Canine Nosework as an Intervention for Behavior Change in Shelter Dogs

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ABSTRACT

Millions of dogs enter the shelter annually in the United States. Dogs living in shelters experience a variety of stressors that can contribute to impaired welfare. Shelter enrichment programs are one way to mitigate these stressors and improve the welfare of kenneled dogs. This study compared the effects of nosework activities and positive human social contact via petting on the behavior of kenneled shelter dogs in response to an unknown person approaching the kennel. The present study found that dogs exhibited three behaviors most often in response to an unknown person approaching the kennel, 1) barking, 2) standing, and 3) jumping on the kennel. There were no effects found in either intervention on the proportion of time spent jumping on the kennel. Dogs exhibited increased standing behavior in their kennels after both interventions. There were no significant effects of the petting intervention on the proportion of time spent barking. The nosework intervention demonstrated an increase in the proportion of time spent barking the day-after the intervention, indicating a possible frustration response.

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INTRODUCTION

1.1 Sheltering in the United States

In the United States, approximately 3 million dogs enter shelters annually (ASPCA, 2019). The outcome of dogs who enter United States shelters has improved dramatically in recent years with live outcomes for 2.9 million dogs in 2023 (SAC), however, approximately 390,000 dogs are still euthanized annually, whether that be for behavior, health, or overcrowding (ASPCA, 2019). Given declining euthanasia rates, many dogs spend longer lengths of time in the shelter environment than in previous decades, which has been thought to contribute to decreased welfare and increased behavioral problems (Hetts et al., 1992; Beerda et al., 1999; Stephen & Ledger, 2006). The volume of dogs housed in shelters across the country requires the continued efforts of researchers and shelter professionals alike to explore interventions that improve the behavior and welfare of dogs while they are housed in the shelter.

1.2 Welfare Concerns in Shelter Dogs

The welfare of shelter dogs is a major concern given the stressors of the shelter environment, including a new environment; new routine; unfamiliar sights, sounds, and smells; unfamiliar dogs and people; and a loss of control over outcomes (Hennessy et al., 1998; Beerda et al., 2000; Wells, 2004; Taylor & Mills, 2007). Broom (2007) defined welfare as an individual's ability to cope with their environment. Welfare may be assessed by behavioral and physiological measures (or a combination of both), however, it can be difficult to assess given that individuals respond differently to and are affected to different extents by the same stressors (Hiby et al., 2006; Titulaer et al., 2013; Barnard et al., 2016).

Physiological stress measures can be useful to assess the acute and long-term effects of the shelter environment. A variety of physiological measures have been used in past research to

assess welfare in shelter dogs (catecholamines, immune function, temperature, heart rate) (Rooney et al., 2007; Bowman et al., 2015; Bowman et al., 2017; Polgár et al., 2019), though cortisol is the most extensively researched (Beerda et al., 1996; Hennessy et al., 1997; Beerda et al., 2000; Coppola et al., 2006; Hiby et al., 2006; Stephen & Ledger, 2006). Cortisol has been used to measure both acute and chronic stress in dogs (Beerda et al., 1996; Beerda et al., 1999; Rooney et al., 2007) and can be collected through hair and fecal sampling, plasma, saliva, and urine, however, urinary cortisol is the most noninvasive collection method and contains the highest concentrations of cortisol (Schatz & Palme, 2001). Research has demonstrated that shelter dogs exhibit higher levels of cortisol compared to owned dogs living in a home, which supports that the shelter environment contributes to stress in dogs (Hiby et al., 2006; Stephen & Ledger, 2006; Rooney et al., 2007). However, cortisol secretion is not always a reliable indicator of stress in animals, given it does not reflect emotional valence and can increase in response to exercise and excitement (Mason & Mendl, 1993; Fox et al., 1994; Boissy et al., 2007; Mormède et al., 2007; Angle et al., 2009; Burman et al., 2011).

Behavioral measures of welfare can provide information about an animal's internal state (positive or negative) and are easy to obtain given that behavior can be observed. Behavioral indicators of poor welfare can differ between individuals, but include low body posture, oral behaviors (auto-grooming, flank sucking), paw lifting, vocalization, and repetitive movement within the kennel, such as pacing, jumping, and tail chasing (Hetts et al. 1992; Hubrecht et al., 1992; Beerda et al., 1998; Beerda et al., 1999). Beerda et al. (1997) reported that escape attempts, panting, and lack of appetite correlated with acute stress in shelter dogs. Some dogs experience a state of listlessness in the shelter as a response to chronic stress (Lindsay, 2000; Mason & Latham, 2004; Gaines et al., 2008). However, the absence of poor welfare indicators

does not necessarily indicate good welfare, as suggested by Broom and Johnson (1993), who argue that the absence of positive behaviors may be just as useful in welfare assessment. Frameworks for welfare assessment that focus on positive welfare indicators in animals have emerged in recent years, including The Five Domains Model (Mellor & Reid, 1994; Mellor & Beausoleil, 2015) and Opportunities to Thrive (Vicino & Miller, 2015).

With the longer lengths of stay (LOS) that many shelter dogs are experiencing, addressing welfare concerns has become more critical. Wells et al. (2002) found that dogs with longer LOS exhibited less exploratory behavior in their kennels and were more likely to position themselves at the back of their kennel. Although dogs with longer LOS did not exhibit behaviors commonly associated with poor welfare, a positive finding, the authors suggested there may be indirect negative welfare implications for these dogs, such as decreased adoption rates in response to behaviors that are less attractive to adopters. Nevertheless, the relationship between LOS and poor welfare is still unclear. Raudies et al. (2021) identified that long term dogs in a shelter exhibited more problematic behaviors than short term dogs, including high scores for aggressive behavior, high arousal, jumping, and other excitable behaviors. Behavior was scored on a four-point scale by shelter staff (1 = never, 2 = occasionally, 3 = sometimes, 4 = frequently). Titulaer et al. (2013) found that shelter dogs with a LOS >6 months demonstrated higher levels of aggression than short term dogs, especially towards other dogs. Though these findings support a connection between behavior problems and increased LOS in the shelter, other papers that explored LOS in shelter dogs did not find a clear relationship. Protopopova et al. (2014) found that when shelter dogs were assessed for individual changes in behavior over time, no patterns were identified, which suggests that different dogs respond differently to longer LOS in the shelter. These findings agree with other studies that identified inconsistent behavior patterns in

dogs housed in shelters for longer lengths of time (Hetts et al., 1992; Beerda et al. 2000; Stephen & Ledger, 2005).

