INDICATORS OF STRESS AND STRESS ASSESSMENT IN DOGS

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Summary

The present study was aimed at evaluating the effect of acute stress on the behaviour and physiology of dogs. Observations were made on entire dogs admitted for neutering in various practices from the UK and housed in individual cages. Observations comprised a 10 minute behavioural observation and the measurement of respiratory rate and heart rate for each dog. Female dogs were more likely than males to display behavioural and physiological indicators of stress. Only previously kennelled dogs were noted to perform stereotypical behaviours. Rescue dogs were found to be more likely to display physiological indicators of stress and to have significantly higher heart rates than privately owned dogs.

Key words: behaviour, dog, stress, stress, stress indicators

Indicators of stress in animals are valuable tools for assessing their welfare, although the relationship between stress and welfare is not a straightforward one. Despite Mench's suggestion that 'one potential indicator of an animal's welfare is the presence or absence of stress' /17/, it may be difficult to decide when exactly a stressful situation impairs an animal's welfare. A single measure of stress might not be a reliable indicator of an animal's welfare and it is usually more informative to combine physiological and behavioural indicators of acute or chronic stress in an individual animal.

Physiological indicators of stress in animals include various hormonal measures (e.g. catecholamines, glucocorticoids, prolactin, gonadotrophins, thyroid-stimulating hormone and insulin), measures of heart rate, blood pressure, respiratory rate and body temperature and evaluations of the immune status and of disease incidence.

Levels of serum catecholamines and glucocorticoids are most commonly measured in dogs, as they correlate with the level of stress, but accurate determinations pose various problems. The anticipatory and immediate stress responses triggered by the procedure of blood sampling may increase the plasma levels of these hormones /17/, which complicates the interpretation of the results. In addition, ethical considerations require the use of non-invasive sampling procedures, such as samplings of saliva, urine or faeces.

Salivary levels of catecholamines were shown to be related to serum levels in laboratory Beagles /16/. Salivary cortisol increased in dogs following insulin-induced hypoglycaemia /3/ and after administration of sound blasts and short electric shocks /5/.

Urinary determinations are considered more useful indicators of stress because they reflect the stress response over a period of several hours prior to sampling /8/. *Beerda et al* (2000) showed that privately owned dogs had lower

urinary adrenaline:creatinine ratios than chronically stressed dogs which had been kept in an impoverished environment for years. Urinary cortisol increased in dogs as a result of insulin-induced hypoglycaemia /3/. *Gaines et al* (2003) showed that urinary cortisol:creatinine ratios increased in dogs immediately following admission to a military training establishment and the increase was more significant in dogs without any prior experience of kennelling. The same effect of kennelling on urinary cortisol was found in dogs newly admitted to a rescue shelter /6/ and in single-housed dogs over a period of 6 weeks (*Beerda*, personal communication).

Measurement of faecal cortisol in dogs by RIA was explored in some studies. This method is probably less specific than the determination of urinary cortisol: creatinine ratios and therefore it has less value as an indicator of changes in the stress level of an individual animal /8/. However, it might be a useful measure for groups of animals, such as group-housed dogs, where individual urine sampling is difficult.

Acute stressors elicit increases or decreases in heart rate, blood pressure, respiratory rate and body temperature. Various studies have found that heart rate increases in dogs subjected to stressors /13, 14/. *Beerda et al* (1998) showed that heart rate increased in dogs non-specifically following administration of various unpleasant stimuli and returned to normal within 8 minutes after the stressor disappeared. Respiratory rate was also shown to increase in dogs anticipating unavoidable shock and in dogs subjected to noise /9/.

Physical and psychological stressors are able to evoke immune responses that are similar to those elicited by infection with various pathogens: neutrophilia, lymphopenia, increased acute phase proteins and decreased circulating proteins /15/. Leukograms that are characterized by monocytosis, lymphopenia and eosinopenia are called stress leukograms /20/. *Verma* (1984) has demonstrated that dogs subjected to acute stress develop a general leucocytosis, characterized by neutrophilia, lymphopenia and eosinopenia.

