the shelter (Edinboro et al. 2004). Indeed, another study found that approximately one half of the shelter dogs measured were infected with some form of canine infectious respiratory disease (Lavan & Knesl 2015), while another found that after three weeks 100% of dogs tested positive for antibodies for the specific disease canine respiratory coronavirus, compared to 30% on day of entry into the kennels (Erles & Brownlie 2008). Unfortunately, it is difficult to quantify whether this increased risk of infection is due to suppressed immune functions caused by stress, or due to the greater likelihood of disease spreading due to the close confines and limited cleaning procedures present in most kennels. It is most likely
a combination of these factors. Kiddie and Collins (2014) did not measure disease prevalence in their assessment tool, however Barnard et al (2014) did record some symptoms that may be indicative of disease (e.g. diarrhoea, coughing), and also included a measure of the centre’s annual expenses for clinical treatment.

2.5 Other Physiological Measures:

There are many other physiological measures that have been suggested as possible welfare indicators in dogs (Table 1), but none have been fully validated and many are difficult to measure. One example is oxytocin, which has been suggested as a non-invasive physiological indicator of positive emotions in dogs (Mitsui et al 2011), but more research is needed to fully understand its relationship with various emotional states as well as the effects of individual differences (Pekkin et al 2016). Some other examples include paw sweating, pupillary dilation, eye redness, skin dryness, faecal consistency and excessive shedding of skin or hair (Belpedio 2010; Part et al. 2014). Kiddie and Collins (2014) included the “presence of scurf” as well as “eye discharge” as physical measures within their scoring system, while Barnard et al (2014) included a “skin condition” section where the presence of wounds, hair loss, swelling, and ectoparasites was recorded. Future studies should continue to examine these measures to assess their potential as useful indicators of canine welfare.

3. Behavioural Measures

3.1 Anxiety & Fear Related Behaviours

Behavioural changes that correspond with fear and anxiety have been extensively documented across a variety of species. Perhaps the most universal of these, which are common among most mammals, including dogs, are a low, cowering body posture, attempts to retreat and avoid the fear-inducing stimulus, freezing, and in severe cases, trembling (Stephen & Ledger 2005; Rooney et al. 2009, 2016; Blackwell et al 2013). There are some other behaviours which have been suggested to be more specific to dogs, such as paw lifting, lip licking, gaze aversion, panting, whining, auto-grooming, and body shaking (Beerda et al 1997, 1999a; Hiby et al. 2006; Rooney et al. 2009). Increases in these behaviours have
been shown when dogs enter kennel environments (Beerda et al. 1999a). Aggression is another behaviour that is closely linked to anxiety and fear in dogs and may indicate compromised welfare, however few studies have examined aggression in this context (Taylor & Mills 2007; Rooney et al. 2016). Kiddie and Collins (2014) included all of these behaviours and additional ones as “behavioural measures assessing negative emotions” in their assessment tool. Barnard et al. (2014) did not list any of these behaviours specifically in their assessment, although the Emotional State Profile section of the protocol does include visual analogue scales for the terms “nervous,” “unsure,” and “anxious.” Panting and shivering are recorded as part of the assessment, and are used as indicators of inadequate shelter (i.e. is the dog overheating or too cold) rather than as behavioural indicators of anxiety or fear.

While some dogs may frequently exhibit fear and anxiety related behaviours during their time in kennels regardless of any external stimuli, the absence of these behaviours does not necessarily indicate good welfare, particularly in cases of chronic stress, where apathy or learned helplessness may influence behaviour (Mason & Latham 2004; Gaines et al. 2008). In some instances, increased fear and anxiety behaviour may become more evident in response to novel stimuli and thus measures looking at these reactive behaviours may be more useful.

