

1           Are smelly toys more fun? Shelter dogs' preferences for toys, scents, and scented toys

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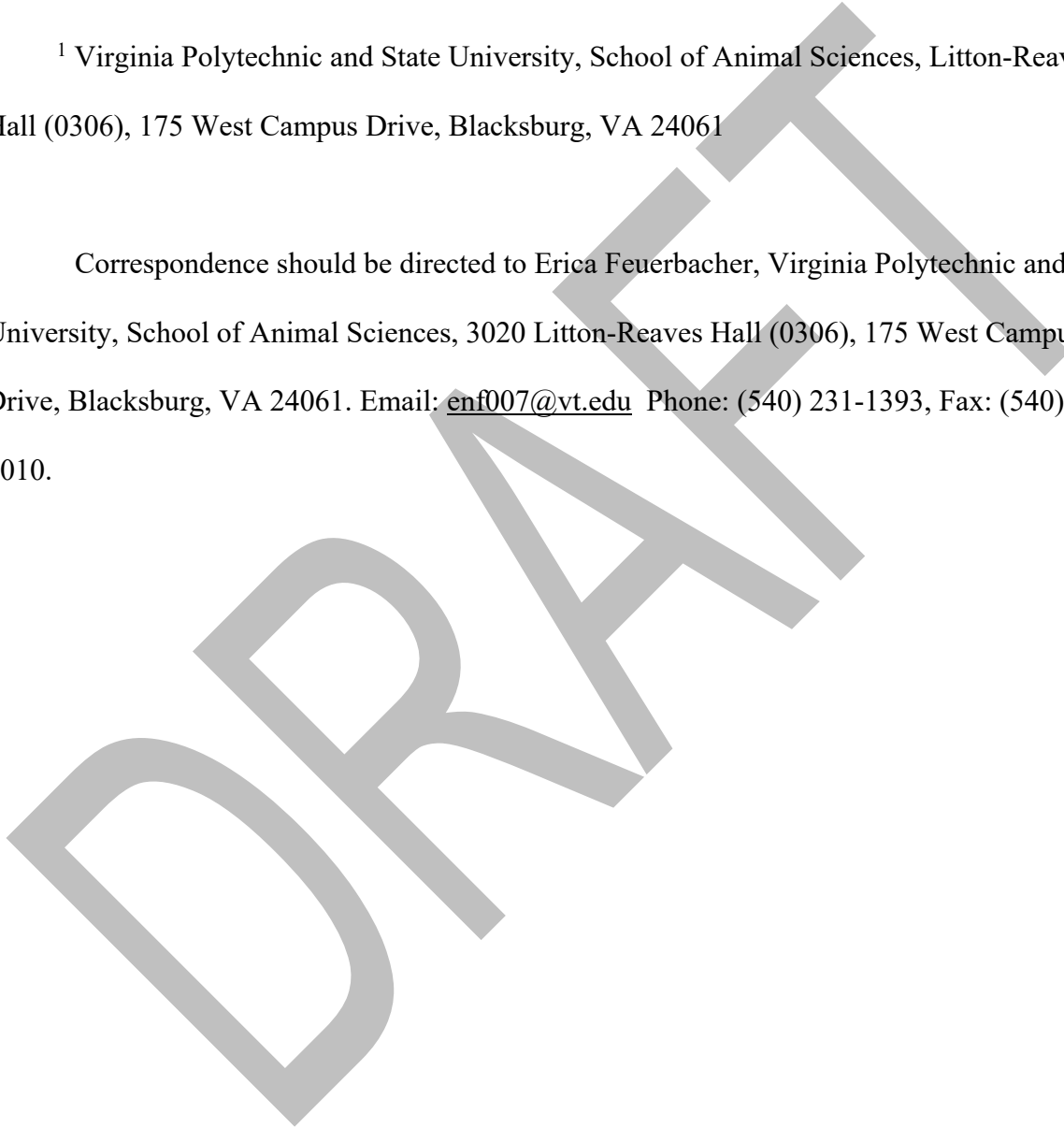
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**ABSTRACT**

