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Application of Free Choice Profiling to assess the emotional state of dogs housed in shelter environments

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Abstract

Dogs housed in shelters may experience poor welfare. To ensure these dogs a good quality of life, welfare assessment tools should be sensitive not only to the animals' physical health but also to their mental state, including the assessment of positive and negative emotions. In this study, we focused on the assessment of shelter dogs' emotional expression using a Qualitative Behavioural Assessment (QBA) approach. Previous work successfully applied QBA to assess the emotional state of working and rescue dogs, and the observations were carried out on individual dogs in standardised settings with little or no stimulation. Results from such experiments might not be fully representative of the expressive demeanour that a dog could show in shelter conditions, where animals are exposed to a number of social and environmental stimuli. Thus, our aim was to apply QBA to a wider variety of shelter environments and social contexts than has been done so far, giving the animals the opportunity to express a wider repertoire of emotions and allowing for a more comprehensive assessment of dogs' affective state. A set of descriptive terms was generated using Free-Choice-Profiling methodology by a group of 13 observers. QBA was made by scoring 16 video clips of shelter dogs in very different contexts (e.g. single/pair/group housing, presence/absence of human activity). Generalised Procrustes Analysis showed a high consensus between observers' scoring patterns (75.7%; $p<0.001$), and generated three main consensus dimensions explaining overall 66.6% of the variation between clips. The terms generated by the observers describing these consensus dimensions were semantically consistent, and characterised dogs as ranging: 1) from "playful/sociable/curious" to "bored/uncomfortable/apathetic", 2) from "relaxed/tranquil" to "nervous/alert/fearful" and 3) from "stressed/anxious" to "wary/timorous/hesitant". Overall, these broad dimensions are similar to those described in previous QBA studies on dogs. However, we detected differences in the type or frequency of the terms used, especially concerning three semantic spheres (i.e. "sociability", "fearfulness" and "boredom"). It appears that, compared to what has been reported previously, by presenting more complex contexts and thus giving the animals the opportunity to express different behaviours, we generated a richer list of terms representing a wider repertoire of emotions. Our results support the notion that QBA can be immediately sensitive to an animal's circumstances, integrating the ways in which animals experience the conditions in which they live into meaningful emotional indicators. This also highlights the importance of developing QBA tools that are species- and context-specific, especially for applied purposes.

Keywords: Shelter dogs, Emotions, Qualitative Behavioural Assessment, Free Choice Profiling, Generalised Procrustes Analysis, Welfare

1. INTRODUCTION

Rescue shelters for abandoned and stray dogs are a reality for thousands of dogs around the world. Conditions of confinement, especially over long periods of time, may have a severe impact on the quality of life of shelter dogs (Hewson et al., 2007). Several factors have proven to affect dogs' quality of life (Kiddie and Collins, 2014 and 2015) such as the length of time in shelter (Wells et al., 2002), the housing environment (Taylor and Mills, 2007; Wells, 2004) and the human-animal interaction (Coppola et al., 2006; Normando et al., 2009). There is increasing interest by the scientific community to provide easy-to-apply and reliable tools to assess the welfare and coping ability of shelter dogs in a confined environment (Barnard et al., 2016; Haverbeke et al., 2015). Previous studies have described physiological and behavioural parameters as useful to assess shelter dogs' welfare (Dalla Villa et al., 2013; Hennessy, 2013; Hiby et al., 2007; Rooney et al., 2007; Titulaer et al., 2013; Tyson, 2005). In particular, behavioural parameters give important information on the animal welfare state, being easily observable and quantifiable in a non-invasive manner (Dawkins, 2004).

It is now widely accepted that animal welfare is based not only on a good health status but also on good mental state (Broom, 2011). To have good welfare, domesticated animals should experience more positive (e.g. pleasure, happiness) than negative (e.g. fear, pain) emotions (Boissy et al., 2007). The emotional state has a great role in influencing animals' behaviour, communication, social bonding (Rolls, 2000) and cognitive functioning (Paul et al., 2005). Hence, an increased interest is shown in studying emotions in animals (Mendl and Paul, 2004) and, of relevance for this study, in dogs (Konok et al., 2015), with attention to assessing positive over negative emotions (Burghardt, 2005; Wemelsfelder et al., 2001; Zupan et al., 2016).

