

HIGHLIGHTS

A questionnaire measures student veterinarians' ability to recognise stress in dogs
Student veterinarians clearly identified stereotypical behaviors, excessive barking and aggressiveness as indicators of stress, but they were less likely to identify yawning, low activity or paw raising
Understanding the basis of stress influenced stress identification
Having a companion animal influenced stress identification
Participants' gender and level of attachment to their pets, had no effect on identification of canine stress

Student veterinarians' ability to recognise behavioural signs of stress in dogs.

David J. Menor-Campos^{1,*} david.menor@uco.es, Joanne M. Williams², Angelo Gazzano³ and

Chiara Mariti³

¹Departamento de Medicina y Cirugía Animal, Campus Universitario de Rabanales.

Universidad de Córdoba. Ctra Madrid-Cádiz, km 385. 14014 Córdoba, España.

david.menor@uco.es

²Clinical and Health Psychology, School of Health in Social Science, Medical School, Teviot Place, University of Edinburgh, Edinburgh, UK.

³Dipartimento di Scienze Veterinarie, Università di Pisa, Viale Delle Piagge, 2. 56124 Pisa, Italy.

Corresponding author: Dr. David José Menor-Campos

Abstract

Veterinarians' perceptions of animal stress influence their practice. Therefore, the aim of this research was to evaluate how veterinary students perceive stress in dogs. Two hundred and eighteen 4th year veterinary students of the University of Cordoba (Spain) participated in the study. An online questionnaire measuring veterinary students' perceptions of behavioral indicators of stress in dogs, their attachment to pets, and demographic measures (e.g. pet ownership, student gender) was administered to

participants in university classes. Data show that veterinary students easily identified some stress indicators such as stereotypical behaviors, excessive barking and aggressiveness, but they were less likely to identify yawning, low activity and paw raising as indicators of stress. Understanding the basis of stress and having a companion animal influenced stress identification but participants' gender, and attachment level to their pets, had no effect on ability to identify canine stress indicators. Misunderstandings about canine behavior might influence veterinary students' ability to recognize subtle stress signs in dogs. However, a good understanding of the psycho-physiological basis of stress and personal experiences of dog ownership were associated with greater ability to identify behavioral stress signs in dogs, suggesting that additional training in canine stress might be beneficial for student veterinarians.

Keywords

dog behavior; dog stress; stress; veterinary students; animal welfare

INTRODUCTION

Dog behavior provides a wide range of information regarding canine health and state of welfare, including stress (Beaver, 1981; Beerda et al., 1998, 1997; Uvnäs-Moberg et al., 2000; Wojciechowska and Hewson, 2005) and understanding behavioral signs of stress should help owners to care for and handle their dogs (Voith et al., 1992; Kerswell et al., 2009; Dodman et al., 2018;). In fact, knowing that some behaviors may be expressed by dogs in a stressful situation, that such behaviors can be used as signals to others (see e.g., Rugaas, 2006; Mariti et al., 2017), that they are displayed according to an increased level of stress up to aggression (see e.g., Shepherd, 2009), could be used by owners to detect the presence of stress in their dogs and act in order to reduce it and then prevent it.

Although stress can be difficult to define (Global Organization for Stress, n.d.) it is usually described as an emotional arousal reaction comprising a variety of physiological, psychological and behavioral changes associated with stimuli that are perceived as aversive by the subject (Seyle, 1973; Lazarus, 1974; Holroyd, 1982; Skinner, 1985; Steinberg, 1990; McEwen, 1993; Levi, 1996; Overall, 2010). However, understanding what experiencing stressors does to animal physiology and behavior does not guarantee people will be able to identify it accurately in animals. Mariti et al. (2012) showed that dog owners found it difficult to correctly identify subtle behavioral changes that can be displayed in the earlier stages of emotional arousal (Kerswell et al., 2009). However, children and adults can be taught to interpret dogs' distress signaling more correctly and the effects endure over time (Meints et al., 2018).

Notwithstanding the importance of owners' ability to identify stress in their dogs,

recognizing stress responses is also crucial for veterinary practice. Unfamiliar surroundings, such as veterinary clinics, where the animal has no control over events, nor can predict them, can easily act as stressors for veterinary patients (Hewson, 2008, 2014; Gazzano et al., 2015a; Mariti et al., 2015a, 2017). Döring, Roscher, Scheipl, Küchenhoff and Erhard (2009) claim that over 75% of the dogs visiting a veterinary hospital were fearful on the examination table and up to 13.3% had to be dragged or carried into the practice. This situation can lead owners to avoid bringing their pets to the veterinary clinic (Volk et al., 2011). Furthermore, animal stress responses can be a risk for veterinarians as they can lead to aggression (Mariti et al., 2015a) and veterinary professionals (i.e., veterinary surgeons, veterinary nurses) are among the occupations that are most at risk of dog bites (Owczarczak-Garstecka et al., 2019; Nienhaus et al., 2005). Heightened stress responses also contribute to misdiagnosis due to test alterations (Tynes, 2014). Animals experiencing heightened stress responses may also require higher doses of anesthetic and sedation (AVSAB, 2017), or experience delays in their recovery (Hewson, 2008) due to changes in immune function leading to an increased susceptibility to disease (Nardone, 2010). Therefore, recognizing behavioral signs stress responses is not only important for the early detection of behavioral disorders and their prevention, but also for the safe handling and treatment of veterinary patients. Moreover, Mariti et al. (2012) suggest that pet owners seek advice from veterinarians about signs of stress responses in their companion animals, so it is crucial that veterinarians are able to explain behavioral signs of stress responses including the more subtle behavioral indicators. Learning about stress should be incorporated into veterinary education because veterinary students, as future veterinary

surgeons, are expected to demonstrate a high degree of professional interest in the welfare of animals. According to Heleski et al. (2005) understanding of veterinary students' attitudes towards and perceptions of stressors, stress responses and animal welfare is fundamental, as it may indicate the adequacy and effectiveness of veterinary education in relation to recognition and management of animal stress responses and distress.