One such test which has been used in kennelled dogs is the response to the approach of a stranger. In farm animals, “avoidance distance” is used to quantify this (Welfare Quality® 2009). In kennel dogs, a combination of approach distance, body postures, and behaviour is generally used. Arhant and Troxler (2014) studied an approach test for dogs in 29 shelters and found that both the test-retest reliability and the between-experimenter repeatability of the procedure was substantial (86.6% and 95% respectively). They also found that the dogs in shelters where staff had more positive attitudes towards dogs and used gentle handling practices were more likely to approach a stranger than dogs at other shelters. This is similar to the results found by Conley et al. (2014) where shelter dogs who received enriched husbandry routines with positive human contact and toys were more likely to approach a stranger than dogs that did not receive the enriched routine. Indeed, Hubrecht (1993) also found that enrichment and human contact reduces avoidance behaviours and increases the willingness to approach strangers. Both the
Welfare Assessment Protocol for Shelter Dogs (Barnard et al. 2014) and the quality of life assessment tool for shelter dogs developed by Kiddie and Collins (2014) employ a stranger approach test. Barnard et al. (2014) recorded behavioural responses to a stranger approaching the kennel and standing for 30 seconds followed by 30 seconds of crouching down and speaking gently to the dog. Kiddie and Collins’ (2014) assessment involved the observer approaching, handling, and initiating play with the dog while its behavioural responses were recorded.

Novel object tests are frequently used in both laboratory and farm animals to assess levels of fear and anxiety (Forkman et al. 2007) and they have also been suggested as useful methods to assess fear in dogs, although it is not included in either of the developed assessment tools (Barnard et al. 2014; Kiddie and Collins 2014). Ley et al. (2007) found that dogs that were given anxiolytic drugs (which reduce fear) were quicker to approach a novel object (a remote-controlled car) and spent more time in its vicinity, indicating that latency to approach a novel object is influenced by fear. King et al. (2003) also used a remote-controlled car as a novel object and found that dogs’ responses were related with a variety of other measures of fear. For example, there was a significant positive correlation between cortisol and the amount of time it took dogs to approach within 100cm of the object. Interestingly, King et al. (2003) also noted that, compared to other breeds, greyhounds exhibited significantly fewer fear-related behaviours on the novel object test (i.e. quicker to approach and spent more time near) as well as on the other behavioural and physiological tests of fear, suggesting that breed differences or rearing environment could have a large influence on fear and anxiety. Plutchik (1971) also found significant breed differences in the patterns of approach/withdrawal between four different breeds of dogs (beagles, wire-haired fox terriers, basenjis, and Shetland sheepdogs) when presented with novel objects. Thus, it is important to note that responses to novel objects in dogs are not solely determined by their levels of fear and anxiety, but also by their baseline temperaments, which may be influenced by breed type or rearing.
Indeed, one of the main difficulties in using fear and anxiety related behaviours to measure welfare is the wide range of individual differences. Dogs can have different “coping styles” in response to kennelling which influences their behaviour, depending on whether their response style is more proactive or reactive (Blackwell et al. 2010; Rooney et al. 2016). A number of factors can influence the individual differences in how dogs behave, including their genetic predispositions and previous life experiences (Stephen & Ledger 2005). For this reason, the presence or absence of fear or anxiety responses should not be used as an exclusive indication of compromised welfare.

3.2 Abnormal Behaviours

The emergence of abnormal behaviours is perhaps the most noticeable sign of stress in captive animals (Mason & Latham 2004). Abnormal behaviours are those that an animal would not generally perform as they tend to be either maladaptive or non-functional. Behaviours that become repetitive and ritualised are known as stereotypies or abnormal repetitive behaviours (ARBs). The emergence of stereotypies has been documented across a wide range of captive species (for a review, see: Mason & Latham 2004) and while some behaviours are common among a variety of animals (e.g. pacing) others seem to be species-specific and dependent on the animal’s anatomy as well as the environment they are kept in.