Previous studies indicate that dogs are good subjects for investigating how animals' emotions are perceived and described by humans. Two interesting studies, one by Morris and collaborators (2008) and the other by Konok and colleagues (2015), for example, suggest that humans regard emotional expression as something that can be shared between humans and dogs. Using a questionnaire, owners were asked which emotions they thought humans could recognise in their dogs choosing from a set of both primary and secondary emotions (Morris et al 2008). In both studies, owners thought that people could recognise most of the listed emotions in dogs (72%), with fear, joy, jealousy, sadness and

curiosity being those reported by the majority of people (>90% of the owners, Konok et al. 2015). Tami and Gallagher (2009) asked a group of observers to classify the behaviour of a focal dog shown in different video clips by scoring a pre-fixed list of adjectives on a 6-point rating scale. Videos portrayed pet dogs during their first social interaction with a specifically trained dog. Results indicated that both experienced and inexperienced human observers agreed in interpreting most of dogs' emotional expressive behaviour through the use of adjectives, supporting the notion of a shared spontaneous human tendency to interpret animal behaviour in a holistic manner (Wemelsfelder, 1997).
Other studies have applied qualitative behaviour measurements based on pre-fixed descriptor lists for the assessment of acute and chronic pain in dogs. Holton et al. (2001), for example, developed a composite scale for assessing acute pain in dogs in a hospital setting on the basis of observations of their behaviour. Veterinary surgeons were asked to generate terms for describing behaviour expressions of animals, and finally the generated words and expressions were reduced and allocated into behaviour categories. Wiseman-Orr et al. (2004, 2006) developed and validated a structured questionnaire to measure the effects of chronic pain on health-related quality of life in dogs. Relevant domains were identified through semi structured interviews to dog's owners.
To formally address the use and validity of qualitative behaviour assessments as a measure of animal emotion, particularly to address concerns about anthropomorphism, Wemelsfelder et al. (2000, 2001) developed Qualitative Behavioural Assessment (QBA). QBA focuses on observation of the whole animal and characterises and quantifies the animal's dynamic demeanour as an expressive body language, using descriptors such as 'sociable', 'fearful' or 'nervous' (Wemelsfelder et al., 2000, 2001). In a growing number of studies QBA has been reported as generally reliable, and, cross-validated against quantitative behavioural and physiological measures, also as a valid measure of animals' emotional state (for recent reviews, see Wemelsfelder and Mullan, 2014, and Fleming et al., 2016). It has been successfully applied to a range of different species (Grosso et al., 2016; Minero et al., 2009, 2015; Napolitano et al., 2012; Stockman et al., 2011; Walker et al., 2010; Wemelsfelder et al., 2001; Wickham et al., 2012), and has been described as a method suitable to assess an animal's affective state quickly, reliably and non-invasively (Minero et al. 2015), also under on-farm conditions (Phythian et al., 2016). The descriptive terms used in QBA can be generated by a methodology known

as Free-Choice Profiling (FCP) (Wemelsfelder et al. 2000 and 2001). Walker and colleagues (2010) used the FCP method to assess the emotional state of a group of working dogs (all Beagles) in a standardised context i.e. a passive experimenter was sitting at the centre of an arena with the dog free to explore or interact with the human for a few minutes. More recently, Walker and colleagues (2016) assessed shelter-housed dogs and found significant and meaningful correlations between QBA dimensions and quantitative behavioural measures, demonstrating that QBA is a valid measure of dogs' expressions. When comparing the results of these two latter studies, the authors found a good overlap between the dimensions extracted by applying the FCP method in the two different contexts (Walker et al., 2016). However, in both studies dogs were recorded while housed in the absence of conspecifics, and in standardised pens in just one or two locations per study.