The aims of this study were to examine whether veterinary students could identify behavioral indicators of stress responses in dogs and whether they were able to identify an appropriate characterization of canine stress responses. As they are going through education process, it was hypothesized that veterinary students would be able to identify more stress-related behaviors and appropriately characterize canine stress responses.

MATERIAL AND METHODS

The survey

The self-report online questionnaire included: 1) Demographic information about the participants (gender); 2) Previous experience with animals including the type of companion animal they currently own and their previous experience of owning companion animals; 3) Their level of involvement with the management and care of one of their pets (selected by the participant) on a 0 to 100 points scale, referred here to as 'involvement'; 4) An adapted version of a standardized attachment to pet scale was completed by participants who currently owned or had previously owned a companion animal (Marsa-Sambola et al., 2016); 5) Two multiple-choice items on the characterization

of stress in animals (see Supplementary Material for the full questionnaire); 6) A measure of perceptions of stress in the dogs (Mariti et al., 2012). This measure required participants to consider dogs behavior in a 'stressful situation' (such as a thunder storm or at the veterinary clinic) and to judge how related to stress each of 20 behaviors (e.g., circling, excessive barking, turning head and aggressiveness) would be on a five-point Likert scale (from 1 = not related to 5 = very strongly related to stress). Questions were translated into Spanish using the back-translation procedure (Brislin, 1970), and Socrative® technology (www.socrative.com), a tool to launch online surveys, was used to collect data.

Participants

A total of 218 4th Year veterinary students across two academic years (Academic Years: 2017-18 and 2018-2019) participated in the study, representing 61.5% of 4th Year veterinary students at the Veterinary Medicine School, University of Cordoba, across both academic years. Detailed sample information is provided in Table 1.

Table 1. Sample information

Respondents' characteristics	Gender (female/male)	143/69
	Pet ownership (yes/no)	105/113
Type of pet owned	Dogs	68
	Cats	21
	Small mammals	9
	Birds	4
	Horses	2
	Reptiles	1

Participants had already attended a course on basic ethology and animal welfare during the 1st Year of their programme, though no specific training in animal stress. Participants

were informed that their answers were anonymous and would have no impact on their academic studies, and that they could withdraw from the study at any point.

Procedure

The survey was used as an introductory activity before a lecture on canine behavior problems and stress during the 4th Year of participants' degree programme. Students were invited to participate in the study, informed that the purpose of the survey was to gain an understanding of human-animal relationships, that their responses would remain anonymous, and would be used in scientific research. The online questionnaire was then administered to participants in class.

Data and statistical analysis

Responses provided data on the following variable blocks for analysis:

Block 1. Demographic and sample information:

- gender (male/female); independent variable
- companion animal ownership (yes/no); independent variable
- type of companion animal; independent variable
- care involvement (from 1 to 100)
- attachment to companion animal (eleven items; five-point Likert scale from 1 to 5):

an aggregate value was calculated by sum, alongside with a percentage over the maximum possible value $[100 * (\text{sum of all item scores} / (\text{total answered items} * 5))]$ (Cohen et al., 1999), resulting in a total scores ranging from 0 to 100%.

Block 2. Characterization of stress (two items): nature of stress responses and consequences

Block 3. Perception of stress (twenty items; five-point Likert scale from 1 to 5): an aggregate value was calculated by sum, alongside with a percentage over the maximum possible value $[100 * (\text{sum of all item scores} / (\text{total answered items} * 5))]$ (Cohen et al., 1999), resulting in a total scores ranging from 0 to 100%.

All statistical analyses were performed using software SPSS v.22. Due to the lack of normal distribution of data, non-parametric analyses were conducted. Perception of stress values were considered the dependent variable, while other values were treated as independent variables that might influence the former. Relationship between those factors were also explored.

Kruskal-Wallis tests and Mann-Whitney U tests were used to explore demographics differences in perception scores related to different levels of stress knowledge.

Using the 1 to 5 stress behavior scores a Principal Component Analysis (PCA) with varimax rotation was carried out and an acceptable model (Cerny and Kaiser, 1977) was obtained ($KMO = 0.693$; $p < 0.001$). Items were assigned to extracted factors following their factor loadings. An aggregate value for each factor or principal component were then calculated by summing the comprised item values, and a related samples Friedman's Two-

Way Analysis of Variance by ranks followed by post hoc pairwise analysis with Bonferroni corrections explored differences between those factor scores. Furthermore, a Kruskal-Wallis test explored differences on factor scores related to different perceptions.

Gender and ownership influence were tested by Mann-Whitney U test on Perception of stress items' values and principal components. Kruskal-Wallis test was used to explore difference related to type of companion animal.

Spearman's rho correlation tests were used to explore relationships between attachment and involvement levels with perception of stress items and principal components.