As dogs reside in shelters awaiting adoption, it is critical that they remain behaviorally healthy. A variety of enrichment strategies improve the welfare of shelter dogs, including object (usually in the form of toys) and scent enrichment. However, for these interventions to be enriching, dogs must engage with the items and their welfare be positively affected. Thus, by identifying dogs' preferences, shelters can improve the function of their enrichment. Using a 15 min free operant preference assessment, an assessment in which the subject is given free access to a variety of items and the duration of their engagement with each item is recorded, we investigated 34 shelter dogs' preferences for four different toys: a stuffed toy, tennis ball, Nylabone, and flying disc. We also investigated dog' preferences for four scents: hotdog, peppermint, duck, and an unfamiliar dog. Finally, we applied the dog's preferred scent to their most and least preferred toys to investigate whether adding their preferred scent would increase the amount of time they engaged with those items compared to unscented duplicates. During the toy preference assessment, we observed that dogs, on average, only interacted with toys 3.35% of the 15 min session. However, we found that dogs engaged over eight times longer with the stuffed toy as compared to all other toys,  $F(1, 134) = 64.40, p < .001$ . There was a marginal effect of type during the scent assessment,  $F(3, 132) = 2.50, p = .062$ , but post hoc comparisons were not significant. When we applied each dog's preferred scent to their most and least preferred toys, we found statistically significant main effects for preference,  $F(1, 132) = 54.95, p < .001$ , and scent,  $F(1, 132) = 7.16, p = .008$ , and a significant preference-by-scent interaction,  $F(1, 132) = 4.66, p = .033$ . The addition of scent increased engagement with both toys, such that dogs spent 4.2 and 13.7 times more seconds with their most and least preferred toys, respectively. In addition to our results aligning with prior research demonstrating that dogs prefer soft versus hard toys, these findings

37 suggest that combining objects and scents can increase dogs' engagement with enrichment and  
38 may be especially impactful when providing shelter dogs with less preferred objects, such as  
39 hard toys.

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41 *Keywords:* Shelter dog; toy; object enrichment; scent enrichment; preference assessment

DRAFT

42 **1. Introduction**

43           Approximately 3.1 million dogs enter animal shelters each year (ASPCA, 2022). Since  
44 the 1970's, surgical sterilization (Rowan & Kartal, 2018) alongside the rise of the "no-kill"  
45 movement in the 1990's (Arluke, 2003) has led to a steady decline in the euthanasia of dogs  
46 entering animal shelters (Protopopova, 2016). A side effect of lower euthanasia rates is that  
47 many of these dogs can spend weeks, months, or even years awaiting adoption (Stephen &  
48 Ledger, 2006). With millions of homeless dogs housed in shelters for possibly prolonged periods  
49 of time, it is especially important that the welfare needs of these dogs are understood and being  
50 met.

51           Dogs living in sheltering environments may experience compromised welfare due to a  
52 variety of factors including limited space and exercise, isolation from humans and other dogs,  
53 and loss of control (for a review see, Taylor & Mills, 2007). Behavioral indicators of stress such  
54 as vocalizing (Beerda et al., 1999; Gunter, 2018), paw lifting (Beerda et al., 1997; Beerda et al.,  
55 1999; Beerda et al., 2000; Hiby et al., 2006; Rooney et al., 2007), autogrooming (Beerda et al.,  
56 1999), panting (Beerda et al., 1997; Gunter, 2018; Hiby et al., 2006; Rooney et al., 2007;  
57 Shiverdecker et al., 2013), lip-licking (Gunter, 2018; Shiverdecker et al., 2013), and stereotypic  
58 behaviors, such as wall-bouncing or pacing (Stephen & Ledger, 2005) have previously been  
59 observed in kenneled dogs. Additionally, Hiby et al. (2006) found that urinary cortisol levels in  
60 dogs surrendered to shelters by their owners continuously increased throughout their 10-day  
61 study, while Stephen & Ledger (2006) found that shelter dogs had higher cortisol levels than  
62 adopted dogs.

63           Newberry (1995) describes enrichment as a modification to the animal's environment  
64 that improves their welfare. Toys are often used as enrichment items for kenneled dogs, and can

65 provide opportunities to engage in species-specific behaviors, such as play and exploration (see  
66 Wells, 2004a for a review); yet the effectiveness of this type of enrichment has yielded different  
67 results depending on the population of dogs (Hubrecht, 1993; Murtagh et al., 2020; Pullen et al.,  
68 2010; Pullen et al., 2012; Wells, 2004b; Wells & Hepper, 2000). Hubrecht (1993) found that  
69 laboratory housed beagles spent a quarter of their time engaging with a rawhide, polymer chew,  
70 and plastic tubing, and the beagles continued to engage with these objects over the next two  
71 months. Conversely, Wells (2004b) observed that shelter-housed dogs spent less than 8% of their  
72 time engaging with various types of balls, a chew, and a rope, and their engagement decreased  
73 across the study's five-day observation period, suggesting that the dogs quickly habituated;  
74 however, the dogs were more active in their kennel, exploring and investigating, when the toys  
75 were provided.