Dogs transported by car and introduced in a new environment had increased total leucocyte counts, with an increase in neutrophils and a decrease in lymphocytes. Dogs subjected to individual housing for 5 weeks had increased neutrophil/lymphocyte ratios /2/. However, in the same chronically stressed dogs, the lymphocyte proliferative responses were increased /2/, which contradicts findings from other species.

In dogs adopted from shelters it was found that, in the two weeks following adoption, half of the dogs displayed symptoms of various illnesses, such as diarrhoea, vomiting, coughing, sneezing and skin problems /18, 21/. It was suggested that these conditions may be due to the immunosuppression caused by the previous stress of kennelling.

Behavioral indicators of stress include normal and abnormal behavior patterns.

Normal behavioural responses of dogs to acute stressors are: avoidance, defensive aggression, hiding, looking for contact with humans or other animals,

attention-seeking behaviours (e.g. pawing), excessive activity or inactivity, digging, panting, salivation, elimination, pacing, visual scanning, dilated pupils, vocalization, lowered posture, flattened ears, low tail, anorexia /7/.

In terms of behavioural responses to chronic stress, dogs subjected to social and spatial restriction for a long period of time displayed enhanced locomotion, yawning, paw-lifting and body shaking /4/, as well as increased autogrooming, coprophagy, low posture and vocalizing /1/, as compared to dogs kept in less austere conditions.

Three categories of abnormal behaviours that are caused by stress can be identified in dogs: displacement activities (e.g. licking, grooming and pica), stereotypical activities (e.g. excessive licking, flank sucking, circling or whirling, tail chasing, fence-line running, excessive barking, polydipsia and polyphagia) and so-called 'hallucinatory' behaviours (e.g. staring and 'fly chasing') /7/.

Materials and methods

1. Subjects

The subjects of this study were dogs presented for neutering at private veterinary practices within the UK. Dogs were selected randomly in terms of breed and age. The study group consisted of 58 dogs, 32 females and 26 males, aged between 6 months and 6 years. 29 dogs (14 females and 15 males) were brought from RSPCA dog centers, while the other 25 dogs (18 females and 11 males) belonged to private owners. All dogs were healthy and in good condition. All dogs were housed in individual cages, without food and water. They had been subjected to food restriction 12 to 14 hours before being admitted.

2. Procedures

The housing in the individual cage was considered to represent an acute stressor for the dogs. An ethogram was designed based on activities or postures that were previously proven to reflect stress in dogs. A continuous recording method was used. Observations were performed between 30 minutes and 1 hour after the dogs were housed in the individual cages and before the dog was administered any drug. Each dog was inspected for a period of 10 minutes. The exact time that the dog was spending engaged in a certain activity or adopting a certain posture was recorded. At the end of the 10 minute observation period, the respiratory rate was measured by inspection. Afterwards, each dog was taken out of the cage and the heart rate was measured by auscultation.

Collected data were coded as continuous variables ('seconds' for the activities and postures, number of inspirations per minute and number of heart beats per minute). Statistical analysis was made with MINITAB 13 for Windows. Significance level was set at $p<0.05$.

Results and discussions

1. Behavioural indicators of stress

The dogs from the study-group performed the following activities that are considered to reflect stress: vocalizations, paw-lifting, oral manipulation of the cage, yawning, digging, licking and grooming. The following postures that can be stress-related were recorded: lowered body posture, flattened ears, low tail, hiding, unresponsiveness.

Among the 58 examined dogs, 50 displayed at least one type of activity or posture indicative of stress. The other 8 dogs did not display any behaviour that could be categorized as stress-related.

Among the activities or postures that indicate stress, vocalizations were the most common, followed by flattened ears, low tail, lowered body posture, paw-lifting, digging, oral manipulation of the cage, hiding, yawning, unresponsiveness and licking and grooming (table 1). Most dogs displayed multiple such activities or postures.