Ethical code

The study was carried out in accordance with "*The European Code of Conduct for Research Integrity*" (ALLEA - All European Academies, 2017). Under the requirements of the host institution, this study did not require ethical approval. However, before data collection, authors provided information to participants about the purpose of the study, the process of data collection, and the use of data, specifying that no personally identifying data would be collected. Participants were informed that completion of the questionnaire would be considered as a written consent and were free to withdraw from data collection at any time.

RESULTS

Sample characterization: gender, ownership, attachment and involvement

Among the 218 4th year veterinary students who completed the questionnaire, 65.6% were

females reflecting the percentage of female students in 4th year (67.0%) at the host institution. One hundred and five (48.2%) participants owned or had owned at least one companion animal, self-reporting a high involvement in pet management/care (Median = 80 out of 100) and a high level of attachment to pets (Mean = 83.75, SD = 12.5; Maximum possible value of 100). The majority of companion animals owned were dogs (68 participants, 64.8%) and cats (21 participants, 20.0%).

Self-reported involvement values and attachment levels were correlated (Spearman's $\rho = 0.425$ $p < 0.001$). Involvement was higher among female students (Median = 90) than male classmates (Median = 70; Mann-Whitney $U = 2093.5$; $p < 0.001$). A similar gender difference was observed for attachment level (Female students median = 87.27; Male students median = 80; Mann-Whitney $U = 2249.5$; $p < 0.001$).

Characterization of stress

Nearly half of the sample correctly viewed the stress response as a psycho-physiological alteration (48.6%), 45.3% responded that it is a psychological alteration, and 6.1% viewed it a solely physiological alteration of the animal. Almost all participants (98.1%) correctly recognized the stress response as a short or long term alteration that can develop into an illness. Only two students failed to submit their answers for these questions and four students responded that the stress response does not have consequences for animal health.

Perception of dog stress

Veterinary students showed good recognition of the stress response indicators in dogs (see

the list Table 2) with a mean score of 71.08 (percentage of the maximum value of 100; standard deviation 9.12). To highlight differences in students' ratings of behavioral stress indicators, Figure 1 shows students' scores grouped in terms of behaviors strongly (score 4 and 5), moderately (score 3) or weakly (score 2 and 1) related to stress responses.

– Figure 1 around here –

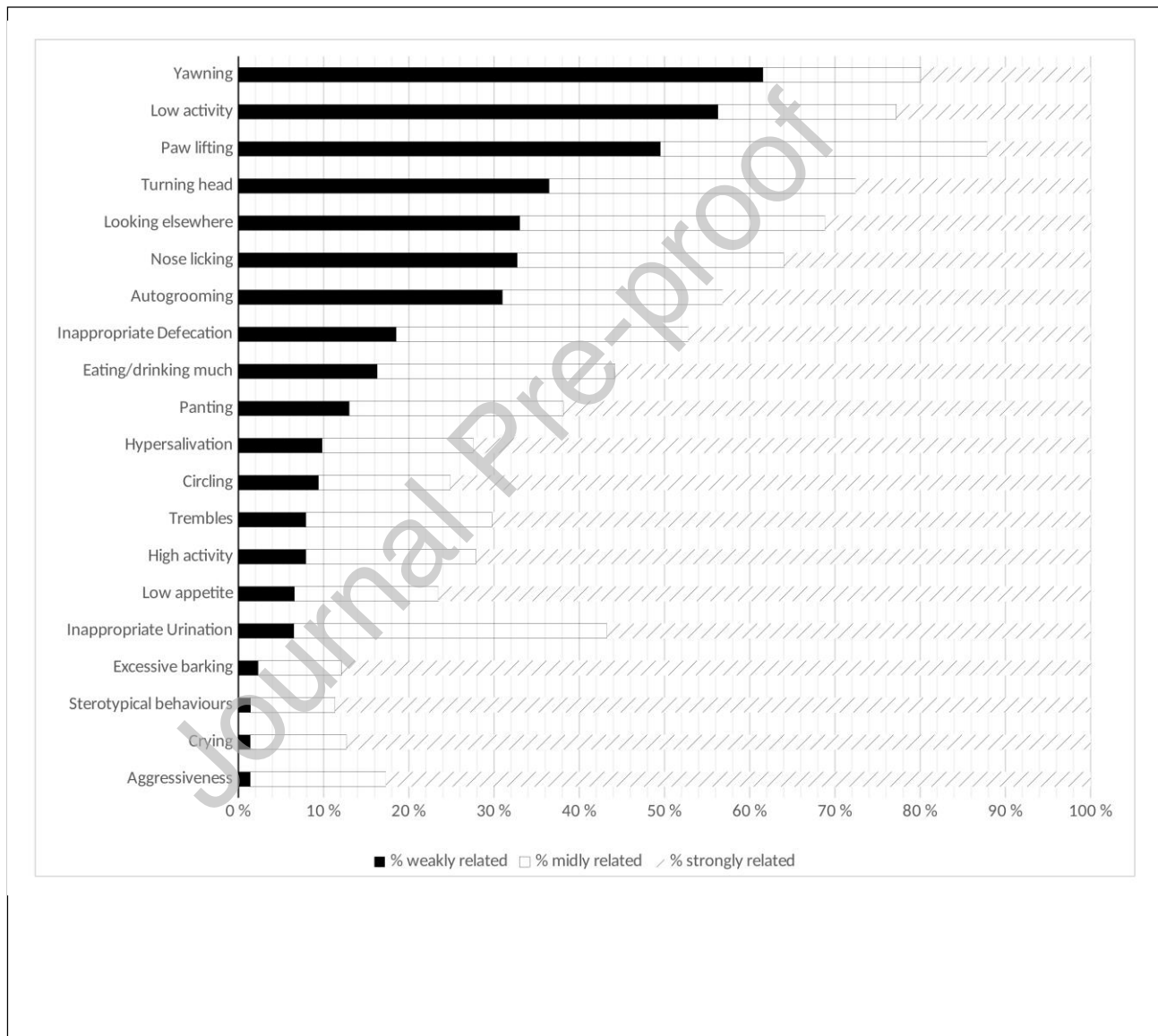


Figure 1: Behaviors listed for rating by students and percentage responses. 'Weakly related' comprised scores of 1 and 2 points. 'Mildly related' comprised scores of 3 points. 'Strongly related' comprised scores of 4 and 5 points. Items were sorted in descending by weakly related frequency.