In dogs, the most commonly seen abnormal repetitive behaviours are pacing, spinning, bouncing off the walls, circling, and repeatedly walking the perimeter of their kennel, while less common but still notable behaviours include biting at their enclosure (i.e. bars or wall), excessive licking of their environment, and self-mutilating behaviours such as flank-sucking, chewing feet, and excessive autogrooming (Stephen & Ledger 2005; Rooney et al. 2009; Belpedio 2010; Denham et al. 2014; Protopopova 2016). ARBs were recorded by both Kiddie and Collins (2014) and Barnard et al. (2014) in their protocols.

The incidence of ARBs in dogs has been found to be relatively high in the kennel environment compared to the home environment, although values vary tremendously depending on the definitions used (Protopopova 2016). Protopopova et al. (2014) found that only between 1.3-4.5% of the pet dogs studied
(n=26) engaged in ARBs in the home, while Denham et al. (2014) found that 93% of 30 kennelled working military dogs showed repetitive behaviours, although this number is reduced to 16.7% in the absence of arousing stimuli such as humans. In Hubrecht et al.’s (1992) dataset, which was recorded by an observer standing in front of the kennels, between 46-84% of laboratory dogs, and 42-62% of dogs in rehoming centres engaged in such behaviours. The percentage of time engaging is similarly varied (Protopopova 2016). In an audit of behavioural indicators of poor welfare, Stephen and Ledger (2005) found that dogs in kennels began repetitive behaviours such circling and wall bouncing later (on average after 10-13 days in the kennel) than fear-related behaviours such as hiding (which began on average after two days). They also found that the incidence of repetitive behaviours increased the longer the dogs were in kennels, whereas fear behaviours decreased. Beerda et al. (1999a) demonstrated that the incidence of ARBs like circling was influenced by factors such as whether the dogs were housed individually or in groups, and even whether the weather was pleasant or unpleasant, which could partially explain the different incidence levels across studies.

Some studies have found that certain stress-reducing interventions can reduce the incidence of ARBs in kennelled dogs (Taylor & Mills 2007). However, caution should be taken when extrapolating that the presence of ARBs indicates compromised welfare. Often these behaviours are emancipated from the original cause and can persist after the animal has been removed from the stressful environment, and thus may represent artefacts from their previous poor welfare states, rather than being representative of their current state (Mason & Latham 2004; Hewson et al. 2007). Furthermore, ARBs may emerge as a coping mechanism for the animal; thus, it is possible that an animal engaging in repetitive behaviour has adapted to its conditions more successfully than an animal not engaging in such behaviour and may have better welfare (Mason & Latham 2004; Hewson et al. 2007; Denham et al. 2014). It is also possible that the behaviours persist because they are rewarded (e.g. through increased attention and human contact) (Hewson et al. 2007; Denham et al. 2014).
As shown in Table 1, other abnormal behaviours that are commonly seen in the kennel environment and have been associated with stress are coprophagia, excessive barking, and excessive drinking. Coprophagia has been found to increase in laboratory beagles when they are socially and spatially restricted (Beerda et al. 1999a). In a study of 120 working dogs housed in kennels, 18% were found to engage in coprophagia (Gaines et al. 2005 as cited in Rooney et al. 2009), compared to non-kennelled dogs, where a study of nearly 8000 dogs found that less than 1% were reported to engage in it (Col et al. 2016). Barking has been found to be more prevalent in dogs housed individually compared to dogs housed in groups and was accompanied by an increased incidence of ARBs as well (Hetts et al. 1992). In an audit of behavioural welfare indicators, excessive barking was found to be the most commonly observed behaviour in kennelled dogs, seen in nearly a quarter of dogs (Stephen & Ledger 2005). Exercise has been shown to reduce the frequency of barking in kennelled dogs (Clark et al. 1997). There may be significant breed differences in the frequency with which both these behaviours are exhibited (see Stephen & Ledger 2005) and this should be taken into account when using coprophagia and barking as welfare measures. The incidence of excessive drinking has also been found to increase the longer dogs are in kennels, both in laboratory settings (Clark et al. 1997) and in rehoming centres (Stephen & Ledger 2005; Hiby et al. 2006; Kiddie & Collins 2014). Kiddie and Collins (2014) included excessive drinking and coprophagia in their quality of life measures, while Barnard et al. (2014) did not. Conversely, excessive barking was excluded from Kiddie and Collins (2014) but was present as a measure in Barnard et al. (2014).