1.3 Enrichment for Shelter Dogs

In recent years, enrichment procedures and their effects on in-kennel behavior and welfare have been vigorously researched. Newberry (1995) defined enrichment as an improvement in the biological functioning of captive animals resulting from modifications to their environment. The goals of enrichment may be broad, but typically include an increase in species typical behaviors, increased ability to cope with challenges, broadened behavioral repertoire, and a decrease in the frequency of maladaptive or problem behaviors (Young, 2003). In dogs, enrichment may look like opportunities to engage in species typical behaviors like foraging, sniffing, problem solving, or social interaction with conspecifics. The use of enrichment procedures in shelters have been found to improve in-kennel behavior and promote behaviors associated with stress reduction, including a relaxed posture, an increase in lying down, decreased vocalization, and decreased contact with the kennel enclosure (Wells, 2004; Herron et al., 2014; Bowman et al., 2017; Protopopova et al., 2018).

Opportunities to engage in social contact with conspecifics have been used as an enrichment strategy for shelter dogs. Wells (1996) discovered that dogs housed alone in a shelter kennel spent much of their time (>65%) at the back of their kennel enclosure, a behavior that has been found to be undesirable to adopters (Wells & Hepper, 1992; Protopopova et al., 2014). Housing dogs in groups of two or three may provide enrichment benefits, including positive social contact, increased opportunities to exercise control over the environment, and increased complexity of the kennel environment (Hetts et al., 1992; Hubrecht et al., 1992). Play groups in shelters are another enrichment strategy to provide positive social contact with conspecifics in a

controlled environment. In a 2018 nationwide survey, Maddie's Fund found that 83% of shelters reported use of play groups, and 71% hosted 3 or more play groups a week. 96% of surveyed shelters reported the perception that playgroups contributed to improved welfare and quality of life and reduced stress in their dog population, however, there are no known studies at this time that measure the effects of play groups in the shelter dog population.

In contrast, positive social contact with humans and its effect on shelter dogs has been thoroughly researched (Hennessy et al., 1997; Hennessy et al., 1998; Hennessy et al. 2002; Shiverdecker et al., 2013; Dudley et al., 2015; McGowan et al., 2018). Positive human social contact can include stroking, playing, or training, and has been demonstrated to reduce physiological stress and allow dogs to exercise increased control over their environment (Hennessy et al. 1997; Hennessy et al, 1998; Wells & Hepper, 2000; Coppola et al., 2006). Positive human social contact has also been found to increase affiliative behavior towards people and other dogs (Normando et al., 2009; Protopopova et al., 2012).

The use of training procedures to teach behaviors thought to be desirable by adopters has become a popular enrichment strategy to attempt to increase adoption rates in shelter dogs, but has had mixed results (Luescher & Medlock, 2009; Protopopova et al., 2012; Herron et al., 2014; Protopopova & Wynne, 2015). For example, Herron et al. (2014) evaluated the effects of a training program that targeted in-kennel behaviors on adoption rates by teaching dogs not to bark when approached, as well as to make eye contact, sit or lay down, and approach the front of the kennel. Though the dogs were successfully trained to exhibit these behaviors when approached in their kennels, the training program did not impact adoption rates, which may reflect the lack of clarity on what behaviors adopters perceive as desirable. Protopopova et al. (2012) assessed the effects of a trained social behavior (gazing) from inside the kennel on increased adoption rates.

While the behavior was successfully trained and exhibited towards the researchers, it did not contribute to significantly increased adoption rates. These findings are contradictory to Luescher and Medlock (2009) who found that trained dogs were adopted at a rate of 1.4 times more than the untrained dogs of the control group. The impact of training on increased adoption rates is still unknown and the literature demonstrates inconclusive findings.

Sensory enrichment and its effect on the behavior and physiology of shelter dogs has been explored in more recent literature. Wells (2009) defined sensory enrichment as stimulation designed to trigger one or more of an animal's senses as a potential method for environmental enrichment in captive animals. Auditory enrichment in the form of classical music has been associated with an increase in lying down and a decrease in vocalizations in shelter dogs (Wells & Hepper, 2002; Kogan et al., 2012; Bowman et al., 2015; Brayley & Montrose, 2016). Bowman et al. (2017) explored the effects of different genres of music on the in-kennel behavior of shelter dogs. The statistical significance between genres was minor, however, the findings were consistent with similar studies and demonstrated that dogs spent significantly more time lying down and increased heart rate variability (HRV) parameters when exposed to music. Visual enrichment has been less researched in dogs compared to other species, however, Graham et al. (2005) found that shelter dogs exposed to moving televised images of both conspecifics and interspecifics (unfamiliar animal species and humans) exhibited lower instances of vocalization.

1.4 Olfactory Enrichment for Shelter Dogs

Olfactory enrichment has been explored in recent years to improve in-kennel behavior and welfare in shelter dogs. In domestic dogs, like many mammal species, olfaction is the primary sensory modality used to interact with the environment and their olfaction abilities are particularly renowned (Hepper, 1988; Walker et al., 2006). Wells (2009) proposed that the most

effective forms of sensory enrichment are those that target the primary sensory modality of the studied species, which makes olfactory enrichment especially promising as an intervention to improve behavior and welfare in shelter dogs. Olfactory enrichment is also attractive as an enrichment strategy in shelters given that it is cost effective and easy to implement compared to more complex types of enrichment (Nielsen et al., 2015).

Multiple studies have researched the effects of essential oils on behaviors associated with stress in shelter dogs (Graham et al., 2005; Binks et al., 2018; Amaya et al., 2020). Graham et al. (2005) found that lavender, and to a lesser extent, chamomile, resulted in increased rest behavior and decreased movement within the kennel. Binks et al. (2018) tested the effects of olfactory enrichment on the behavior of shelter dogs through the use of vanilla, coconut, ginger, and valerian, and found that exposure to all of the olfactory conditions resulted in significant behavior change, including a decrease in vocalizations and movement under all conditions and an increase in sleep levels during the coconut and ginger conditions. The use of olfaction-based products like calming pheromones (Dog-Appeasing Pheromone (DAP)), have also been explored to improve in-kennel behavior and stress reduction in shelter dogs, however, it was demonstrated to have little impact in the shelter environment (Hermiston et al., 2018).

Murtagh et al. (2020) was the first study to explore the effects of scented toys (lavender and rabbit) on the behavior of shelter dogs. The scented toys elicited more play behavior from shelter dogs compared to unscented toys, even when presented with both toy options simultaneously. The effects of both scented and unscented toys were reduced stress-related behaviors (lip licking, yawning, crouching, coprophagy, paw lifting, startling, and body shaking) and abnormal repetitive behaviors, however, scented toys had a stronger effect on the reduction of these behaviors compared to unscented toys. The authors noted that these effects were most

likely short-term, and more research is needed to determine longer term effects, but the utility of scented toys shows promise as an enrichment strategy for shelter dogs.