From this brief overview of past research, it emerges that dogs' emotions have been studied mainly by asking the owners to describe the emotions of their dogs, or by assessing working or shelter dogs in standardised experimental settings. In the European legal framework, as well as many other countries around the world, there is a lack in setting housing system requirements for shelter dogs. This generates a large variability of infrastructures, management procedures and husbandry standards (Barnard et al., 2016). So, the question rises whether the emotional dimensions developed so far are representative of the large range of behavioural expressions that a dog could show in confined conditions, including social interaction with conspecifics, reaction to familiar and unfamiliar people and/or to environmental stimuli. QBA could potentially be applied for daily monitoring of dog mental state in shelter environments (Walker et al., 2016) but, because of its context-specific nature, it could be that more fit-for-purpose behavioural dimensions need to be created to fully represent the range of emotions potentially expressed by dogs in rescue shelters.

In light of these considerations, the aim of this study was to gain a broader understanding of dogs' expressive demeanour by assessing them in a wider variety of shelter environments and social contexts, (outdoor/indoor pen, single/pair/group housing, presence/absence of human activity etc.) than was done in previous studies.

2. MATERIALS AND METHODS

2.1 Animals and video recording

A convenience sample of four Italian shelters was selected to prepare the video-material for the project. The shelters were distributed along the north-south axis of the country: one in Northern Italy (Emilia-Romagna Region), two in the Centre (Abruzzi Region) and one in the South (Apulia Region). Shelters had different types of management: one was managed by the municipality, another was private and two were managed by charities. Eight pens per shelter were randomly selected among those hosting long-term confined animals (> 6 months). All the dogs present in the pens were video-recorded for 5 minutes with a mobile phone (Samsung GT-I9100P) mounted on a tripod positioned a few meters away. Each pen was randomly assigned to one of three groups: no stimulus, unknown person or familiar person. The social stimulus was introduced to elicit a range of expressions commonly shown by dogs in this environment. The unknown person could be one of three researchers (two females and one male) while the familiar person was a shelter operator. Unfamiliar people were asked to approach and stand in front of the fence ignoring the dog (30 seconds) and subsequently to crouch and talk gently (30 seconds). Shelter operators were asked to enter the pen and interact with the dogs (60 seconds).

All video-material was later analysed by the first author and 16 video-clips (four per shelter) were selected and prepared in such a way that they represented the widest possible variety and range (i.e. positive to negative) of expressive behavioural qualities in shelter-housed dogs. The video-clips were cut to a length of about 1.5 minutes (using the free video editor Avidemux 2.6.8) during which a focal dog visible at all time was selected. The final clips included a range of different housing environments and social stimuli. Namely, three clips showed pens with a single dog, six clips showed pens housing two dogs and seven clips showed pens containing more than three dogs. Overall, six clips showed dogs in absence of any person, eight reacting to the presence of an unknown person and two of a shelter operator. A large variety of dogs' morphology, size, age and sex was also represented.

2.2 Observers

Thirteen observers, four males and nine females, were recruited. The majority of them were students in their final year (fifth year) at the Veterinary Medicine faculty of Teramo (Italy), while five of them had graduated three in Veterinary Medicine, one in Natural Science and one in Animal Welfare and Protection. All observers were familiar with dogs but had different levels of experience with shelter dogs. None of the observers had previous experience with FCP or with QBA methodologies.

2.3 Free Choice Profiling

The FCP procedure consisted of two sessions, carried out on the same day (with a two-hour break in between) and with the same group of observers.

2.3.1 Session one

Before starting with the first observation session, approximately 1 hour was dedicated to introducing the observers to the aim of the study and to the operative procedures. This phase was very important for standardisation purposes (Aviezer et al., 2008; Barrett et al., 2010; Clarke et al. 2016). Observers were told that the experiment had the aim of investigating the reliability of a methodology for assessing the behavioural expression of shelter dogs. Behavioural expression was defined as the animal's style of interaction with the environment, co-specifics and humans (i.e. how the animal behaves as opposed to what it does). They were told to focus their attention on one animal, indicated by the moderator, in each video, and to characterise its dynamic demeanour as an expressive body language using qualitative descriptors generated by them.

Observers were asked to avoid talking about the exercise during the two sessions.