76       Regardless of the proximal welfare effects, providing toys in kennels might improve  
77 dogs' distal welfare: Wells and Hepper (2000) found that while provision of a polymer chew had  
78 little effect on shelter dogs' proximate welfare, they were more likely to be adopted. If  
79 interactions with added objects are minimal in duration within this environment yet such  
80 interventions may affect dogs' adoption likelihood (Wells, 2004b; Wells & Hepper, 2000),  
81 investigating ways to increase object engagement could be beneficial for shelter dogs' proximate  
82 and distal welfare.

83       Wells (2009) suggested that to maximize the benefits of enrichment, provided items  
84 should target an animal's dominant sense, which for many animals is olfaction (Nielsen et al.,  
85 2015; Wells, 2009). Olfactory enrichment is relatively inexpensive and easy to implement  
86 (Nielsen et al., 2015), making it a potentially useful enrichment strategy for shelters.

87       Additionally, for dogs residing in animal shelters, the provision of scent enrichment can impact

88 their behavior (Binks et al., 2018; Graham et al., 2005). Binks et al. (2018) found that ginger,  
89 coconut, vanilla, and valerian reduced shelter dogs' vocalizations and movement in their kennels  
90 with ginger and coconut increasing their rest. Graham et al. (2005) observed that lavender and  
91 chamomile also decrease dogs' movement and vocalizations and increase rest, while rosemary  
92 and peppermint have the opposite effects on movement and vocalizations.

93         When we consider the importance of olfaction in the daily lives of dogs, it is possible that  
94 adding scents to toys may increase the salience of toys in a stimulating environment like the  
95 animal shelter. Pullen et al. (2012) found that after dogs habituated to a toy, providing them a  
96 replica of that toy, likely with a different scent profile than the original toy after playing with it,  
97 produced dishabituation. That is, dogs engaged with the new toy longer than they had engaged  
98 with the old toy during its last presentation; thus, providing the same toy with a new scent can  
99 reverse habituation. Additionally, Murtagh et al. (2020) found that shelter dogs spent more time  
100 engaging with scented versus unscented toys with the authors concluding that adding scents to  
101 toys may increase dogs' engagement and could be differentially provided based on individual  
102 preferences.

103         Preference assessments are an effective means of learning what items an individual  
104 animal prefers (Mehrkam & Dorey, 2014). One type of preference assessment, free operant, is an  
105 efficient, undemanding method (Roane et al., 1998; Sautter et al., 2008). In these assessments,  
106 the subject is given free access to a variety of items, and the duration of the subject's engagement  
107 with each item is recorded. By offering a variety of items and recording which ones an animal  
108 interacts with, caregivers can ensure that they are providing animals with enrichment items that  
109 they prefer (Fernandez et al., 2004). Previous studies have used preference assessments to  
110 investigate the effectiveness of enrichment in a variety of species, including lions (Woods et al.,

111 2020), giraffes (Fay & Miller, 2015), Galapagos tortoises (Mehrkam & Dorey, 2014), domestic  
112 cats (Shreve et al., 2017), and cotton-top tamarins (Fernandez et al., 2004). An enrichment  
113 practice based on an individual animal's preference for different items not only increases the  
114 likelihood of delivering salient stimuli, it can also ensure that an organization's economic and  
115 human resources are most effectively utilized (Hoy et al., 2010; Newberry, 1995; Tarou &  
116 Bashaw, 2007).

117 The purpose of the present study was to explore the effectiveness of scented toy  
118 enrichment with dogs in animal shelters by investigating their scent and toy preferences and  
119 examining how scents applied to these toys can affect dogs' engagement. Our investigation used  
120 free operant preference assessments to initially determine dogs' preferences for the study's four  
121 toys and four scents. We used dogs' duration of engagement with the individual scents and toys  
122 to determine each dog's most and least preferred toy and most preferred scent. We then applied  
123 the dog's most preferred scent to its most preferred and least preferred toys, along with  
124 unscented duplicates, to explore how the addition of the preferred scent affected their toy  
125 engagement.