1.5 Canine Nosework as an Intervention for Shelter Dogs

Despite evidence that olfactory enrichment may play a vital role in improved behavior and stress reduction in shelter dogs, little research has been conducted on this type of enrichment outside of essential oils and calming pheromones. In owned dogs, canine nosework is a rapidly growing sport that can be found at many local training facilities. Canine nosework trains dogs to alert and discriminate between odors in various levels of difficulty, most often in the form of birch, anise, and clove dabbed on a hidden cotton swab. It is an activity that dogs of any age or physical ability can train in and is inclusive to dogs whose behavior may rule out participation in more environmentally difficult dog sports (Gibeault, 2019). For these reasons, canine nosework has recently been explored as an intervention in shelter enrichment programs to improve in-kennel behavior and reduce stress (Ogleby, 2019; "Shelter Project," 2020). In the pet dog population, Duranton & Horowitz (2019) found that dogs who received a nosework activity demonstrated positive cognitive bias when exposed to an ambiguous stimulus compared to the control group who was trained in heelwork. The researchers concluded that time spent engaged in foraging type olfactory activities promoted optimism and increased welfare. More research on canine nosework in shelter dogs is needed to assess its efficacy as an intervention to improve in-kennel behavior.

The objective of this study was to explore the effects of canine nosework sessions on the behavior of shelter dogs using a between-subject design. Shelter dogs who exhibited either excessive vocalization or movement within the kennel were selected for participation in this study. The research team selected these behaviors as criteria for participation due to their

correlation with longer LOS in shelter dogs and possible indicators of poor welfare. The present study compared two types of enrichment, 1.) canine nosework and 2.) positive social contact with humans via petting, and their effects on behaviors associated with poor welfare and a longer LOS in the shelter (excessive vocalization and movement within the kennel). Based on the anecdotal evidence of professionals in both the dog training and shelter behavior profession and the body of research that supports other forms of olfactory enrichment as an effective intervention for stress reduction in shelter dogs, we predicted that the effects of nosework sessions would result in a higher increase in behaviors associated with rest and relaxation and a decrease in behaviors associated with stress compared to dogs who received the petting intervention. Our research will speak to the possible utility of using canine nosework as an intervention to improve the behavior of shelter dogs.

MATERIALS AND METHODS

2.1 Subjects

Thirty-eight adoptable dogs housed at Harris County Pets in Houston, Texas, participated in this study. Dogs were selected based on the behaviors exhibited in their kennel (i.e., excessive vocalization or movement within the kennel, such as jumping at the kennel door and repetitive back and forth motion) upon the researcher's appearance. These behaviors were selected as participation criteria because they correlate with welfare concerns and longer lengths of stay in the shelter (Wells and Hepper, 1992; Protopopova et al., 2014; Protopopova & Wynne, 2014). Dogs were assessed by the researcher, who walked by kennels and observed the in-kennel behavior exhibited upon her appearance.

Dogs selected for participation were 1) deemed healthy upon veterinary examination, 2) at least 6 months old, and 3) at least 11 kg in weight to mitigate the likelihood of satiation during

the intervention. An additional criterion of participation was that dogs did not exhibit aggressive behavior towards humans (e.g., growling, baring teeth, or lunging from outside of the kennel).

2.2 Setting

Harris County Pets is a 5,000 square meter facility with 253 kennels allocated to dogs. The exact number of kennels used for adoptable dogs is subject to change based on the number of dogs in their care. All dogs resided in a kennel that had a concrete floor, three concrete walls (chain link fencing above the partial concrete walls of some kennels), a chain link fence, and a guillotine door that connected the indoor and outdoor kennels. Each kennel contained a raised bed and stainless-steel food and water bowls clipped to the indoor kennel door. Kennels varied between single housed dogs and multi-housed dogs given the high number of intakes.

The meet-and-greet room used for the intervention was about 2.5 m wide and 3 m long. The room had a glass front wall that provided visual access to the indoor kennels and supply closets, a bench centered on the back wall of the room, and a partial glass back wall that provided visual access to the outdoor kennels and exercise yard. The room was barren of toys and food and water bowls. Dogs selected for the study were led from their kennel to the meet-and-greet room on Day 2, where they then received one of the interventions.

2.3 Procedure

2.3.1 Overview

Dogs were randomly assigned to one of two experimental conditions: nosework activities or petting by the researcher. The researcher worked with one group of four to five dogs per experimental condition at a time to assure that participant selection was pseudorandom. The nosework group always occurred first, as each petting group dog was matched with a nosework

group dog to yoke number of treats and delivery time to control for the possible effects of food in the intervention. One experimental day would be all nosework dogs, followed by all petting dogs the following experimental day. Freshpet dog food was used as a treat throughout this study, though the exact protein formula varied upon availability (i.e., chicken recipe; beef and lamb recipe; beef, chicken, salmon, and egg recipe).

On Day 1, we recorded a 30-second iPhone video of dogs who met behavioral criteria. We did this by approaching and standing at the front of the kennel while recording. Whistle Fit activity monitors attached to a nylon collar were outfitted on participating dogs immediately after the video had been recorded.

On Day 2, dogs received their assigned intervention (15-minutes in length). Intervention sessions were filmed with a MacBook web camera placed on a bench at the back of the room. The researcher was inside the meet-and-greet room with the dogs while the research assistant was in a utility room across the hall. Dogs were allowed approximately 60-seconds to acclimate to the room while I called my research assistant and prepared the web camera to record. The call with the research assistant lasted the entire 15-minute intervention for coding purposes.

After completion of the intervention, I returned the dogs to their kennels and left the kennel area. Within 2-3 minutes of the dog being returned to their kennel the research assistant (Day 2) or an administrative staff member (Day 3) recorded a 30-second iPhone video of the dog's behavior in response to their approach of the kennel. Thus, all videos were recorded by a person novel to the dog at the time of recording. I removed the Whistle Fit activity monitors from dogs on Day 3 after the third and final video was recorded.

The study was conducted on weekday mornings before Harris County Pets opened to the public, from approximately 09:00 h to 12:00 h. The order in which we worked with dogs and approximate time that we recorded videos remained consistent throughout the three-day study.

2.3.2 Nosework Condition

After the 60 s acclimation period, I presented a single cardboard box by placing it on the ground positioned along the front wall. The box was about 45 cm long and 30 cm wide, though the exact size varied. The top of the box, and all subsequent boxes used throughout the nosework intervention, was open to allow the dogs to eat from inside them.