No significant difference was found between the amounts of time that dogs spent engaged in a possibly stress-related activity or posture (Friedman test, $p=0.689$). However, a Chi-square test showed that females were generally more likely than males to engage in one of the mentioned behaviours or to adopt one of the mentioned postures ($p=0.035$). However, males spent significantly more time vocalising than females ($p=0.042$), while females adopted stress-related postures (flattened ears, low tail, lowered body posture and hiding) significantly more often than males ($p=0.029$).

Table 1

Activity or posture	No of dogs displaying the activity or posture
Vocalizations	30 (60%)
Flattened ears	22(44%)
Low tail	16 (32%)
Lowered body posture	13(26%)
Paw-lifting	10(20%)
Digging	6 (12%)
Oral manipulation of cage	4 (8%)
Hiding	3 (6%)
Yawning	3 (6%)
Licking and grooming	1 (2%)
Unresponsiveness	1 (2%)

The background did not seem to influence the frequency of stress manifestations in the study group, as dogs from the RSPCA and privately owned

dogs were equally likely to display stress-related activities or postures (p=0.659). However, it was noted that all dogs that displayed stereotipies, such as oral manipulation of the cage or licking and grooming, belonged to the RSPCA. The explanation might be that such stereotipies generally reflect chronic stress /12, 15/, and these dogs might have been subjected to chronic stress if they had been kennelled for a long while.

2. Physiological indicators of stress

Physiological indicators of stress included panting, salivation, body shaking, elimination, tachypnoea and tachycardia.

The normal average respiration rate in dogs is between 10 and 30 respirations per minute, so dogs that had a respiratory rate higher than 30 respirations/minute were considered to have tachypnoea. In what concerns the heart rate, its values vary remarkably with the size of the dog: the average heart rate is 100 to 160 beats per minute for dogs weighing less than 15kg and 60 to 100 beats per minute for dogs weighing more than 15kg. Therefore, dogs less than 15kg were considered to have tachycardia if their heart rate was higher than 160, while dogs of more than 15 kg were considered to have tachycardia if their heart rate was higher than 100.

Among the 54 examined dogs, 42 displayed at least one physiological indicator of stress (table 2). The most common finding was tachycardia, followed by tachypnoea, panting, body shaking, elimination and hypersalivation.

Table 2

Symptoms	No of dogs
Tachycardia	35 (83.33%)
Tachypnoea	30 (71.42%)
Panting	17 (40.47%)
Body shaking	13 (30.95%)
Elimination	3 (7.14%)
Hypersalivation	3 (7.14%)

Again, no significant difference was found between the amounts of time that dogs displayed physiological indicators of stress (Friedman test, p=0.425). A Chi-square test showed that females were generally more likely than males to display physiological indicators of stress (p=0.027). A Mann-Whitney test was used to check if the values of heart rate and respiratory rate differed between males and females, but no significant difference was found (p=0.156 and p=0.375).

A Chi-square test showed that dogs that belonged to the RSPCA were more likely to display physiological indicators of stress than privately owned dogs (p=0.022). A Mann-Whitney test revealed that the RSPCA dogs had significantly higher heart rates than owned dogs (p=0.035). The reason might be that these dogs had suffered the chronic stress of previous kennelling and some authors have

shown that chronic stress accounts for exaggerated responses to acute stressors /16/. No significant difference was found between respiratory rate of dogs from the RSPCA and privately owned ones (p=0.347).

Studies performed on two populations of entire Beagles /2, 10/ showed that females have higher basal plasmatic cortisol concentrations and more pronounced increases in cortisol after noise exposure, CRH and ACTH stimulation tests and dexamethasone suppression tests than males, suggesting that females might be more susceptible to environmental stress than males. The present study confirmed the existence of such a difference between male and female dogs, as it was found that females displayed behavioural and physiological indicators of stress more often and for longer periods of time than males.

Conclusions

The dogs from the study group displayed a wide variety of behavioural and physiological indicators of stress. The background of dogs did not influence the occurrence of stress-related behaviours, but it was found that rescue dogs were more likely to display physiological indicators of stress. This might reflect a greater stress-sensitivity in dogs subjected to the chronic stress of kennelling. Females displayed behavioural and physiological indicators of stress more often and for longer periods of time than males, which suggests they are more susceptible to acute stress than males.

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