After the introduction, all observers watched the 16 clips projected onto a lecture hall screen. After each 1.5 minute clip, observers had 2 minutes to describe the behavioural expression of the dog by writing down terms of their own choice which they considered as the best descriptors for the observed animal. To maximise the outcomes of this exercise, the students wrote the terms in their own language (i.e. Italian). For the purpose of this publication, all terms were translated to English, checking on multiple dictionaries the accuracy of the definitions. To check the accuracy of the English terms, a translator not involved in the project translated these back to Italian.

No limits in the number of terms to be generated were imposed and observers were free to re-use terms for different dogs. Subsequently, the observers were asked to create a unique list containing all the terms they had used, deleting repetitions as well as the negative form of terms given both in its positive and negative form (e.g. unhappy and happy). Furthermore, the observers were asked to leave out terms that described more what a dog was physically doing rather than its expression (e.g. scratching).

2.3.2 Session two

Each observer was provided with scoring sheets (one for each video clip) on which Visual Analogue Scales (VAS) of 125 mm of length were printed. They were asked to place each term of their own list next to a VAS, and to repeat this on each of the 16 forms. Then, the observers were instructed on how to use the VAS to score their list of terms for each video. The left end of the scale corresponded to the minimum score (0 mm), meaning that the expressive quality indicated by the term was entirely absent in that dog, whereas the right end represented the maximum score (125 mm), meaning that the expressive quality indicated by the term was fully expressed in that dog. Observers were told to score each clip on every term in their list, as much as possible using the whole range of the VAS.
Observers then watched the same 16 clips as in session one, but shown in a different order. After each clip, they had approximately 2 min to score the animals' expressions on the rating scale, by drawing a vertical line across the VAS at the point they felt was appropriate.

2.4 Method of analysis

A score was assigned to each term for each clip, measuring with a ruler the distance in millimetres between the minimum point of the VAS and the point where the observer marked the line. These scores were entered into data matrices, one for each observer, with each matrix defined by the number of terms used by a particular observer and the number of video clips assessed. An observer's terms were specified in the first row, and the 16 video clips in the first column, with scores for each clip on each term filling the resulting data matrix.

The concordance between the 13 observer matrices was investigated using Generalized Procrustes Analysis (GPA), a multivariate statistical technique that is associated with FCP because it does not depend on the use of fixed variables (Gower, 1975; Oreskovich et al., 1991). GPA can be thought of as a pattern matching mechanism, assuming that even if observers use different variables (terms) for measurement, the distances between measured units (dogs) will be comparable because these units are the same. As a first step, GPA represents each individual observer data matrix as a multidimensional configuration, in which the number of dimensions correspond to the number of terms used by that observer, and in which the position of the 16 dogs is defined by their VAS scores. Equi-dimensionality across data matrices is achieved by adding columns of zeros to individual matrices to match the matrix with the largest number of terms. The observer configurations thus obtained are then matched to each other through a complex iterative process of translation, rotation, reflection and scaling. The final output of this process is the 'consensus profile', reflecting a 'best-fit' between individual observer scoring patterns (i.e. the average matrix of individual transformed data matrices once no improvement in minimizing inter-configurational distances can be gained by further transformation). The percentage of the total variance between observer configurations explained by this consensus profile, i.e. the degree of inter-observer agreement, is quantified by the so-called Procrustes Statistic (see Wemelsfelder et al. (2000) for a more detailed explanation of these GPA computation steps).

The significance of this consensus profile can be evaluated using a randomization test. Original observer data matrices were analysed in randomized form 100 times, and mean and standard deviation of the ensuing 100 PS values were calculated to reflect a random association between matrices for each study. A 1-tailed Student-t-test ($n = 100$, $df = 99$) was then used to determine whether the consensus PS differed significantly from this mean randomized PS. A probability of $p<0.001$ was taken to indicate that the consensus profile was a meaningful feature of the data set and not a statistical artefact. The use of Principle Coordinate Analysis (PCO) enables visual projection of the distance between each of the transformed observer configurations and the final consensus profile into an 'Observer Plot'. Using robust methods (i.e. not influenced by outliers), PCO estimates the centre of distribution of observers (and its standard deviation) and draws a 95% confidence region. Observers lying outside this region are potentially outliers, and possible reasons for their greater distance from the consensus can be considered.