### 3.3 Activity Level & Resting Behaviours

Both increased and decreased activity levels have been suggested as potential indicators of stress in animals. As activity level is closely linked with other behavioural measures, such as the presence of ARBs like pacing or spinning, it is unclear how useful it is on its own as a measure of welfare. In farm animals, accelerometers are used to detect reduced activity, which may be indicative of lameness or pain (Rushen et al. 2012). Assessing the frequency and duration of resting behaviours could also shed light on welfare status and housing preferences; dairy cows have been found to engage in resting behaviours more frequently and for longer durations when they are given softer flooring and have more...
space (Haley et al. 2000). In the existing assessments of kennel dog welfare, Kiddie and Collins (2014) included “high level of activity” and “lying down” as indicators of positive emotional states, and “listlessness” as an indicator of negative emotional states, while Barnard et al. (2014) did not measure activity level or resting specifically but did include the terms “boisterous” and “quiet” in their Emotional State Profile.

In studies on dogs, Jones et al. (2014) used accelerometers on shelter dogs to measure average activity level and found a significant positive correlation with mean urinary cortisol levels, although the valence of the arousal causing these effects is difficult to interpret. Part et al. (2014) also studied kennelled dogs and, while no relationship was found with cortisol levels, they did find that kennelled dogs spent less time lying down, resting, and sleeping (i.e. were more active) than dogs in homes (although this may be due to home dogs being under-stimulated, so care should be taken when interpreting their lower activity as positive welfare). Another study looked specifically at sleep in dogs kennelled at rehoming centres and, although it did not find a relationship between night-time sleep and behavioural measures, it did find that dogs that spent more time resting during the day had a more positive judgement bias and exhibited fewer repetitive behaviours than dogs that did not rest as much in the daytime (Owczarczak-Garstecka 2016). While this may suggest that reduced activity and increased resting during the day, may be a useful indicator of positive welfare in kennelled dogs, another study by Hiby et al. (2006) found that this relationship may be more complex. In their sample of dogs kennelled in rehoming centres, when looking at the data on any specific day, those dogs that were the least active during the day had the most elevated cortisol. However, when looking at longer-term trends over a ten-day period, the cortisol levels of the dogs that had the highest mean activity (trotting, drinking, walking, etc) increased over time, whereas the levels of dogs with lower levels of activity decreased. Some studies have differentiated between truly restful inactivity (i.e. sleeping) and other causes of still but awake inactivity by recording whether the animal’s eyes are open or closed (Fureix et al. 2016), which may provide an important clarifying distinction between inactivity that is indicative of positive welfare compared to inactivity that is negative and may be a sign of depressive states. Thus, activity level seems to have potential as welfare measure, but more research needs to be done to clarify their exact relationship.
### 3.4 Play behaviours

The modern understanding of animal welfare emphasises that good welfare consists not only of the absence of negative states but also of the presence of positive ones (Lawrence 1987; Yeates & Main 2008; Held & Špinka 2011). Therefore, a thorough assessment of kennel dog welfare should also include measures of positive behaviours, such as the willingness/desire to engage in play. Level of play behaviour has been found a useful measure of welfare in a myriad of other species such as cattle, sheep, deer, cats, wolves, meerkats, seals, rats, chimpanzees and of course humans (for reviews, see: Ahloy-Dallaire et al. 2017, and Held & Špinka 2011). Kiddie and Collins (2014) included “willingness to play” as an indicator of positive emotional states in their shelter dog quality of life assessment and measured this through recording both unprovoked play behaviours in the kennel (both solitary and with other dogs) as well as initiated play, where the assessor engaged the dog with a “Ragger”. Barnard et al. (2014) included the term “playful” in their Emotional State Profile as an indicator of positive emotional state.