The behavioral indicators perceived by students as more strongly related to stressors (score 4 and 5 > 80%) in dogs were '*stereotypical behaviors*', '*excessive barking*', '*crying*', and '*aggressiveness*'. The indicators most frequently perceived not to be related or weakly related to stressors (score 1 and 2 > 30%) were '*autogrooming*', '*nose licking*', '*looking elsewhere*', '*turning head*', '*paw lifting*', '*low activity*' and '*yawning*'.

Demographic influence on Perception of stress item values

Students' gender was found to have some influence only in one perception of stress item (Inappropriate Defecation, Female mean = 3.6 ± 0.95 median = 4, Male mean = 3.9 ± 0.9 median = 4; Mann-Whitney test $U = 5620$; $p = 0.033$). Ownership too was found to have some influence in only one item (Circling, non-owner mean = 3.88 ± 1.15 , median = 4, Owner mean = 4.26 ± 0.94 median = 5; Mann-Whitney test $U = 1074$; $p = 0.025$). No difference was found related to type of companion animal (Kruskal-Wallis test $p = 0.039$; post hoc pairwise comparison non-significant).

Attachment level was found to correlate positively with two perception of stress items (Inappropriate Defecation, Spearman rho's $r = 0.234$; $p = 0.021$. Eating and/or drinking much, Spearman rho's $r = -0.217$; $p = 0.033$) while involvement was found to correlate negatively with one item (Panting, Spearman rho's $r = -0.217$; $p = 0.033$).

No difference on perception of stress response scores was found regarding characterization of stress (Mann-Whitney U test $p > 0.05$).

Factor analysis of perception of stress item values

The PCA found that most of the variances were explained by 7 components (total variance explained = 61.14%). Table 2 shows the principal components and the items they comprised.

Table 2. Principal Component Factors: median and comprised items. In bold, the highest loadings which classify the item in the subsequent component.

	Component						
	1	2	3	4	5	6	7
Factor label	Explicit distress	Avoidance	Problem behavior	Facial indicators	Self-focused behavior	Motor activity indicators	Withdrawal
Variance explained	19.59	10.47	7.28	6.92	6.41	5.46	5.00
Median	86.67	60	73.33	68	60	80	60
Circling	0.664	0.015	-0.153	0.081	0.198	-0.034	0.119
Crying	0.642	0.137	0.285	0.134	-0.113	0.085	0.000
Excessive barking	0.778	0.010	0.060	0.073	0.088	0.189	0.065
Looking elsewhere	-0.016	0.843	0.047	0.071	0.018	0.084	0.106
Turning head	0.131	0.866	0.039	-0.039	0.049	-0.051	0.030
Inappropriate Defecation	-0.045	-0.012	0.841	0.130	0.148	0.071	0.023
Inappropriate Urination	0.123	0.078	0.815	0.082	-0.023	0.048	0.167
Aggressiveness	0.256	0.245	0.316	0.026	0.169	0.251	0.211
Hypersalivation	0.403	0.058	0.210	0.421	0.148	0.176	-0.064
Nose licking	-0.104	0.272	0.004	0.529	-0.068	0.311	0.278
Panting	0.230	-0.113	0.177	0.766	0.023	0.061	-0.038
Trembles	0.288	0.016	0.043	0.539	-0.114	-0.032	0.493
Yawning	-0.468	0.334	0.039	0.445	0.212	-0.019	0.004
Autogrooming	-0.090	0.300	-0.043	0.324	0.485	0.387	-0.091
Eating/drinking much	0.168	-0.086	0.048	-0.102	0.676	0.209	0.075
Low activity	0.025	0.128	0.128	0.086	0.735	-0.302	0.118
High activity	0.085	0.049	0.293	0.047	-0.111	0.709	-0.004
Stereotypical behaviors	0.223	-0.045	-0.085	0.157	0.157	0.672	0.213
Low appetite	0.108	-0.052	0.155	-0.109	0.267	0.177	0.719
Paw lifting	-0.022	0.370	0.094	0.189	-0.029	0.015	0.584

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization

Related samples Friedman's Two-Way Analysis of Variance by ranks revealed differences between factor scores ($X^2 = 492.26$ $p < 0.001$). Post-hoc pairwise analysis with Bonferroni corrections confirmed that scores on *Explicit distress* and *Motor activity indicators* (first and sixth extracted factors) were significantly higher than any other (Table 2; Adj. $p < 0.001$), while scores on *Avoidance* (second extracted factor) were similar to scores on *Self-focused behavior* and *Withdrawal* (fifth and seventh extracted factors) and significantly lower than any other scores (Table 2; Adj. $P < 0.01$).