As a second step, Principal Component Analysis (PCA) was applied to reduce the number of dimensions of the GPA consensus profile, in order to identify the main dimensions of expression explaining the majority of variation between dogs. Each dog was attributed a score on each of these dimensions, and two-dimensional "Dog-Plots" were generated showing the distribution of the 16 dogs along various combinations of the main dimensions, with a standard error ellipse depicting the reliability of each dog's position in these frameworks.

In a third interpretative step, the coordinates of the consensus profile were correlated with the coordinates of each of the 13 original individual observer data matrices, creating two-dimensional interpretative 'Word-Charts' for each observer. On each Word-Chart, all terms generated by an observer were correlated with the principle dimensions of the consensus profile, and the more strongly a term was correlated with a dimension, the more that term could be considered a representative descriptor of that dimension. The two terms showing the highest positive and negative correlations for each principle dimension in each observer word chart were selected and pooled together to create a table of high-loading terms for each consensus dimension. A final step of interpretation for the experimenter was then to summarize this collective information by selecting two or three representative terms as labels for both ends of each of the main consensus dimensions.

3. RESULTS

3.1 Consensus profile

The Procrustes statistic of the consensus (75.7%) was significantly higher than the mean Procrustes statistic of 100 randomised profiles (60.1%; $p < 0.001$), indicating significant agreement between observers in assessing the behavioural expressions of the shelter dogs. The good consensus between the observers is also reflected in the observer plot, where the majority of individual observers are enclosed within the 95% confidence interval (Figure 1). Although 3 observers (#8, 12 and 13) seemed somewhat distant from the majority, they shared no immediately obvious characteristic (e.g. gender, academic degree or experience with sheltered dogs).

The GPA extracted three main dimensions of the consensus profile, each explaining 32.9%, 24.5% and 9.2% of the variation between animals respectively, giving a total of 66.6% of the variance between dogs explained. These dimensions represented the axes of the observers' word charts (Fig. 2a, b) and of the dog plots (Fig. 3a, b).

3.2 Observer word charts

The word charts (see Figure 2a, b as example) reflect how well each of the observer's term correlates with the consensus dimensions. Dimension 1, for example, is characterised by the term 'playful', which was used by nine out of 13 observers. Other terms used frequently to describe dimension 1 were 'sociable', 'affectionate', 'curious' and 'happy' on the positive end, and 'bored', 'wary', 'apathetic', 'uncomfortable', 'anxious' and 'stressed' on the negative end (Table 1). All terms loading on one group are not necessarily synonyms, but they reflect a coherent characterisation of an aspect of the dogs' behavioural expression. This means, for example, that a playful dog is likely to also be sociable, curious, active etc. On this basis, dimension 1 was labelled 'playful/sociable/curious to bored/uncomfortable/apathetic'. By applying the same approach, dimension 2 was characterised by the terms 'relaxed/tranquil to nervous/alert/fearful' and dimension 3 by 'stressed/bored/anxious to wary/timorous/hesitant'.

To allow a comparison of the dimensions created in our study with those of Walker and colleagues (2010, 2016), we reported the dimensions' labels in Table 2.

3.3 Dog plots

The dog plots show how individual dogs are distributed on the three main dimensions (Figure 3a, b). Dogs are distributed evenly over the plots, indicating that the selected dimensions are characterising well the observed variances in behavioural expression. In addition, the position of the dogs seems reliable, since the standard error ellipse (as reflected by the dotted circle in the bottom right hand corner) is small. By assigning a semantic valence to the dimensions, it was possible to characterise individual differences in the behavioural expression of the dogs. For example, in Figure 3a dog 10 can be characterised as playful, and dog 3 as relaxed, while in Figure 3b dog 7 appears as nervous and wary, and dog 8 as nervous and stressed.

4. DISCUSSION

With this work, we successfully applied Qualitative Behaviour Assessment (QBA), using the Free Choice Profiling (FCP) method, to study the behavioural expression of shelter dogs. We found meaningful dimensions describing the dogs' emotional state and a good inter-observer agreement, confirming previous works in this field (Walker et al., 2010 and 2016).