## 126 **2. Methods**

### 127 **2.1 Setting and Subjects**

128 A total of 37 dogs housed in the kennel area of the Lewis and Clark Humane Society in  
129 Helena, Montana participated in the study. Dogs were of unknown breeds, at least 6 months old,  
130 and arrived at the shelter either as a stray or surrendered by their owner. Dogs had resided in the  
131 shelter for at least one day prior to participation in the study. Dogs were excluded if they had  
132 symptoms of an upper respiratory infection. Additionally, dogs displaying fearful or aggressive  
133 behavior (e.g., growling, cowering, baring teeth) towards humans were excluded from the study.

134 **2.2. Housing and Husbandry**

135           The kennel area consisted of two rows of seven back-to-back kennels for a total of 28  
136 kennels. Twenty kennels were small in their area (1.87 m<sup>2</sup>) and eight kennels were large (3.91  
137 m<sup>2</sup>). Each kennel had a concrete floor, three concrete walls, and a chain link gate. A drain  
138 covered with a metal grate was located in the back of each kennel. Each dog was provided with a  
139 water bucket, a plastic Kuranda bed (Glen Burnie, MD), a blanket, and toys unless staff reported  
140 that the dog was ingesting these items. If such behavior occurred, the items were no longer  
141 provided. More information on the housing and husbandry of participating dogs can be found in  
142 Supplementary Materials.

143 **2.3 Procedure**

144           The large kennels (3.91 m<sup>2</sup>) located in the kennel area of the shelter were used for this  
145 study's data collection; these were not the home kennels of any of the study's dogs, and as such,  
146 were relatively novel. Prior to these sessions, the kennel was disinfected with Rescue™ (Virox,  
147 Oakvill, ON, Canada), scrubbed, rinsed, and dried. During the preference assessments, the only  
148 objects in the kennel were two large plastic bins placed upside down over the drain and the  
149 enrichment items. Bins were placed over the drain due to observations in pilot sessions that dogs  
150 spent a large portion of their time sniffing and exploring the drain. Placing bins over the drains  
151 deterred the dogs from engaging in these behaviors and encouraged participation in the study.  
152 Shelter staff was instructed not to enter the adoption area during study sessions. Barring  
153 inclement weather, during days of data collection, testing dogs would remain in the adoption area  
154 while non-testing dogs were in their outdoor kennels per the usual husbandry schedule. If the  
155 weather was too poor for non-testing dogs to stay in outside kennels, non-testing dogs remained  
156 in the adoption area. The kennel area was not accessible to the public.

157 On Day 1, dogs participated in two free operant preference assessment sessions (Roane et  
 158 al., 1998; Sautter et al., 2008) in one of the designated testing kennels. In the Toy Assessment,  
 159 four toys, consisting of a tennis ball, Nylabone (Neptune City, NJ), West Paw flying disc  
 160 (Bozeman, MT), and stuffed toy (all approximately 0.3 m tall, with a plush textile exterior,  
 161 constructed in the shape of dog, bear, or rabbit), were arranged in a row with each item  
 162 approximately 57 cm apart on the kennel floor (Figure 1). We chose toys based on their  
 163 availability at the shelter, such that we would have duplicates for each toy, while ensuring that  
 164 the toys had a variety of stimulus features (e.g., hard vs. soft, round vs. flat), similar to the range  
 165 of toys tested by Pullen et al. (2010). Toy order presentation on the floor was randomized for  
 166 each session. Two dogs were provided with a larger ball instead of a tennis ball due to their size  
 167 and concern that they might ingest the tennis ball. New toys or toys that had been washed with  
 168 soap and water between sessions were used, and the researcher wore latex gloves when handling  
 169 them. Toys were stored in a lidded plastic tote or in sealed garbage bags when not being utilized  
 170 in the study. The researcher brought the subject dog to the gate of the testing kennel, unclipped  
 171 the leash, and then, using the dog's collar, guided it into the kennel. The researcher started a  
 172 stopwatch, began recording the session on a Lenovo ThinkPad laptop (Quarry Bay, Hong Kong),  
 173 which was placed on a chair outside the kennel, and left the kennel area. After 15 minutes, the  
 174 researcher re-entered the kennel area, opened the kennel, leashed the dog, and walked the dog to  
 175 an alternate kennel before beginning the Scent Assessment.