Demographic influences on perception of stress components

A Kruskal-Wallis tests found differences on *Facial indicators* (fourth extracted factor) scores related to different perceptions of canine stress responses (Kruskal-Wallis test $\chi^2 = 8.44$ $p = 0.015$) indicating that students who perceived stress responses as a physiological alteration scored this extracted factor lower (Median = 16) than those who perceived these as a psycho-physiological alteration (Median = 17; Adj. $p = 0.045$).

Gender was found to have no influence on extracted factors values as there were no gender differences for any factor (Mann-Whitney U test Adj. $P > 0.05$).

Those students who owned a companion animal scored higher on *Explicit distress* (first extracted factor; U Mann – Whitney $U = 2542$; $p = 0.032$) and on *Self-focused behavior* (fifth extracted factor; U Mann – Whitney $U = 1516$; $p = 0.05$) than those who did not. The type of pet owned did not influence results (Kruskal – Wallis test Adj. $p > 0.05$).

Attachment level was positively associated with scores on *Avoidance* (second extracted factor; Spearman's $\rho = 0.158$; $p = 0.042$) and with scores on *Facial indicators* (fourth extracted factor; Spearman's $\rho = 0.159$; $p = 0.041$). Indeed, those students with high attachment levels scored higher on *Avoidance* (second extracted factor; Median = 60) than those with low attachment levels (Median = 50; Mann-Whitney U = 4706.5; $p = 0.025$). Involvement level was not related to any PCA component scores.

DISCUSSION

Exposure to stressors and the subsequent stress response can increase the risk of contracting a disease, increase recovery time, increase challenging behavior in home and community settings, or increase dogs likelihood of responding aggressively to their surroundings (Amadori et al., 2009; Amat et al., 2016; Gazzano et al., 2015b; Shin and Shin, 2017). Therefore, identification of animal stress responses is crucial for veterinary surgeons during any clinical activity, so that they can reduce these reactions by modifying the approach taken or altering the delivery of medical treatment if necessary. Furthermore, veterinarians' perception of animal stress responses allows identification of behavioral problems and possible prevention and intervention of stress-related behavioral issues.

This study examined veterinary students' ability to identify behavioral indicators of stress responses in dogs and to explore how they characterize stressor response.

As expected, veterinary students identified stress responses as indicating a health hazard for dogs even though they failed to fully understand the underlying mechanisms. Mariti et al. (2012) originally designed these questionnaire items to reveal owners' perceptions of dog stress responses, and found that their participants showed greater doubts about the

nature of stress than veterinary students reveal in this study. Therefore, veterinary training seems to have increased awareness of stress reactions, but has not led to substantial improvements in understanding stress responses compared with non-veterinarian dog owners.

In terms of recognition of stress indicators, veterinary students were able to correctly identify most of the behaviors included in the measure as related to canine stress responses. However, the distribution of scores shows that recognition of stress response was higher when behaviors were 'gross' (i.e., stereotypical behaviors, aggressiveness, crying). By contrast, 'subtle' behaviors such as nose licking, avoidance (i.e., turning head and looking elsewhere) and paw lifting, as well as inhibited or non-problematic behaviors (i.e., low activity and auto-grooming), were less often perceived as stress-related. In Mariti et al.'s study (2012) dog owners tended not to identifying subtle behaviors, which are usually displayed in the earlier stages of emotional arousal (Kerswell et al., 2009), as related to stress responses. There are, however, some differences in the perception of dog stress responses between dog owners and veterinary students. Dog owners reported fear and anxiety behaviors (e.g., trembling and whining) as the most stress-related (Mariti et al., 2012) while veterinary students highlighted stereotypical behaviors, barking and aggressiveness as most related to reactions to stressors. These differences might be due to professional veterinary training. For dog owners stereotypical behaviors may be viewed as undesirable, while veterinary training recognizes that stereotypical behaviors can indicate stress. Furthermore, those veterinary students who had lower understanding of the psycho-physiological basis of stressors and responses were less likely to identify related

behaviors (i.e., yawning, hypersalivation, trembling, panting and nose licking). A similar pattern was also found among dog owners (Mariti et al., 2012). Encouraging veterinary students to engage in experiential learning acquiring contextually relevant knowledge through 'hands-on' problem solving, critical reflection, discussion, and decision-making (Millenbah and Millspaugh, 2003), might enhance their recognition of stress-related behaviors.

Little could be said of the demographic influence on perception of stress item values. Even though there were some statistic indicators that might suggest some effects, the overall assessment does not support any. Therefore, a factor analysis proved to be helpful. Sample size, homogeneity sample, or professional training could be behind these outcomes.

Although the analysis using PCA provided interesting results, and revealed patterns in students' ability to identify certain signal of canine stress, the grouping of behavioral signs of stress in different components was not always easy to interpret. Nevertheless, the grouping of indicators suggests that they are differentiated by veterinary students in a way that requires further research. It is clear that the indicators are not all treated equivalently and that veterinary students are drawing on different information to identify stress. For example, one component deals with explicit problem behavior, one deals with facial stress indicators, one deals with withdrawal behaviors, one with avoidance, et cetera. These results suggest vet students are not combining these behavioral cues into an overall global assessment of stress responses. If they were there would be one component

Female veterinary students showed greater pet attachment levels and self-reported involvement in caring their companion animals, findings that are in line with previous

research (Paul and Podberscek, 2000; Colombo et al., 2017; Menor-Campos et al., 2019).