It has been found that dogs are less likely to play with strangers after having been housed in kennels for more than six months (Titulaer et al. 2013). A study of laboratory beagles found that dogs who were only provided with environmental enrichment played less overall and were less likely to solicit play than dogs that had daily social contact either with humans or larger groups of dogs (Hubrecht 1993). A number of studies have found that shelter dogs who are given access to play sessions, whether with other dogs (Coppola et al. 2006; Belpedio et al. 2010; Johnson et al. 2013; Shiverdecker et al. 2013; Flower 2016) or with humans (Bergamasco et al. 2010; Conley et al. 2014;) display fewer stress-related measures than dogs that do not have such access. This suggests that not only are responses to play opportunities a potential measure of welfare, but also that access to these opportunities may affect their welfare states as well, although, it should be noted that a decrease in negative affect does not necessarily equate with the presence of an absolute positive affective state (Ahloy-Dallaire et al. 2017). Therefore, on its own, willingness to play cannot be used a definitive sign that an animal has good welfare.
There are some other difficulties in using play to assess welfare as well. While the majority of studies examining the link between play and welfare have found that increased play is linked to better welfare, there have been some notable counter-examples across a number of species (rats, cats, horses, humans) where those individuals that seemed to have poorer welfare were the ones that engaged in the most play, potentially as a coping mechanism (see Ahloy-Dallaire et al. 2017 for examples). Other potential difficulties include the fact that, although the drive to play may be instinctive in young animals like puppies (Bradshaw et al. 2015), for adult dogs who may not have received proper socialisation when they were young, their readiness to engage in play behaviours may not be as strong. In other words, some dogs may not ‘know’ how to play (particularly with humans) and thus an assessment of their willingness to play may not reflect their current welfare status, but rather previous learning experiences. There may also be breed differences which may affect an individual dog’s willingness to engage in play behaviour, or the style of play behaviour exhibited (Rooney et al. 2000). Furthermore, although dogs are naturally more playful throughout their whole lives than other species may be (Bradshaw et al. 2015), there is still a tendency for older dogs to be less playful than young dogs (Rooney et al. 2000), which should be taken into account when using playfulness as a measure. Finally, it should be noted that, when assessing play behaviours as an indicator of welfare, it is important that the behaviours are relatively spontaneous, particularly with working dogs, who may have been trained to ‘play’ on command (Horváth et al 2008).

4. Cognitive Measures

4.1 Cognitive Bias

Recent research in both humans and a variety of species has demonstrated that affective states can have a large impact on an individual’s perception of their environment and their consequent decision-making (Mendl et al. 2009). A number of ‘cognitive bias’ tests have found that animals with negative affective states tend to perceive ambiguous stimuli more pessimistically compared to animals with positive affective states. This is generally tested by teaching an animal to associate one stimulus with a positive experience and another stimulus with a negative experience and then testing whether the presentation of an intermediate stimulus elicits a negative or positive anticipatory response (Mendl et al. 2009). For example, in the first study of this kind in animals, rats learned to associate the pressing of a lever after
one tone with the presentation of food (a positive event) and the pressing of a lever after a tone of a
different frequency with an electric shock (a negative event). Once they had learned the associations,
in addition to the original tones, they were also presented with ambiguous tones of intermediate fre-
quencies. Rats that were thought to have more positive affective states (due to their more stable hus-
bandry routines) tended to press the lever faster and for more of the ambiguous tones, indicating that
they anticipated food, whereas rats the were thought to have more negative affective states refrained
from pressing the lever more often and were slower at pressing when they did (Harding et al. 2004).
Similar results have been found in cows, pigs, horses, sheep, chickens, monkeys (for a review, see
Mendl et al. 2009) and even bees (Bateson et al. 2011).