I placed a piece of food on the ground within 0.5 m of the cardboard box while positioned parallel to the dog, either squatting or sitting on the ground. I allowed the dog to investigate the food on the ground without verbal or physical encouragement. If the dog ate the food, I offered another piece of food in the same way. If the dog did not eat the food, they were given 60 s to do so before being eliminated from the study. This was repeated for a total of three repetitions. For each piece of food consumed by participants, I said “treat” out loud for coding purposes, which the research assistant coded from across the hall.

If the dog ate the three successive pieces of food offered within 0.5 m of the cardboard box, I placed a piece of food inside the box and said, “search” immediately after. If the dog ate the food from inside the box, I placed another piece of food inside the box and repeated "search.” If the dog did not eat the food from inside the box, I verbally encouraged the dog by saying their name and pointed inside the box to show them. Dogs were given 60 s to eat the piece of food placed inside the box before being eliminated from the study. Dogs were offered a piece of food inside the box and allowed 60 s to eat it for a total of three repetitions.

If the dog successfully ate food from inside the box on three successive trials, I tossed a piece of food approximately 1.5 m away from the box and said, “find it.” I placed a piece of food inside the box while the dog chased and consumed the piece of food that had been thrown across the room. When the dog returned within 0.5 m of the box, I said “search,” which was said in all successive trials to indicate to the dog that there was food inside the box. Dogs could search for up to 15 s without my encouragement. If dogs did not search inside the box (defined as movement towards the inside of the box, often led by the dog’s nose, that resulted in the location and consumption of a piece of food) within 15 s, I pointed to the box and repeated “search” to encourage the dog to search for the food placed inside the box. Dogs were given 60 s to successfully search for and eat the food inside the box before being eliminated from the study. The search procedure with a single cardboard box was repeated for a total of three trials.

If the dog successfully located and ate the piece of food placed in the single cardboard box, a second cardboard box was introduced. The second box was placed along the front wall approximately 15 cm apart from the first cardboard box. I tossed a piece of food across the room, then placed a piece of food in each box. When the dog returned within 0.5 m of the boxes, I said “search” to indicate to search for food inside the two boxes. Dogs were given 60 s to successfully search for and eat the food inside both boxes before the researcher provided encouragement for the search task by calling their name and pointing to the boxes. If the dog did not search for and consume the food inside both boxes within 60 s of the researcher providing verbal and physical encouragement, the researcher removed the second box by placing it with the unused boxes piled on the back wall of the room and restarted the procedure with one box (three successful trials consuming food within 0.5 m of the box, three successful trials searching for and consuming food in one box, and then reintroduction to the second box). At this point in the intervention,

dogs were no longer eliminated from the study due to longer latencies to search for and consume food from inside the cardboard boxes.

If the dog successfully searched for and ate food from inside both boxes, they moved on to the next trial, where I placed a piece of food in only one of the two boxes and varied which box it was placed in. I tossed a piece of food across the room, then placed a piece of food in one of the two boxes. Dogs were given 60 s to successfully search for and eat the food inside the target box before the researcher provided encouragement for the search task by calling their name and repeating "search." If the dog did not search for and consume the food inside the target both within 60 s of the researcher providing verbal encouragement, the researcher removed the second box and restarted the procedure with one box (three successful trials consuming food within 0.5 m of the box, three successful trials searching for and consuming food in one box, and then reintroduction to the second box with one trial of searching for and consuming food in both boxes). The search procedure with a piece of food placed in one of two cardboard boxes was repeated for a total of three trials.

I repeated this procedure for the introduction of all subsequent boxes if the dog met criteria for progression, which was defined as successfully searching for and consuming the piece of food placed in one of the boxes in 60 s or under. If the dog did not search for and consume the food in the target box, they were returned to the starting point of the intervention (three successful trials consuming food within 0.5 m of the box, three successful trials searching for and consuming food in one box, and reintroduction to the second box with one trial of searching for and consuming food in both boxes followed by three trials of search for and consuming food in one of two boxes). The maximum number of boxes used in this study was

five. There were three successive trials for boxes number three, four, and five, with a piece of food placed in only one of the boxes.

If dogs successfully searched for and consumed food in the target box for three trials on box number five, I spaced the boxes further apart (30.5 cm) and staggered their position from a straight line to a zig zag style line. I placed a piece of food in one of the five boxes until the end of the 15 minute intervention.

2.3.3 Petting Condition

After the 60 s acclimation period, I sat on the ground towards the front wall of the meet-and-greet room and called to the participating dog by name to encourage them to approach me. I reached out to pet the dog when they were within an arm's length distance of me and petted them by moving my hand back and forth in a motion that lifted the dog's fur and moved the dog's skin across its underlying muscles (Feuerbacher & Wynne, 2014; Hennessey et al., 1998). The areas petted included the side of the dog's neck, shoulder, and torso, though the dogs could move away and demonstrate preferences for other areas of their body.

Dogs that received the petting intervention were paired with a dog from the nosework group, wherein treats were yoked to the number of treats and time received by the nosework dog to control for the effect of food consumption in the intervention. At pre-programmed times, my research assistant would say "treat" on our phone call to indicate to feed the petting group dog in accordance with the nosework group dog. I delivered the food by tossing it approximately 1.5 m away from me towards the back wall and allowed them to chase and consume it.

I adjusted the length of time that petting lasted according to the dog's demonstrated preferences. For example, if the dog leaned onto me or laid down while I petted them, petting would last longer than the dogs who stood still for a few seconds and then moved away. On

average, I petted the dog for 5 s followed by a 5 s pause to provide the dog with the opportunity to move away from me. If the dog did not move away, then petting resumed. If the dog moved away, the researcher allowed them time to move freely throughout the room and resumed petting when they returned to an arm's length distance. This procedure was repeated for the remainder of the 15 minute intervention. The only behavioral criteria that would result in a dog being eliminated from the study in this intervention was aggressive or fearful behavior directed at the researcher (e.g., growling, baring teeth, or hiding).

2.4 Behavioral Coding

This study used a modified version of the ethogram created by Protopopova et al. (2014). The behaviors and operational definitions were used verbatim, apart from the behavior "jump at neighbor," which was not included in the original ethogram. The full list of the behaviors and their operational definitions can be referenced in Table 1.

Table 1.

Ethogram of In-Kennel Behaviors of Shelter Dogs.