This finding may be related evidence that women may be more empathetic due to a greater anatomical and functional development of certain areas of the brain that are involved in communication and empathy (Wedl et al., 2011; Pongrácz and Szapu, 2018).

However, female students' scores on dog stress perception were not different from male classmates scores. Among pet owners, women have been reported as more able to correctly define stress, while men were more able to identify subtle behavioral indicators of stress, such as low activity or low appetite (Mariti et al., 2012). Professional veterinary training might be closing the gender gap in terms of perceptions of canine stress.

Having a companion animal was found to have some effects on stress identification.

Students who owned a companion animal identified some stress response signs (i.e., crying, circling, excessive barking, or autogrooming) more readily than non-pet owners.

Indeed, veterinary students' previous experiences with animals were expected to have a greater effect on their perceptions of stress, because experience of owning companion animals has typically been reported to be associated with greater knowledge of animals (Paul and Serpell, 1993; Paul, 2000; Paul and Podberscek, 2000; Miura et al., 2002; Prokop and Tunnicliffe, 2010; Rothgerber and Mican, 2014). Veterinary training has been previously found to enhance veterinarian-to-be responses in relation to their attitudes toward animals (Menor-Campos et al., 2019).

When evaluating the effect of companion animal ownership in people's attitudes or behaviors towards animals, not only ownership but also involvement and attachment levels should be assessed (Knight et al., 2004; Menor-Campos et al., 2018). In the present

study involvement in animal care and pet attachment were related to one another.

Attachment level was also related to higher identification of subtle dog stress signs (e.g. looking elsewhere and turning head). Higher levels of attachment to a dog may lead to greater attention being paid to the dog's behavior in order to recognize behavioral changes that might indicate their stress levels, health and welfare status. Veterinary training may enhance students' ability to recognize behavioral signs of canine stress, over and above their personal experiences of pet ownership and attachment to pets.

Limitations

Likert scales, as used in this study, are used in a wide variety of research fields, including published standardized measures (Smith and Roodt, 2003; Pornel, 2009). However, limitations include: the central tendency bias (Douven, 2018) whereby participants avoid extreme response categories; the social desirability bias where participants may attempt to portray themselves in a socially favorable light rather than being honest; and the acquiescence bias (Paulhus, 1991) where participants might agree with statements as presented in order to please the experimenter. In our study, students might have tended to overestimate the extent to which each behavior was related to stress, given the focus of the study and their status as veterinary students. However, the variability in recognizing some of the more subtle behaviors as part of the stress response, and PCA results, suggests this potential bias may have been minimal.

Another important issue to consider is that veterinary students might have found it difficult to distinguish between arousal "*a generalized state of increased physiological activity without implication of positive or negative valuation of that state*" (Duckro et al., 1989) and

stress signs in dogs, as stress is often overlooked by owners and dog enthusiasts (Kerswell et al., 2009; Mariti et al., 2012). Indeed signs of stress in dogs are characterized by low pathognomoncity (Mariti et al., 2015b). However, participants were asked if the listed behaviors were related to stress, and all of them were. More detailed research on students' ability to distinguish between stress and high arousal, or between chronic and acute stress, is required.

There are also some limitations to the PCA analysis that should be noted. The PCA revealed patterns in students' responses about which behaviors might indicate stress responses in dogs, however, these patterns require further investigation in future research. Larger samples, analyzed using stronger statistic methods (e.g. GLMs, categorical regression) are recommended for future research.

Finally, generalization of these results should be made cautiously before replication of the study in different national contexts is achieved, in view of the wide variation in veterinary curricula on dog behavior and welfare.

Conclusions

As expected, veterinary students identified stress as a health hazard for dogs. However, misunderstandings of underlying mechanisms of stress influence veterinary students' ability to recognize subtle stress signs in dogs. Veterinary students were found to perceive the stress-related nature of gross behaviors more readily than subtle stress-related behaviors, in line with previous research on dog owners. This finding suggests that additional focus on recognition of stress-related behaviors, and stress mechanisms, would

be beneficial in veterinary education.

In this study, no gender differences were found in accuracy of recognizing stress signs in dogs. However, pet attachment level was related to a higher performance, while attachment and involvement were higher among female students, which is worthy of further exploration. Further research might reveal a latent association between recognition of stress indicators and the quality of relationship with a dog (e.g., in terms of attachment and shared activities). It would also be useful to explore recognition of canine stress indicators among other professional groups who work with dogs, such as handlers of dogs involved in animal assisted interventions, who are responsible for their canine's welfare.

Authorship statement

The idea for the paper was conceived by Dr David J. Menor-Campos. The experiments were designed by all authors, and performed by Dr David J. Menor-Campos and Carlos Ruiz Soriano. The data were analyzed by Dr David J. Menor-Campos, and the paper was written by Dr David J. Menor-Campos, Prof. Joanne M. Williams, Prof. Angelo Gazzano and Dr Chiara Mariti.

Conflicts of interest

The authors declare no conflicts of interest and that they received no specific funding for this work.