176 The Scent Assessment was the same as the Toy Assessment but with scented cloths  
 177 instead of toys arranged linearly as the toys shown in Figure 1. Four cloths were scented with  
 178 Remington duck (Alliance, OH), Now peppermint essential oil (Bloomingdale, OH), the scent of  
 179 an unfamiliar dog, or oil from a hotdog. Cloths were color-coded, so that each scent was

## RUNNING HEAD: SHELTER DOG TOY, SCENT, & SCENTED TOY PREFERENCES

180 distributed onto the same-colored cloth for the duration of the study: duck scent on white cloths,  
181 peppermint on green cloths, hotdog on red cloths, and dog on blue cloths. The researcher placed  
182 five drops of duck scent, peppermint, or hotdog oil, with one drop onto each corner and one onto  
183 the center of the cloth. For the unfamiliar dog scent, the cloth was rubbed down the back of an  
184 owned dog belonging to a shelter employee. The researcher wore latex gloves throughout  
185 handling. Cloths were washed with laundry detergent and bleach between sessions; and, when  
186 not in use, stored in sealed plastic bags.

187 Video recordings of assessment sessions were coded for the dog's duration of  
188 engagement with each enrichment item. Engagement was defined as the dog pawing at the item;  
189 picking up or flinging the item with its mouth; jumping or rolling on the item; or chewing,  
190 licking, shaking, sniffing, or nosing the item (Murtagh et al., 2020). If both the dog's head and  
191 the enrichment item were obscured from view, either by the dog's body or by a feature of the  
192 kennel, no engagement was recorded (this occurred in approximately 0.5% of session  
193 recordings). Each dog's duration of engagement with the toys and scents was used to determine  
194 toy-scent pairings on Day 2.

195 The procedure on Day 2 was similar to the procedure on Day 1, except that each dog was  
196 presented with two toys that were scented and two toys that were not. These unscented and  
197 scented toys were determined based on the dogs' preferences on Day 1. Scented toys were  
198 marked with a small piece of green tape to differentiate them from unscented toys. Toy 1 was the  
199 toy the dog spent the most time with. Toy 2 was a duplicate of Toy 1 except that it was paired  
200 with the scent that the dog spent the most time with. Toy 3 was the toy the dog spent the least  
201 time with; and Toy 4 was a duplicate of Toy 3 except that it was paired with the scent the dog  
202 spent the most time with. If on Day 1, a dog engaged with a toy or a scent for an equal amount of

203 time, a coin was flipped to determine which scent or toy would be used on Day 2. To apply the  
204 scent to the most and least preferred toys, we pipetted drops of hotdog oil, peppermint oil, or  
205 duck scent (depending on the dog's preference) onto the toy via pipette. Toys scented with the  
206 unfamiliar dog were rubbed down the back of a dog belonging to a shelter employee. As on Day  
207 1, Day 2 sessions were video recorded and coded for the dog's duration of engagement with each  
208 toy.

209 We tested 37 dogs, but three dogs were later excluded from the study: two dogs were  
210 adopted before participating in the scent and scented toy assessments, and one dog did not  
211 engage with any of the scents. Thus, a total of 34 dogs provided data for our analyses of the toy,  
212 scent, and scented toy assessments.

#### 213 **2.4 Statistical Analysis**

214 To better understand the amount of time dogs spent interacting with toys and scents in the  
215 three preference assessments, generalized linear mixed models were utilized throughout: one that  
216 examined time in seconds spent with the four categories of toy (i.e., tennis ball, Nylabone, West  
217 Paw flying disc, and stuffed toy), a second model for toy preference with a binary toy type  
218 variable, a third model for the four scents (i.e., duck, peppermint, unfamiliar dog, and hot dog),  
219 and a final model with dogs' most and least preferred toys, scented with their most preferred  
220 scent and unscented. In the final model, fixed effects for preference (i.e., least and most), scent  
221 (i.e., scented and unscented), and an interaction of preference-by-scent were entered. In all other  
222 models, categorical variables with either two or four levels were used to characterize the toy and  
223 scent types.