Behavior	Operational Definition
Body position	
Front of kennel	Located between front of cage, and up to and including the midpoint of kennel
Back of kennel	Located between back wall of kennel, and up to, but not including, midpoint of kennel
Out of sight	Not visible from the front of the cage, behavior cannot be defined
Sitting	Supported by two extended front legs and two flexed back legs
Standing	Supported upright with all four legs
Pawing at door	One front paw makes contact with the cage door
Locomotion	

Jump on cage	Both front paws make contact with the cage door that does not include lunging
Lunging	Quick diagonal forward motion; may be accompanied by barking, growling or piloerection
Pacing	Repeatedly (>3) locomoting around kennel in fixed route
Jump at neighbor	Both front paws make contact with the cage wall parallel to the neighboring kennel
Vocalization	
Barking	Vocalization of very short duration and low frequency
Growling	Throaty, rumbling vocalization; usually low in pitch
Howling	Prolonged high-amplitude vocalization of varying pitch, lips drawn together while exhaling
Whining	A cyclic vocalization
Grooming	
Scratching	Paw makes repeated contact with body/face; head may be angled in direction of moving limb
Licking self	Oral contact with any part of body
Shaking off	Motions body and/or head back and forth repeatedly and rapidly

The researcher coded behavioral data using the mobile app, Countee. Behavior was coded for duration of time exhibited in a 30-second video.

2.5 Data Analysis

R version 4.3.1 was used to complete all analyses.

Several behaviors included in the ethogram were excluded from analyses due to sparsity (either rarely displayed or nearly always displayed). The behaviors that were analyzed included barking, standing, and jumping on the cage. The data were recorded as the proportion of video time spent performing each behavior. To allow for the use of beta regression (no 0 or 100% cases allowed) those proportions were transformed using $(proportion\ of\ time*(n-1)+0.5)/n)$, where n is the sample size, to equally force the range between 0 and 1 (Smithson & Verkuilen, 2006).

Beta regression models were used to determine whether the proportion of time spent performing a given behavior was explained by the enrichment intervention, video phase, or the interaction of the two. The models initially included the enrichment intervention, video phase, and their interaction as fixed effects and a random intercept for the individual dog. When the interaction was not significant, it was removed from the model. A separate model was used for each behavior. All models were fitted using the glmmTMB package in R (Brooks et al., 2017) and the model assumptions were checked using the DHARMa package (Hartig, 2022).

An additional model to the sum of the proportion of time spent doing each of the three analyzed behaviors was used due to the sparsity of the selected behaviors and bias in the initial behavioral tendencies between the intervention groups. This model was a linear mixed model, because the sum of the proportions no longer followed a beta distribution. Analysis of the residuals suggested that the core model assumptions were met, and the model was appropriate for the data.

2.6 Inter-Observer Reliability

To calculate inter-observer reliability, 20% of videos were double coded. The observer scores were considered in agreement if coded behaviors were within durations of three seconds. An inter-observer reliability score of 96% was calculated for in-kennel behavior.

2.7 Ethics Statement

All procedures were approved by the Virginia Tech Institutional Animal Care and Use Committee (21-202).

RESULTS

3.1 Participants

Thirty-eight dogs housed at Harris County Pets in Houston, Texas participated in this study. Participant dogs were a minimum of 6 months of age (range = 6 months to 7 years of age; *M* = 1.89 years). Of the 38 dogs, 20 were male (15 intact; 5 altered) and 18 were female (13 intact; 5 altered). The lengths of stay ranged from 6-104 days (*M* = 28.9 days). Most participant dogs were found as strays (*n* = 31), while 4 dogs were surrendered to the shelter by their owner and 3 dogs were returned to the shelter after adoption. The full list of participant dog demographic data can be found in Table 2.

Table 2.

Participant Dog Demographics.

Demographic	**Number**
Age	
<1 year	15
1 year to <7 years	21
7 years and older	2
Sex	
Male	20
Female	18
Neuter Status	
Intact	28
Neutered	10
Weight	
<14 kg	2
14-22.5 kg	19
22.5 kg and heavier	17
Breed Group	
Fighting	13
Herding	6
Hound	3
Sporting	9
Working	7
Intake Type	
Owner surrender	4

Returned to shelter	3
Stray	31

3.2 Effects of Enrichment Interventions on Shelter Dog Behavior

3.2a Jumping on Cage

No significant main effects of intervention type or day, or interaction of those factors were found in the proportion of time dogs spent jumping on the cage by intervention type or day (Table 3).

Table 3.

Estimated Mean Proportion of Time Spent Jumping on Cage by Day and Intervention.

		Model Estimated Mean	SE	Overall p-value
Day	1	0.134	0.050	0.5848
	2	0.105	0.060	
	3	0.181	0.097	
Intervention	Petting	0.123	0.057	0.6419
	Nosework	0.152	0.046	

3.2b Standing

We found no main effect of intervention type on the proportion of time dogs spent standing by intervention. There was a significant main effect of day which suggests that the interventions uniformly impacted the proportion of time dogs spent standing across days. The proportion of time was 1.25 times greater in the day-of video than in the day-after video (Table

4, Figure 1, z = 2.619, p = 0.0240). However, there was no significant interaction between the day-before and day-of videos.

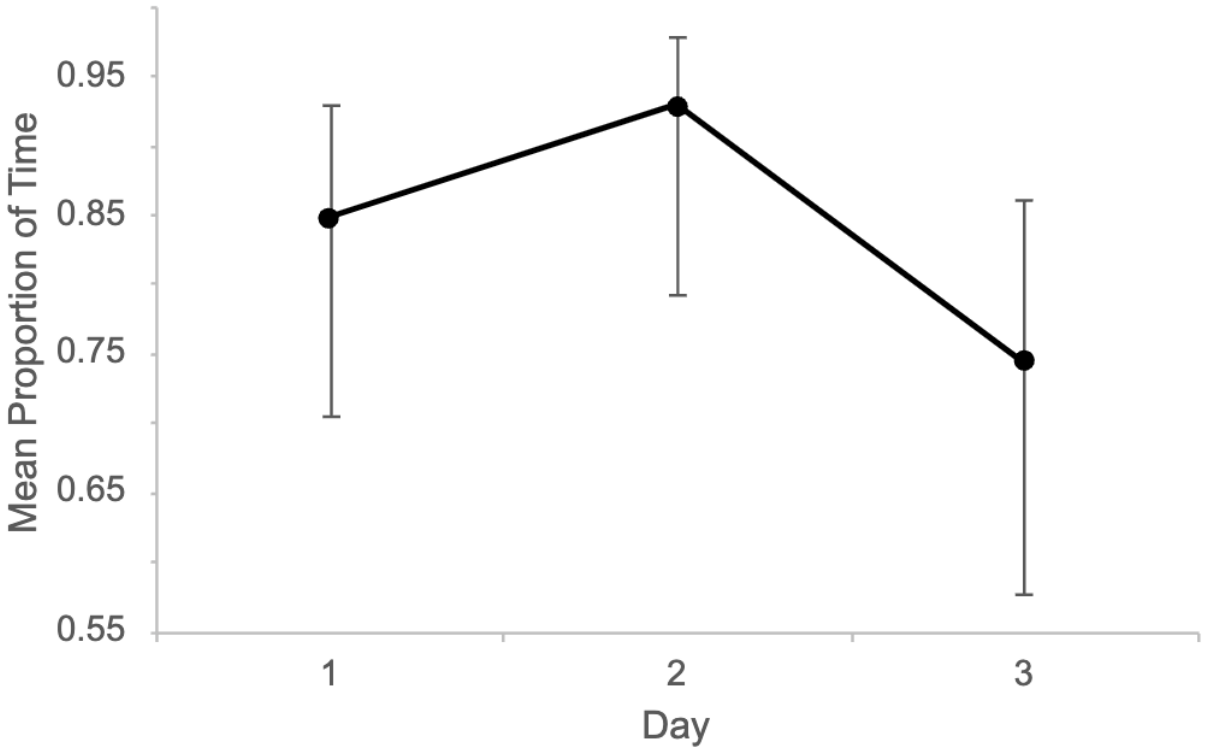
Table 4.