REFERENCES

- ALLEA – All European Academies, 2017. The European code of conduct for research integrity table of contents. doi: 10.1037/e648332011-002
- Amadori, M., Stefanon, B., Sgorlon, S., Farinacci, M., 2009. Immune system response to stress factors. *Ital. J. Anim. Sci.* 8, 287–299. doi: 10.4081/ijas.2009.s1.287
- Amat, M., Camps, T., Manteca, X., 2016. Stress in owned cats: behavioral changes and welfare implications. *J. Feline Med. Surg.* 18, 577–586. doi: 10.1177/1098612X15590867
- AVSAB, 2017. Avsab position statement on positive veterinary care.
- Beaver, B.V., 1981. Friendly communication by the dog. *Vet. Med. Small. Anim. Clin.* 76, 647–649.
- Beerda, B., Schilder, M.B.H., van Hooff, Jan, A.R.A.M., de Vries, H.W., 1997. Manifestations of chronic and acute stress in dogs. *Appl. Anim. Behav. Sci.* 52, 307–319. doi: 10.1016/S0168-1591(96)01131-8
- Beerda, B., Schilder, M.B.H., van Hooff, J.A.R.A.M., de Vries, H.W., Mol, J.A., 1998. Behavioural, saliva cortisol and heart rate responses to different types of stimuli in dogs. *Appl. Anim. Behav. Sci.* 58, 365–381. doi: 10.1016/S0168-1591(97)00145-7
- Brislin, R.W., 1970. Back-translation for cross-cultural research. *J. Cross. Cult. Psychol.* 1, 185–216. doi: 10.1177/135910457000100301
- Cerny, B.A., Kaiser, H.F., 1977. A study of a measure of sampling adequacy for factor-analytic correlation matrices. *Multivariate Behav. Res.* 12, 43–47. doi: 10.1207/s15327906mbr1201_3
- Cohen, P., Cohen, J., Aiken, L.S., West, S.G., 1999. The problem of units and the circumstance for pomp. *Multivariate Behav. Res.* 34, 315–346. doi: 10.1207/S15327906MBR3403_2
- Colombo, E.S., Crippa, F., Calderari, T., Prato-Previde, E., 2017. Empathy toward animals and people: The role of gender and length of service in a sample of Italian veterinarians. *J. Vet. Behav.* 17, S221–S222. doi: 10.1016/j.jveb.2016.10.010
- Dodman, N.H., Brown, D.C., Serpell, J.A., 2018. Associations between owner personality and psychological status and the prevalence of canine behavior problems. *PLoS ONE* 13, e0192846. doi: 10.1371/journal.pone.0192846
- Döring, D., Roscher, A., Scheipl, F., Küchenhoff, H., Erhard, M.H., 2009. Fear-related behavior of dogs in veterinary practice. *Vet. J.* 182, 38–43. doi: 10.1016/j.tvjl.2008.05.006
- Douven, I., 2018. A Bayesian perspective on Likert scales and central tendency. *Psychon. Bull. Rev.* 25, 1203–1211. doi: 10.3758/s13423-017-1344-2
- Duckro, P.N., Korytnyk, N.X., Vandenberg, B.R., 1989. The stress-arousal checklist as a measure of situational stress versus simple arousal. *Psychol. Rep.* 64, 239–242. doi: 10.2466/pr0.1989.64.1.239
- Gazzano, A., Bianchi, L., Campa, S., Mariti, C., 2015a. The prevention of undesirable behaviors in cats: Effectiveness of veterinary behaviorists' advice given to kitten owners. *J. Vet. Behav.* 10, 535–542. doi: 10.1016/j.jveb.2015.07.042
- Gazzano, A., Migoni, S., Guardini, G., Bowen, J., Fatjo, J., Mariti, C., 2015b. Stress in aggressive dogs towards people: behavioral analysis during consultation. *Dog Behav.* 1, 6–

13. doi: 10.4454/db.v1i3.23

- Global Organization for Stress, 2021. *STRESS DEFINITIONS* | *Global Organization for Stress*. [online] Global Organization for Stress | Stress, Stress Management and Stress Relief Solutions for You. Available at: <<http://www.gostress.com/stress-definitions/>> [Accessed 30 December 2021].
- Heleski, C.R., Mertig, A.G., Zanella, A.J., 2005. Results of a national survey of US veterinary college faculty regarding attitudes toward farm animal welfare. *J. Am. Vet. Med. Assoc.* 226, 1538–1546. doi: 10.2460/javma.2005.226.1538
- Hewson, C., 2014. Evidence-based approaches to reducing in-patient stress – Part 2: Synthetic pheromone preparations. *Vet. Nurs. J.* 29, 204–206. doi: 10.1111/vnj.12140
- Hewson, C.J., 2008. Stress in small animal patients: Why it matters and what to do about it. *Ir. Vet. J.* 61, 249–254.
- Holroyd, K.A., Lazarus, R.S., 1982. Stress, coping and somatic adaptation, in: Goldberger LEaB, S. (Ed.), *Handbook of stress: theoretical and clinical aspects*. Free Press, New York, pp. 21–35.
- Kerswell, K.J., Bennett, P.J., Butler, K.L., Hemsworth, P.H., 2009. Self-reported comprehension ratings of dog behavior by puppy owners. *Anthrozoös* 22, 183–193. doi: 10.2752/175303709X434202
- Knight, S., Vrij, A., Cherryman, J., Nunokoosing, K., 2004. Attitudes towards animal use and belief in animal mind. *Anthrozoös* 17, 43–62. doi: 10.2752/089279304786991945
- Lazarus, R.S., 1974. Psychological stress and coping in adaptation and illness. *Int. J. Psychiatry Med.* 5, 321–333. doi: 10.2190/T43T-84P3-QDUR-7RTP
- Levi, L., 1996. *Managing physical stress*. Thomson Delmar Learning., Australia.
- Mariti, C., Falaschi, C., Zilocchi, M., Fatjó, J., Sighieri, C., Ogi, A., Gazzano, A., 2017. Analysis of the intraspecific visual communication in the domestic dog (*Canis familiaris*): a pilot study on the case of calming signals. *J. Vet. Behav.: Clin. Appl. Res.* 18, 49–55
- Mariti, C., Gazzano, A., Moore, J.L., Baragli, P., Chelli, L., Sighieri, C., 2012. Perception of dogs' stress by their owners. *J. Vet. Behav.: Clin. Appl. Res.* 7, 213–219. doi: 10.1016/j.jveb.2011.09.004
- Mariti, C., Pierantoni, L., Sighieri, C., Gazzano, A., 2017. Guardians' perceptions of dogs' welfare and behaviors related to visiting the veterinary clinic. *J. Appl. Anim. Welf. Sci.* 20, 24–33. doi: 10.1080/10888705.2016.1216432
- Mariti, C., Raspanti, E., Zilocchi, M., Carlone, B., Gazzano, A., 2015a. The assessment of dog welfare in the waiting room of a veterinary clinic. *Anim. Welf.* 24, 299–305. doi: 10.7120/09627286.24.3.299
- Marsa-Sambola, F., Muldoon, J., Williams, J., Lawrence, A., Connor, M., Currie, C., 2016. The Short Attachment to Pets Scale (SAPS) for children and young people: development, psychometric qualities and demographic and health associations. *Child Indic. Res.* 9, 111–131. doi: 10.1007/s12187-015-9303-9
- McEwen, B.S., Mendelson, S., 1993. Effects of stress on the neurochemistry and morphology of the brain: counterregulation versus damage, in: breznitz, s., Goldberger, L. (Ed.), *Handbook of stress: theoretical and clinical aspects*. The Free Press, New York, pp. 100–126.
- Meints, K., Brelsford, V., De Keuster, T., 2018. Teaching children and parents to understand dog signaling. *Front. Vet. Sci.* 5, 257. doi: 10.3389/fvets.2018.00257

