**Stress behaviours in kennelled dogs (*Canis familiaris*), with a focus on responses to auditory enrichment**

Stress responses in dogs can be exhibited in different ways and are categorized and studied most frequently as behavioural or physiological (Beerda et al., 1997). Many behavioral responses have been reported which include increased vocalization frequency, alertness, and behaviour associated with fear and submission such as snout licking, paw lifting lowered posture and body shaking (Beerda et al., 1997; Kogan et al., 2012, Amaya et al., 2020). The performance of thermoregulatory behaviour such as drooling and panting and the development of stereotypies are other behaviors associated with more severe stress (Beerda et al., 1997). Chronically stressed dogs may show increased excitement, aggression, and uncertainty and low posture, increased auto grooming, paw lifting, vocalizing, repetitive behavior, and coprophagy (Beerda et al., 1999). Physiological changes in dogs experiencing stress are also manifested in a wide variety of parameters and are studied by measuring increases in salivary or urinary cortisol and through measuring cardiovascular performance as decreased heart rate variability (HRV) (Beerda et al., 1997; Hiby et al., 2006; Bowman et al., 2017).

Dogs are kennelled for many reasons and during kennelling they are exposed to psychogenic stressors (Bowman et al., 2017; Bowman et al., 2015; Kogan et al., 2012). This adverse environment, which includes social and spatial restriction, can lead to poor welfare in dogs (Beerda et al., 1997; Beerda et al., 1999). Rescue dogs can remain in kennels for long periods and are at risk of becoming chronically stressed, resulting in a negative effect to their physical and mental well-being with both short-term and long-term effects (Kogan et al., 2012; Bowman et al., 2017). Environmental enrichment, and notably, sensory stimulation which includes auditory stimulation, is an area of research that directly affects the welfare of kenneled dogs (Kogan et al., 2012). To examine the effect of auditory enrichment on stress behavior in dogs using behavioral observations, researchers observe activity using various sampling techniques as well as ethograms. Physiological changes in dogs experiencing stress in the kennel environment are also examined as it is found that studies kennelled dog welfare should use multiple measurement parameters, as no single welfare parameter has yet been found to be effective alone (Beerda et al., 1997; Hiby et al., 2006).

Different treatments of auditory stimulation, most frequently genres of music, have been presented to dogs over various time periods to assess changes in their behaviors relating to stress. Wells et al. (2002) and Kogan et al. (2012) found that auditory stimulation affects the behavior and stress of kenneled dogs with classical music promoting restful behaviors that may indicate relaxation. These results are consistent with Bowman et al. (2015) who found that classical music can reduce stress in kenneled dogs, measured as changes in HRV, urinary cortisol and behavior. A review of the influence of auditory enrichment on canine health and behavior by Lindig et al. (2020) corroborates that exposure to music, notably classical, affects kenneled dogs’ behavior, reducing stress and increasing relaxation. Bowman et al. (2017) conversely found that different genres, particularly soft rock and reggae, were associated with decreases in stress through beneficial physiological and behavioral changes. Amaya et al. (2020) tested for behavioral changes in response to varying music conditions, but for pitch and tempo and found low pitch to increase arousal, a component of the stress response. As well as testing different genres and characteristics of music to assess stress in kenneled dogs, Brayley and Montrose (2016) investigated the effects of audiobooks on the behavior of kenneled dogs and compared the effects to other forms of auditory stimulation. They found that exposure to audiobooks was more effective than all other auditory conditions, including classical music, in enhancing resting behaviors, an indicator of relaxation and improved welfare. Lindig et al. (2020) indicate that to advance the knowledge of this field, future studies can be conducted using specifically chosen target populations, interventions and response measures. They also highlight the importance of individuals’ and species’ preferences for specific music and being mindful in avoiding habituation to the enrichment. Bowman et al. (2015) and Bowman et al. (2017) have also found habituation to auditory enrichment to occur quickly and suggest that a variety of music minimizes the extent that this occurs.

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