Estimated Mean Proportion of Time Spent Standing by Day.

		Model Estimated Mean	SE	Overall p-value
Day	1	0.847	0.0558	0.0310
	2	0.928	0.0413	
	3	0.744	0.0736	

Figure 1.

Mean Proportion of Time Spent Standing by Day.



Note. This figure demonstrates error bars representing upper and lower 95% confidence limits.

3.2c Barking

There was a significant interaction between intervention and day in regard to the proportion of time spent barking. Within the petting intervention, there were no differences detected in the proportion of time spent barking between days. Within the nosework intervention, the proportion of time spent barking was four times greater the day after the intervention than in either of the days prior (Table 5, Figure 2, day-before mean = 0.06, SE = 0.03; day-of mean = 0.05, SE = 0.03; day-after mean = 0.25, SE = 0.09; p = <0.01).

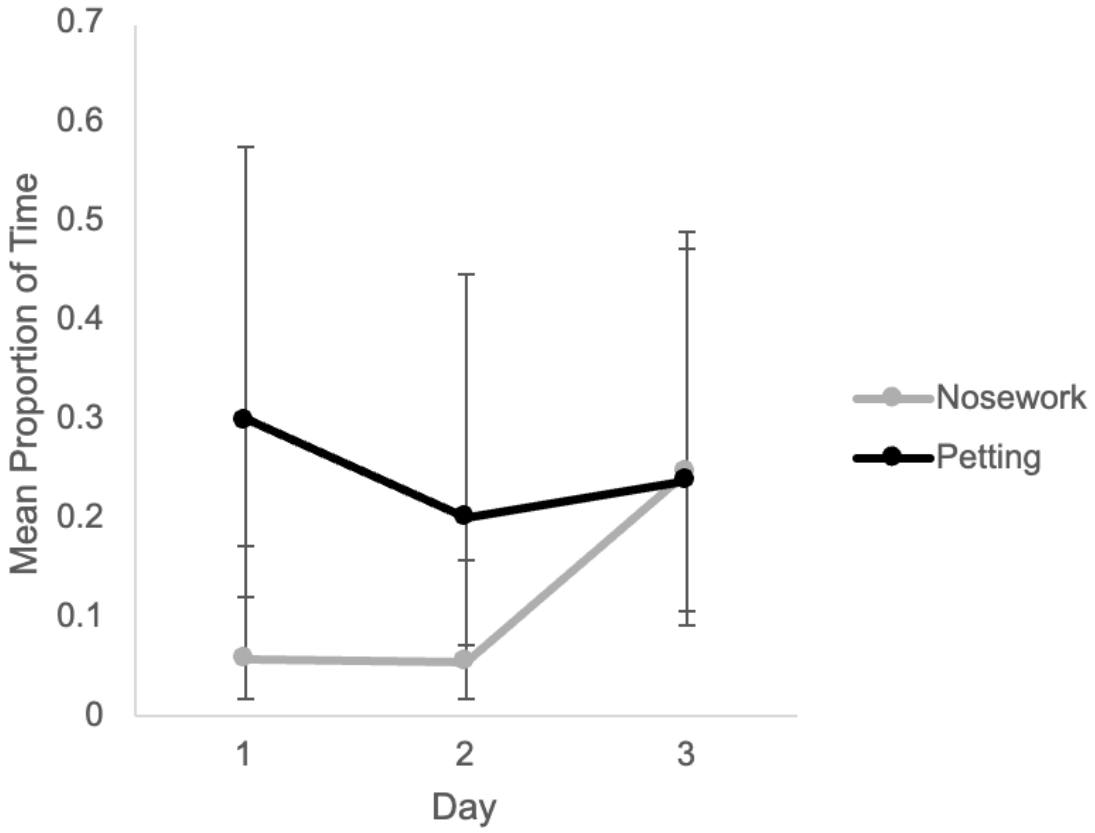
Table 5.

Mean Proportion of Time Spent Barking by Day and Intervention.

Intervention	Day	Model Estimated Mean	SE	Overall p-value: 0.00235
Petting	1	0.2999	0.1233	
	2	0.2009	0.096	
	3	0.2382	0.1035	
Nosework	1	0.0577	0.0336	
	2	0.0544	0.0311	
	3	0.2466	0.0952	

Figure 2.

Mean Proportion of Time Spent Barking by Day and Intervention.