224 Because the toy and scent preference assessments occurred the day prior to the final toy  
225 and scent combination assessment, we included a main effect of preference in our final statistical

226 model in order to test whether dogs' preferences for their most and least preferred toys persisted  
227 the following day. Our scented and unscented conditions, with both toy types, provided us an  
228 opportunity to examine how the addition of dogs' most preferred scent affected time spent with  
229 their least and most preferred toys, above and beyond when these toys were unscented, as they  
230 had been previously assessed on the first day. The inclusion of an interaction term in the final  
231 statistical model allowed us to test whether the addition of a dogs' preferred scent differentially  
232 affected dogs' preference for their most and least preferred toys.

233 Independent variables and covariates were entered into our models as fixed effects and  
234 retained based on model fit with the dependent variable of time in seconds. No variables  
235 describing characteristics of the dogs (i.e., their intake type, age in months, weight in kilograms,  
236 length of stay in days) were retained in the models. Along with the models' fixed effects, we also  
237 included a random effect for dog to control for multiple observations per dog.

238 In our generalized linear mixed models, we used a negative binomial distribution, with a  
239 log link function, and a variance component covariance structure. To determine which model  
240 was a better fit for the data in each analysis, Bayesian Information Criterion (BIC) was used.  
241 When indicated, incident rate ratios (IRR) are reported with confidence intervals.

## 242 **2.5 Inter-Observer Reliability**

243 In order to calculate inter-observer reliability (IOR), 20% of dogs' assessment videos  
244 were coded by a second observer. Time spent with each object, as coded by the individual  
245 observers, was compared and considered in agreement if durations of engagement were within  
246 five seconds of one another. Upon completion of these comparisons, an overall IOR score of  
247 94% was calculated for the preference assessments used in this study.

## 248 **2.6 Ethical Approval**

249 This research project was approved by the Virginia Tech Institutional Animal Care and  
 250 Use Committee (IACUC: 22-187).

### 251 3. Results

#### 252 3.1 Dog Participants

253 A total of 37 dogs housed at the Lewis and Clark Humane Society (Helena, Montana)  
 254 participated in this study (see Table 1 for dog demographics). On average, dogs were 24.5  
 255 months of age (range: 6-120 months) and housed for at least one day at the animal shelter before  
 256 study participation ( $M = 37$  days, range: 1-161). Over half of dogs were female (56.8%) and  
 257 altered (59.5%). With regards to dogs' mode of intake into the shelter, a greater proportion of  
 258 dogs were surrendered by their owners (56.8%) as compared to arriving to the shelter as a stray  
 259 (43.2%). Estimations of dogs' breeds and breed mixes are included in Supplementary Table S1,  
 260 but breed heritage is typically difficult to assess by visual appearance alone (Gunter et al., 2018).

#### 261 3.2 Toy Assessment

262 To examine dogs' preferences for the type of toy provided during their assessment, we  
 263 analyzed the amount of time, in seconds, they spent interacting with each toy using a generalized  
 264 linear mixed model. We found that the main effect of toy type was statistically significant,  $F(3,$   
 265  $132) = 22.02, p < .001$  (Figure 2a), indicating that the amount of time dogs spent differed  
 266 between toy types. In pairwise comparisons, we found no statistically significant differences;  
 267 however, upon inspection of toy type means, we found that the time dogs spent with the tennis  
 268 ball ( $M 2.94, SE 2.28$ ), Nylabone ( $M 2.90, SE 2.25$ ) and flying disc ( $M 2.07, SE 1.62$ ) were much  
 269 more similar to each other than the stuffed toy ( $M 22.25, SE 17.16$ ).

270 Considering this and our small sample size, we carried out another generalized linear  
 271 mixed model. With this model, we collapsed toy type and created a binary variable: stuffed toy

272 and all others (i.e., tennis ball, Nylabone, and flying disc). In this analysis, we found a  
 273 statistically significant main effect for toy type,  $F(1, 134) = 64.40, p < .001$  (Figure 2b).  
 274 Specifically, we observed that the stuffed toy was the most preferred type when compared to the  
 275 combined other toy category: incident rate ratio (IRR) = 0.12, 95% CI [0.07, 0.20],  $t = -8.03, p <$   
 276  $.001$ . As such, dogs spent 8.5 times more seconds with the stuffed toy than the other toys.