Most of the studies that applied the FCP to other species extracted two main dimensions (Fleming et al., 2013; Minero et al., 2009; Napolitano et al., 2008 and 2012; Rousing and Wemelsfelder, 2006; Rutherford, 2012; Wemelsfelder et al., 2001 and 2009). Exceptions can be found whenever the assessment involved environmental challenges, e.g. road transportation, which may elicit a wider expression of behaviours; in such cases the dimensions extracted can be three (Stockman et al., 2011; Wickham et al., 2012). Our analysis identified three main emotional dimensions. Similar results were found by Walker and colleagues in both the 2010 work, when observing customs dogs in a standardised setting and in the 2016 work, when observing shelter dogs while housed in either their Home Environment (HE) or in a standardised Novel Environment (NE). Possible reasons for detecting three dimensions in dogs could be their large expressive repertoire when showing their emotional state as compared to other studied species, and/or the thousands-year old cohabitation and domestication that created unique human-dog social-communicative skills (Hare and Tommasello, 2005) that perhaps enhanced the ability of humans to interpret dogs' behaviours and emotions (Konok et al. 2015). The three dimensions extracted in our study represented a total variance of 66.6% between dogs, which is smaller compared to both the Walker et al. (2010) study, where the three dimensions explained 80.9% of the total variance and the Walker et al. (2016) where dimensions explained 85.4% and 75.9% of the variation for the HE and in the NE respectively. The lower level of standardisation of our video-clips (i.e. higher "background noise") that portrayed 16 dogs in very different environmental conditions and during different types of interactions with humans and co-specifics (adding a level of complexity to the term generation task), could have played a role in this.

Overall, the dimensions identified by our study contained descriptors such as fear, curiosity, anxiety and happiness that in human psychology are recognised as “primary emotions” (Ekman, 1992; Izard, 1992; Plutchik, 2001). According to previous studies, humans are more willing to attribute primary rather than secondary emotions to dogs (Morris et al., 2008, Konok et al. 2015). Other terms extracted from our study, such as playful, alert and sociable, were found in a number of previous works, showing a consistency in the descriptors used to assess dogs’ behaviour traits (Strandberg et al., 2005; Svartberg and Forkman, 2002; Valsecchi et al. 2011).

The three dimensions of dogs’ behavioural expression described in this study are similar to those described in previous QBA studies on dogs (Walker et al., 2010 and 2016). However, the perception of emotions is influenced by context (Careau et al., 2010; De Palma et al., 2005) and when we compared the terms generated in the three studies we detected differences in the type or frequency of term use especially for those pertaining to the semantic spheres of ‘sociability’, ‘fearfulness’ and ‘boredom’.

In more detail, our results showed a preponderance of terms associated with ‘sociability’, especially on the positive end of dimension 1, whereas in the other two studies (Walker et al., 2010 and 2016) this aspect was either absent or fairly unrepresented. This result could be expected as in our study the majority of dogs were integrated in social groups, while in both Walker’s studies dogs were observed individually. Furthermore, in our study both familiar and unfamiliar people were asked to interact with dogs while no dog-human interactions were included in Walker et al., 2016 and a passive researcher was present in Walker et al., 2010.

Another affective state that differed across studies was the one related to ‘fear’. This emotion is one of the most recognised by people observing dogs (Tami and Gallagher, 2009, Konok et al 2015). In our study, we found a strong component of fear, described by terms such as fearful, timorous, scared, phobic, frightened, hesitant and shy. This could be related to either the presence of unfamiliar people interacting with the dogs or to a general state of fearfulness created by the shelter environment itself which can be challenging for some dogs failing to cope with it (Tod et al., 2005). In Walker et al.’s papers this emotion is mainly represented by the term ‘unsure’. Interestingly this term emerges in both novel situations, i.e. when the dogs are taken to a test arena with a passive person and when they are housed in a novel environment (NE), but is barely represented when dogs are in their home environment (HE) (Walker et al 2016). Again, this result may not be surprising, as in both of Walker et al. papers, dogs were not presented with situations designed to elicit a fearful response. Fearfulness, as well as sociability, are the most studied dimensions in pets (Gartner et al., 2015). The ability to assess these emotions in shelter dogs is extremely important as they are directly linked to animal welfare and adoption success (Tuber et al., 1999). It has also been reported that some emotional traits shown by dogs in the shelter may be predictors of behavioural problems after adoption. For example, fearfulness is the most common behavioural problem exhibited by dogs coming from rescue shelters and may be a cause for the dog being returned (Wells and Hepper, 2000).