- Menor-Campos, D.J., Diverio, S., Sánchez-Muñoz, C., López-Rodríguez, R., Gazzano, A., Palandri, L., Mariti, C., 2019. Attitudes toward animals of students at three European veterinary medicine schools in Italy and Spain. *Anthrozoös*. doi: 10.1080/08927936.2019.1598658
- Menor-Campos, D.J., Hawkins, R., Williams, J., 2018. Belief in animal mind among spanish primary school children. *Anthrozoös* 31, 599–614. doi: 10.1080/08927936.2018.1505340
- Millenbah, K.F., Millsbaugh, J.J., 2003. Using experiential learning in wildlife courses to improve retention, problem solving, and decision-making. *Wildl. Soc. Bull.* 31, 127–137.
- Miura, A., Bradshaw, J.W.S., Tanida, H., 2002. Childhood experiences and attitudes towards animal issues: A comparison of young adults in Japan and the UK. *Anim. Welf.* 11, 437-448
- Nardone, A., Ronchi, B., Lacetera, N., Ranieri, M.S., Bernabucci, U., 2010. Effects of climate changes on animal production and sustainability of livestock systems. *Livest. Sci.* 130, 57–69.
- Nienhaus, A., Skudlik, C., Seidler, A., 2005. Work-related accidents and occupational diseases in veterinarians and their staff. *Int. Arch. Occup. Environ. Health*, 78 (3), 230-238.
- Owczarczak-Garstecka, S., Christley, R., Watkins, F., Yang, H., Bishop, B., & Westgarth, C., 2019. Dog bite safety at work: An injury prevention perspective on reported occupational dog bites in the UK. *Saf. Sci.*, 118, 595-606. doi: 10.1016/j.ssci.2019.05.034
- Overall, K.L., 2010. What rigorous experimental design can tell us about learning, memory, feeding strategies, welfare and improved working dog ability. *J. Vet. Behav.: Clin. Appl. Res.* 5, 67–68. doi: 10.1016/j.jveb.2010.02.001
- Paul, E.S., 2000. Empathy with animals and with humans: Are they linked? *Anthrozoös*. doi: 10.2752/089279300786999699
- Paul, E.S., Podberscek, A.L., 2000. Veterinary education and students' attitudes towards animal welfare. *Vet. Rec.*. doi: 10.1136/vr.146.10.269
- Paul, E.S., Serpell, J.A., 1993. Childhood pet keeping and humane attitudes in young adulthood. *Anim. Welf.* 2, 321-337
- Paulhus, D.L., 1991. Chapter 2 - Measurement and control of response bias, in: Robinson, J.P., Shaver, P.R., Wrightsman, L.S. (Eds.), *Measures of personality and social psychological attitudes*. Academic Press, pp. 17–59. doi: 10.1016/B978-0-12-590241-0.50006-X
- Pornel, J., 2009. A new model for Likert Scale data analysis. *Philipp. J. Sci.* 14, 41–46.
- Prokop, P., Tunnicliffe, S.D., 2010. Effects of having pets at home on children's attitudes toward popular and unpopular animals. *Anthrozoös*. doi: [10.2752/175303710X12627079939107](https://doi.org/10.2752/175303710X12627079939107)
- Pongrácz, P., Szapu, J.S., 2018. The socio-cognitive relationship between cats and humans—Companion cats (*Felis catus*) as their owners see them. *Appl. Anim. Behav. Sci.* 207, 57-66 doi: 10.1016/j.applanim.2018.07.004
- Rothgerber, H., Mican, F., 2014. Childhood pet ownership, attachment to pets, and