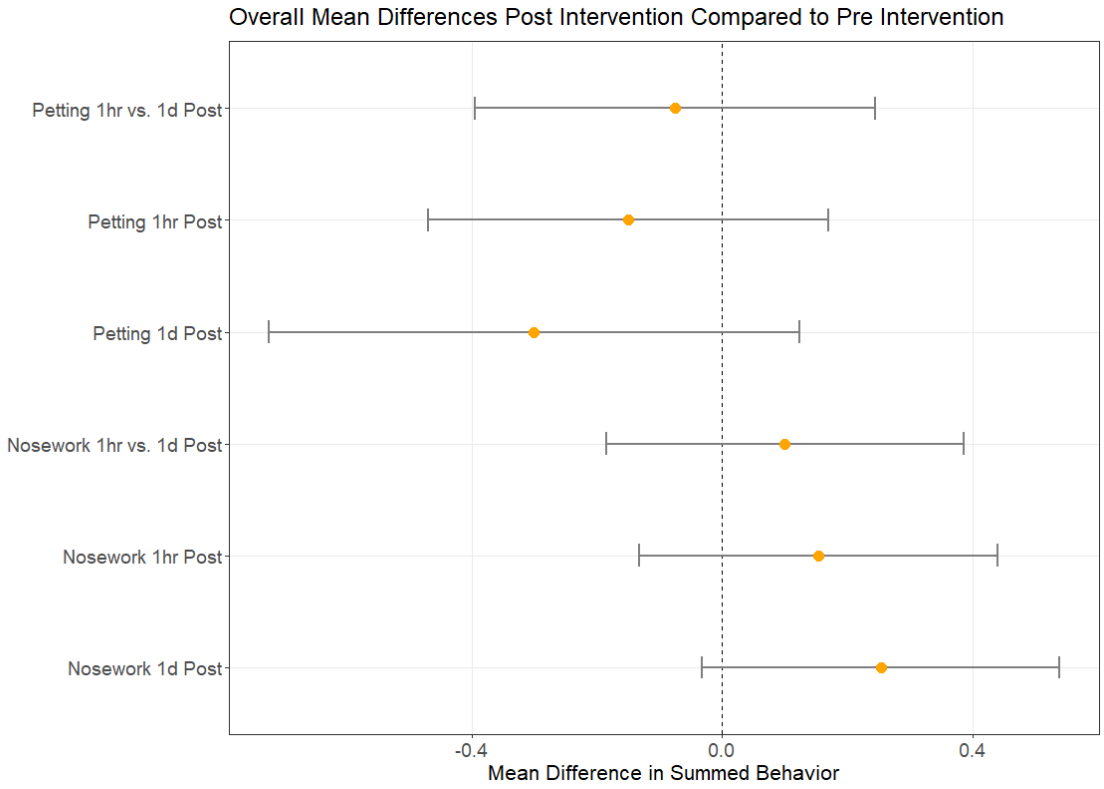
Note. This figure demonstrates error bars representing upper and lower 95% confidence limits.

3.2d Summed Behaviors

The analysis of the summated proportions produced a significant interaction effect between day and intervention. However, there were no detectable differences between relevant pairings (Figure 3). This suggests that, overall, there was no clear effect of either intervention either an hour or a day after application or between one hour and one day later.

Figure 3.

Overall Mean Differences Post Intervention Compared to Pre-Intervention



Note. A linear mixed model was fit to the sum total of each of the analyzed variables combined. The effect of intervention, day, and the interaction of the two were included as fixed effects and the individual dog was included as a random intercept. Comparisons between time points within intervention groups yielded no detectable differences, as indicated by the 95% confidence intervals. The orange center point represents the estimated difference between group means, and the bars represent the 95% confidence intervals. When a bar crosses the 0 line, this implies that there is not enough evidence to support concluding that there is a difference between the groups being compared with 95% or more confidence.

3.3 Effects of Enrichment Interventions on Shelter Dog Activity Levels

Due to circumstances beyond their control, the researchers were unable to obtain data from the Whistle activity monitors used in this study, though they hope to explore the effects of enrichment type on shelter dog activity levels in future research.

DISCUSSION

4.1 General Overview

The present study hypothesized that dogs who received nosework activities would exhibit an increase in desirable behavior and a decrease in undesirable behavior following the intervention to a greater degree than dogs who received the petting intervention. The term *undesirable* used in this context means "likely to prolong the time to adoption," as found in Protopopova et al. (2014). The hypothesis operated on the assumption that nosework activities provided a greater outlet for species typical behaviors, such as foraging, compared to petting by the researcher. Though nosework activities engaged the primary sensory modality of participant dogs, which has been thought to be important to effective enrichment interventions (Wells, 2009), the argument could be made that positive human social contact also engages species typical behaviors in domestic dogs (Udell et al., 2010). The lack of discernible differences between the intervention effects on the behavior of kenneled shelter dogs suggests that the intervention effects may be more similar than hypothesized by the researchers.

4.2 Effects of Enrichment Interventions on Shelter Dog Behavior

4.2a Jumping on Cage

Neither intervention demonstrated significant effects on the jumping on cage behavior. Olfactory enrichment studies in shelter dogs have found that certain olfactory conditions can reduce repetitive movement within the kennel, such as lavender, chamomile, vanilla, coconut,

ginger, and valerian (Graham et al., 2005; Binks et al., 2018). These studies did not isolate the jumping on cage behavior in their behavior analysis and instead analyzed locomotion more broadly, making it difficult to assess their effects on jumping behavior. Interestingly, Graham et al. (2005) found that certain olfactory conditions stimulated movement within the kennel. Rosemary and peppermint were found to encourage more standing, movement, and vocalization within the kennel, which suggests that certain olfactory conditions can have a stimulating effect on behavior. Studies that explored the effects of petting on shelter dog behavior did not analyze movement within the kennel (Shiverdecker et al., 2013; McGowan et al., 2018), so researchers cannot state if petting decreased movement within the kennel on average.

4.2b Standing

Both interventions produced an increase in standing behavior on Day 2. Standing was performed after the interventions (Day 2) for a proportion of time 1.25 times greater than the day-after (Day 3), which suggests that both interventions affected alert in-kennel behavior. Though an increase in standing behavior following enrichment could be thought to be a positive change, given that standing is the antithesis of repetitive movement within the kennel (an indicator of poor welfare and longer LOS in the shelter) (Hubrecht et al., 1992; Beerda et al., 1998; Protopopova et al., 2014), the behavior has also been found to correlate with longer LOS in the shelter (Protopopova et al., 2014).

There are no known studies that explore the effects of petting on standing behavior, however, Graham et al. (2005) found that exposure to rosemary and peppermint encouraged more standing behavior within the kennel in shelter dogs. Graham et al. concluded that some olfactory conditions could have a stimulating effect on behavior. In the present study, both interventions produced an increase in standing behavior in the kennel on Day 2, in contrast to

olfactory enrichment and petting studies that demonstrated calming effects in shelter dogs (Graham et al., 2005; Shiverdecker et al., 2013; Binks et al., 2018). The results of the present study may reflect procedural or environmental differences unique to its design.

The increase in standing behavior produced by both interventions might be attributed to unknown humans approaching the kennel becoming a discriminative stimulus for something reinforcing to the dogs (e.g., food or time outside of the kennel). Protopopova et al. (2014) found that the probability of standing behavior increased when researchers actively offered attention to kenneled dogs (bending down and speaking directly to the dog) compared to passively filming them. The current study did not offer active attention to dogs when filming, however, passive filming by the research assistant following the intervention with the researcher who offered active attention and food could have produced a more alert response to the research assistant. Carryover effects were not found on Day 3, which suggests that the increase in standing behavior found in both interventions is unique to the conditions of Day 2.