Studies using dogs have found contrasting results. Burman et al. (2011) used light and dark shades of
cards to predict either the presence or absence of food and expected that dogs that had just been re-
warded would have a more positive cognitive bias towards intermediately shaded cards than dogs that
had not. Surprisingly, they found that dogs that had been rewarded were slower to approach the ambig-
uous cards than the unrewarded dogs. The authors propose several explanations for this, including pos-
sible satiation, differences in motivation, and a greater anticipation in the unrewarded dogs eliciting an
unexpected positive affective state. Other studies have used setups where dogs were taught that bowls
presented in one location contained food while bowls in another location did not (Mendl et al. 2010;
Owczarczak-Garstecka 2016). Once the dogs had reached criterion, they were then tested on their
speeds to reach bowls that were in different locations between the two original places. Their results
matched with those done on other species, where the dogs assumed to have more negative affective
states (expressing more separation-related behaviours or having less sleep) were slower to approach
ambiguous stimuli than dogs with positive affective states. While cognitive bias tests are certainly a
promising method for assessing the affective states of dogs in kennels, the current amount of time re-
quired to train the dogs to reach the discrimination threshold necessary for testing makes them imprac-
tical for most situations. Indeed, neither Barnard et al. (2014) nor Kiddie and Collins (2014) incorpo-
rated these into their assessments.
4.2 Impacts on Learning

In addition to causing a negative cognitive bias, distress and poor welfare have also been suggested to impact an animal’s ability to learn (Blackwell et al. 2010). Using learning ability to assess welfare is particularly relevant in dogs, as they have been selected to be particularly receptive to training through their domestication (Gácsi et al. 2009). Few studies have used learning speed to specifically measure canine welfare (neither Kiddie and Collins (2014) nor Barnard et al. (2014) used it in their tools), however relationships have been found inadvertently. In a study assessing training methods and dog-owner interactions, dogs with owners who used high levels of punishment and aversive training techniques (and thus can be tentatively assumed to have poorer welfare) performed significantly worse at a novel training task than dogs whose owners tended to use positive, reward-based training methods (Rooney & Cowan 2011). Of course, as the techniques used to train the novel task were different for each dog, it cannot be determined whether the impaired learning ability was due to the dogs’ welfare states or the inefficiency of the training method, and thus more research needs to be done to validate this measure.

A study examining whether the performance of abnormal repetitive behaviours (ARBs) is associated with learning ability found interesting results when comparing dogs living in rehoming centres to those living in homes. While home dogs performing ARBs did not differ in their ability to learn a spatial discrimination task compared to home dogs not performing ARBs, ARB dogs at rehoming centres did take longer to reach criterion compared to their matched non-ARB pairs. Furthermore, centre dogs took longer overall to learn the task compared to home dogs, regardless of whether they engaged in ARBs or not (Hobbs et al. 2018).

Another study that aimed specifically to examine the relationship between canine welfare and associative learning found mixed results (Blackwell et al. 2010). While dogs that displayed the most behavioural signs of fear generally either failed to learn a novel task entirely or learned it more slowly than less behaviourally fearful dogs, it was actually those dogs that had the highest physiological measures of stress (measured through cortisol:creatinine ratios) that learned the task the fastest. More research is needed to assess the usefulness of learning ability in dogs as a welfare measure.
5. Conclusion

Developing optimal methods to assess the welfare of dogs in kennels is clearly a difficult, though worthwhile, endeavour. Hundreds of thousands of dogs are living in kennels, many of them long-term. As there is ample evidence to suggest that this can have a negative impact on their welfare, the need to measure this impact becomes evident. Assessing the various management and environmental elements of kennels can give some insight into whether basic needs are being met. These measurements however, give no information on the dogs’ emotional and psychological wellbeing, which the modern understanding of animal welfare suggests is as equally important as physical wellbeing. Animal-based measures, be they physiological, behavioural, or cognitive, need to be included in welfare assessments to provide a complete picture.