Finally, the semantic sphere of ‘boredom’ is differently represented among the three studies. In our study, this emotional state is represented by different descriptors such as bored, apathetic, depressed and indifferent, some of which were also used in Walker et al. (2016) when describing dogs in the HE (i.e. long and short-term shelter dogs and pet dogs recorded when alone). In Walker et al. (2010) and in the NE setting in Walker et al. (2016), however, this emotion is not described. Here, in both situations, dogs were placed in a novel environment for a short amount of time, which made the emergence of such emotions unlikely. Shelter housing can be hypo-stimulating for dogs, leading over time to learned helplessness, and high level of inactivity and a depression-like state. Hence, a comprehensive welfare tool should detect such affective sate when assessing shelter dogs’ well-being.

Such differences, detected when comparing our study to Walker and colleagues’ studies (2010, 2016), were probably generated by the wide variety of environmental and social conditions in which dogs were presented. This highlights the importance of developing QBA tools that are species- and context-specific (Grosso et al., 2016) but also that are fit for purpose, especially when this tool is used in applied studies. In our case, for example, the observers extracted terms associated with sociability, fearfulness and boredom, which are important elements to be assessed during the monitoring of dogs in kennel environments.

A QBA tool specifically created for shelter dogs could add complementary and relevant information to existing on-shelter welfare assessment protocols, extending their power to identify and detect emotional shifts in dogs across the positive and negative emotional spectrum. To investigate the practical efficacy of QBA, the next step will be to apply it to real life scenarios of dog welfare management in kennels, by training staff and inviting them to include QBA in their daily routines.. This would also open the possibility to explore whether, in the longer term, different housing or management systems have significant effects on dog emotional expression.

5. CONCLUSION

In conclusion, the current study found that when dogs were shown to observers in a range of environmental and social conditions, QBA was able to generate meaningful dimensions of dog behavioural expression reflecting the variation of affects experienced by the dogs in these different circumstances. Three dimensions were extracted: QBA dimension 1: 'playful/sociable/curious-bored/uncomfortable/apathetic', QBA dimension 2: 'relaxed/tranquil-nervous/alert/fearful', and QBA dimension 3: 'stressed/bored/anxious-wary/timorous/hesitant'. These broad dimensions were similar to those found by Walker et al (2010, 2016) showing an overall consistency of dog behavioural expression independent from the observers or dogs assessed. However, we also detected that some emotional states were represented differently across the three studies. Where the experimental conditions of the current study differed from those used in Walker's studies, QBA terms generated by the observers also differed in sensible ways. This supports the notion that QBA can be immediately sensitive to an animal's circumstances and it integrates the many (subtle) ways in which animals engage with their environment into meaningful emotional indicators. Applying a FCP technique, we generated richer expressive dimensions than in Walker et al.'s studies by presenting more complex contexts and giving the animals more opportunities to express a wider repertoire of emotions. These outcomes, combined with previous FCP research on dogs, could serve as the basis for designing a standardised and comprehensive list of QBA terms for the assessment of dogs' emotional state. The application of such a QBA tool in assessing dog welfare should be validated against known and trusted dog welfare indicators, and, if successful, can be integrated into comprehensive welfare assessment tools for shelter dogs that combine qualitative and quantitative measures (Barnard et al., 2016; Walker et al., 2016).

6. CONFLICT OF INTEREST

All authors of the manuscript "Application of Free Choice Profiling to assess the emotional state of dogs housed in shelter environments" declare no actual or potential conflict of interest including financial, personal or other relationships with other, or be perceived to influence, their work.

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