### 277 3.3 Scent Assessment

278 To understand dogs' scent preferences, we analyzed the amount of time they spent  
 279 interacting with each scent using a generalized linear mixed model. We found that the main  
 280 effect of scent type was marginally significant,  $F(3, 132) = 2.50, p = .062$  (Figure 2c), but no  
 281 pairwise comparisons were statistically significant. Most notably, dogs interacted the longest  
 282 with the duck scent ( $M 2.85, SE 1.38$ ) in comparison to peppermint ( $M 1.27, SE 0.63$ ) with a  
 283 mean difference of 1.58 ( $SE 0.94$ ), 95% CI [0.07, 0.20],  $t = -1.67, p = 0.095$ .

284 While the duck scent is the most likely candidate for dogs' preferred scent as indicated by  
 285 the time spent with it in comparison to their least preferred scent (peppermint), we must also  
 286 consider the relatively short durations of time that dogs spent with each of the scents throughout  
 287 this assessment ( $M$  range: 1.27 – 2.85 seconds). While these differences might reach statistical  
 288 significance with the addition of more dogs and, thereby, provide greater statistical power, it is  
 289 unlikely that such a difference in scent preferences would be practically meaningful in this  
 290 applied setting.

### 291 3.4 Scented Toy Assessment

292 To investigate how the combination of toy preference and scent influenced dogs'  
 293 behavior, we examined the amount of time they spent interacting with their least and most  
 294 preferred toy types scented with their most preferred scent as well as when these toy types

295 remained unscented. Using a generalized linear model, we tested for an effect of preference,  
 296 scent, and a preference-by-scent interaction. We found statistically significant main effects for  
 297 preference,  $F(1, 132) = 54.95, p < .001$ , and scent,  $F(1, 132) = 7.16, p = .008$ , and a significant  
 298 preference-by-scent interaction,  $F(1, 132) = 4.66, p = .033$  (Figure 3).

299 When further describing the preference-by-scent interaction, our model predicted that the  
 300 amount of time dogs spent with their preferred toy when scented was 15.00 seconds, 95% CI  
 301 [3.04, 74.01]. When unscented, the preferred toy predicted time of engaged was 13.02 seconds,  
 302 95% CI [2.64, 64.26]. Conversely, the predicted length of time for their scented least preferred  
 303 toy was 3.56 seconds, 95% CI [0.72, 17.72], and 0.95 seconds, 95% CI [0.19, 4.86] when  
 304 unscented.

305 This results in an interaction IRR of 0.31 ( $t = -2.16, p = 0.033, 95\% \text{ CI } [0.10, 0.91]$ ) when  
 306 we compare the IRRs of the most preferred to the least preferred toys, scented and unscented. As  
 307 such, dogs' interaction time was 13.7 times greater when their least preferred toy was scented  
 308 versus when it was unscented. In comparison, the time spent with the scented preferred toy was  
 309 4.2 times greater than the time spent with the unscented preferred toy. Thus, our findings indicate  
 310 that the provision of a scent is most impactful when the toy is not preferred by the dog, and  
 311 scenting the toy can extend the amount of time the dog spends with it.

#### 312 **4. Discussion**

313 In this study, we utilized free operant preference assessments to investigate toy and scent  
 314 preference in shelter dogs. Overall, we found shelter dogs preferred plush toys; they engaged for  
 315 significantly longer periods of time with them compared to all other enrichment items combined  
 316 (i.e., tennis ball, a rubber disc, and a Nylabone). Dogs' scent preferences varied more widely,  
 317 though, and there was no significant difference in time spent engaging with those that were

318 provided. Nevertheless, we found that adding the dog's preferred scent to its most and least  
319 preferred items increased toy engagement, with a larger effect on the dog's least preferred toy.

320 On average, dogs spent less than 4% of their 15-minute session interacting with toys  
321 during their first preference assessment. These results are similar to those of previous studies.  
322 Wells (2004b) found that dogs engaged with toys in their kennel in only 8% of observation  
323 periods which were longer in duration. Similarly, Pullen et al. (2010) reported that shelter dogs  
324 interacted with robust toys for a median of 0 s during a 15 min experimental session, and most  
325 dogs ignored a KONG toy for the first five minutes when it was provided in their kennel (Wells  
326 & Hepper, 1992).