4.2c Barking

There was a significant interaction between the nosework intervention and day in regard to the proportion of time spent barking in response to an unknown person approaching the kennel. Within the nosework intervention, the proportion of time spent barking was four times greater the day after the intervention (Day 3) than the previous two days. However, the petting intervention exhibited higher percentages of barking across all days compared to the nosework intervention. Though there was a slight decrease in barking on Day 2 within the petting group, it was not statistically significant, and overall, dogs in the petting group barked more than dogs in the nosework group. The higher proportion of time spent barking in the petting group may be attributed to the lack of specificity in controlling the proportion of time spent barking in the

participation criteria (vocalization and repetitive movement within the kennel). Future research could select dogs based on their baseline barking behavior to explore the effects of the interventions with similar proportions of barking exhibited between intervention groups.

The increased proportion of time spent barking on Day 3 within the nosework group is more difficult to interpret. The effect of food on behavior was controlled between both groups, which makes the possibility of an unknown human approaching the kennel becoming a discriminative stimulus for reinforcement and producing an increase in expectant barking behavior unlikely, especially given that the proportion of time spent barking did not increase on Day 2 following the intervention. The effects of length of time outside of the kennel and time of day were also controlled between groups. There are no studies that explore the effects of canine nosework on the behavior of shelter dogs, however, other olfactory enrichment studies in shelter dogs have shown promise in decreasing the proportion of time spent barking in the kennel (Graham et al., 2005; Binks et al., 2018).

The researchers were unable to isolate uncontrolled variables that could have impacted the results, but the present data does not support that the nosework intervention itself is the cause for the increased proportion of time spent barking demonstrated on Day 3. No other behaviors demonstrated carryover effects to Day 3, which implies that the effects of the interventions are short term. These results agree with other shelter dog enrichment studies that demonstrate short-term effects of enrichment interventions (Graham et al., 2005; Shiverdecker et al., 2013; Amaya et al., 2020). Coppola et al. (2006) is the only known shelter dog enrichment study that found longer term effects from their intervention, with dogs who received human interaction sessions on the second day of being in a shelter demonstrating lower and relatively stable cortisol levels throughout the study compared to the dogs who did not receive the intervention. The lack of

carryover effects demonstrated in most shelter dog enrichment studies further strengthens the thought that the increased proportion of time spent barking on Day 3 exhibited by the nosework group dogs is not reflective of the intervention.

4.3 Limitations and Future Research

There were several limitations of this study that may have impacted the results, including number of participants, intervention length, and intervention frequency. Ideally, this study would be replicated with more participants to control for unknown variables that may have affected our small sample size. The length of the interventions (15 min) may have affected our results, though it was comparable to other studies on shelter dog enrichment (Protopopova et al., 2018; McGowan et al., 2018; Murtagh et al., 2020). It is possible that longer intervention lengths would have impacted behavior differently, however, we were mindful of the limited amount of time that shelter staff and volunteers have to dedicate to individual enrichment sessions.

The intervention frequency was a large limitation of this study. Comparable shelter dog enrichment studies have measured the effects of repetitive enrichment interventions over a period of several days, which provides more data to draw conclusions from (Bowman et al., 2017; Binks et al., 2018; Protopopova et al., 2018). The single intervention date utilized in this study was necessary due to the resources available to the research team, however, it did not provide enough data to measure beyond the potential short-term effects on behavior.

Another possible limitation of this study is habituation to shelter staff members. On Day 3, shelter staff members who did not work in the kennels participated in this study, though we cannot be sure that the dogs never observed them walk through the kennels prior to the study. We did not control for physical appearance (including sex) of the human participant on Day 3, so

it is possible that the dogs would have behaved differently if we did. Human sex remained consistent on Day 1 and Day 2 throughout the study, as the dogs were always exposed to the researcher (female) and the research assistant (male).

Future research on the effects of canine nosework on the behavior of shelter dogs should also investigate in-kennel behavior with a remote monitoring camera. The addition of a second remote camera would allow researchers to observe and code behavior that occurred during an allotted period after the intervention and compare it to the control group. The videos (30 s) recorded for the current study only provide data for a short period of time, which may miss important behaviors that occur after the intervention. Another consideration for future research on canine nosework is the inclusion of physiological measures. Previous research on stress in shelter dogs has demonstrated elevated cortisol levels in the shelter environment (Hiby et al., 2006; Stephen & Ledger, 2006), which may be a useful tool for assessing the efficacy of nosework as an intervention for stress reduction. Olfactory enrichment has shown promising results to reduce stress behaviors in shelter dogs (Graham et al., 2005; Binks et al., 2018; Amaya et al., 2020), so the physiological measurement of an olfaction-based enrichment activity may provide additional insight into its possible uses and welfare implications.

CONCLUSION

The welfare of kenneled dogs living in shelters is a major concern due to the variety of stressors they experience (Hennessy et al., 1998; Beerda et al., 2000; Wells, 2004; Taylor & Mills, 2007). Shelter enrichment programs are one way to mitigate the stressors of kenneled dogs (Wells, 2004; Herron et al., 2014; Bowman et al., 2017; Protopopova et al., 2018). The goals of enrichment include an increase in species typical behaviors, increased ability to cope with challenges, broadened behavioral repertoire, and a decrease in the frequency of maladaptive or

problem behaviors (Young, 2003), and the efficacy of an enrichment intervention may be measured by either behavioral or physiological measures. The present study found that shelter dogs exhibited three behaviors most often in response to an unknown person approaching the kennel, 1) barking, 2) standing, and 3) jumping on the kennel. The prevalence of these behaviors can encourage future exploration of enrichment interventions that decrease the proportion of time that dogs exhibit undesirable behaviors in response to people, which Protopopova et al. (2014) found to be more predictive of longer lengths of stay in the shelter.

Neither intervention had significant effects on the proportion of time that dogs spent jumping on the cage across days. Both interventions correlated with an increase in proportion of time that dogs spent standing in response to an unknown person approaching the kennel within minutes of the intervention. There was a significant interaction between intervention and day in regard to the proportion of time spent barking by nosework dogs, who exhibited increased barking behavior the day-after the intervention. More research is necessary to assess whether these results would be replicated in a larger group of participants and if they are reflective of the intervention itself. Our results indicate that there are no unique effects of nosework activities on behavior change in shelter dogs. Based on these results, positive human social contact via petting, which has already been studied in the shelter dog population, may be a more effective intervention for behavior change in shelter dogs and provide shelter staff and volunteers with an easy enrichment activity to engage dogs in.

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