The discussion of each measure has mentioned whether or not it is included within the welfare protocols created by Barnard et al (2014) and Kiddie and Collins (2014), however the true validity, practicality, and usefulness or these protocols is still being determined. For the Shelter Quality Protocol, the authors tested the inter-observer reliability, test-retest reliability, and feasibility of the protocol at 29 shelters across six countries and found promising results (Barnard et al. 2015). They also aimed to assess validity, however this was defined as the similarity between observations taken through the fence and observations while handling the dogs up-close. Thus, the data only provides evidence that observations from a short distance have substantial agreement with up-close observations, not that their measures are valid indicators of overall welfare. To date, there has only been one published application of the Shelter Quality Protocol, where the authors noted several concerns, namely the long duration of the audit, the difficulty in scoring, and lack of ability to use the protocol to identify problems and provide advice (Osella & Ferraris 2014).

In Kiddie and Collins’ protocol, dogs were scored on a binary scale for provoked and unprovoked indicators of both positive emotional states (e.g. playing, grooming, exploring, spending time at the front of the kennel, etc.) and negative emotional states (e.g. pacing, wall-bouncing, hiding, chewing bars,
aggression, etc.). They used this system to assess the quality of life of 202 dogs across 13 rehoming centres and found good inter-rater reliability and evidence of content validity (the assessment measured what it was designed to measure), response process validity (those conducting the assessments understood the construct in the same way), and convergent validity (similar constructs hypothesised to agree were shown to agree). In a later study, the authors used the tool to monitor the quality of life of kennelled dogs over time, as well as to assess the impact of different handling and husbandry changes (Kiddie & Collins 2015). This study was able to identify a number of management practices (i.e. provision of bunk beds, 30+ minutes of staff interaction, daily training, quiet environments) that significantly increased the quality of life scores of the dogs, showing that the tool can be valuable when determining which factors are important for the wellbeing of dogs in kennels (Kiddie & Collins 2015).

Both of these assessment tools provide useful information about the states of kennelled dogs and represent important progress, but they both focus primarily on behaviour and health and hence may not give a full picture of canine welfare. For example, apart from general body condition and skin condition, neither tool includes any other physiological measures, such as heart rate or cortisol, which would indicate the level of physiological stress the dogs are experiencing. Kiddie & Collins (2014) chose their indices based on a literature search for the most validated behaviours that were either associated with positive or negative emotional states in dogs, and then used a binary scale to produce welfare scores. Their indices therefore do not include any novel behavioural or cognitive measures, nor are they able to take into account differences in welfare states between dogs that perform a behaviour only once during the observation and dogs that perform them continuously. Barnard et al. (2014) chose their indices by developing measures that covered the 12 welfare criteria used by the Welfare Quality consortium in their welfare protocols for farm animals. Because of this, their measures have a larger emphasis on health and management over behaviour and include fewer measures that are specific to dogs. Our review of plausible measures suggests the inclusion of additional measures may be justified, but that their validation is also a priority.
Overall, it is clear that considerable progress has been made in assessing indicators of welfare in kennelled dogs, and indeed in combining these indicators into applicable protocols. However, although a great number have now been identified as being potential indicators of welfare, without a gold standard against which these measures can be compared, very few can be considered truly “validated.” The direction of future research should consider following the approach of farm animal welfare studies, and aim to further validate measures, using animal-centric measures such as preference and motivation testing. Assuming that animals are motivated to choose the best options for their own interests and overall welfare, assessing the relationships of their choices relative to other supposed welfare indicators is a robust method for validating welfare measures (Nicol et al. 2009). These methods could be used across different kennelling environments, breeds, age groups, and dogs with varying previous life histories to further assess the usefulness of each of the measures discussed in this review, creating a greater understanding of the use of animal-based measures to assess welfare in kennelled dogs.
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