327 We found fairly consistent preferences for toy type across dogs; dogs engaged with the  
328 stuffed toy eight times longer than the mean time they engaged with the other three toys. These  
329 results are similar to the findings of Pullen et al. (2010) in which they found that shelter dogs  
330 spent significantly more time engaging with less robust toys (i.e., plush teddy bears) than robust  
331 ones (i.e., rubber tugs). In our study, dogs interacted with the stuffed toy for an average of 22.25  
332 seconds. Likewise, Pullen et al. (2010) observed that the greatest median time of toy engagement  
333 in their study, 13.3 s out of a 15 min session, was seen with a less robust toy. Murtagh et al.  
334 (2020) found slightly longer interaction times, on average, than we or Pullen et al. (2010) did,  
335 but interaction durations were still relatively short when not scented: dogs spent less than one  
336 minute during a 20 min session interacting with any one of three unscented toys.

337 Although dogs engaged with the toys for a relatively short duration of time in our study, a  
338 high percentage of dogs interacted with the enrichment items. No dogs were excluded from the  
339 study for not engaging with at least one toy, and only one dog was excluded for not engaging  
340 with at least one scent. Additionally, when we consider the percentage of participating dogs that

341 engaged for at least 1 s with the items, 100% of dogs engaged with at least one toy, 97% of dogs  
342 engaged with at least one scent, and 97% of dogs engaged with at least one of the scented or  
343 unscented versions of their preferred and least preferred toys.

344 Shelters often opt for easy-to-clean and difficult-to-destroy toys for object enrichment  
345 (Bayne, 2003). Our study along with those by Pullen et al. (2010), Hubrecht (1993), and Wells  
346 (2004b) have found that dogs spend the most time engaging with destructible toys. If the goal of  
347 affording shelter dogs toys is about enriching their lives, the published literature, ours included,  
348 indicates that we should be providing stuffed toys. Of course, an individual dog's history of  
349 consuming such toys should be considered when determining what types of enrichment should  
350 be offered in a shelter environment that often allows for minimal supervision (Gunter &  
351 Feuerbacher, 2022). Of practical importance, although a number of dogs destroyed the stuffed  
352 toy in our study, none of them ingested it, indicating that while dogs are likely to destroy these  
353 items, ingestion will likely be rare. As such, we can use observations and known history of  
354 consuming toys to determine if an individual dog should not receive a stuffed toy, rather than  
355 making population-level decisions that no dogs can receive these items. Stuffed toys can also be  
356 kept with the individual dog to reduce additional concerns about cleaning and disease spread.

357 We found no significant differences of duration of engagement between the scents,  
358 suggesting that dogs might have more individualized scent preferences as compared to their  
359 preferences for toys. Murtagh et al. (2020) found that overall shelter dogs did not have a  
360 preference between lavender and rabbit scents, which aligns with our results and suggests that  
361 scent preference for shelter dogs may be based on the novelty of the scent and not on the scent's  
362 evolutionary relevance. When we applied dogs' preferred scents to toys, we found that they spent  
363 significantly more time engaging with both their most preferred and least preferred toys when

364 these toys were combined with their preferred scent. This effect was especially large for the least  
365 preferred toy, with the addition of the preferred scent increasing interaction time by nearly 14  
366 times compared to that of the unscented toy. These results are in agreement with the findings of  
367 Murtagh et al. (2020) who also found that shelter dogs spent more time engaging with scented  
368 versus unscented toys.

369 Because we and Murtagh et al. (2020) found no evidence of scent preferences, or even  
370 categories of scents (e.g., biologically relevant), our results and theirs suggest that the addition of  
371 any novel scent to a toy could be useful to increase shelter dogs' engagement with toys.  
372 Importantly, if shelters are restricted to using less preferred items, either at a population level or  
373 for an individual dog, adding a scent could be especially useful to increase engagement with less  
374 preferred items and increase their utility as an intervention that improves shelter dogs' proximate  
375 welfare. Additionally, shelters can use more scents than just those that are biologically relevant;  
376 however, the safety of selected odors should be considered prior to implementation (Gunter &  
377 Feuerbacher, 2022).

378 As enrichment is defined in part by the animal's engagement with the item (Dawkins,  
379 2017), finding strategies to reduce habituation over repeated presentations is essential. Wells  
380 (2004b) found that dogs engaged with toys significantly less on days 3 and 5 compared to day 1,  
381 suggesting that within days dogs habituated to the toy's presence, diminishing its enriching  
382 effects. On Day 2 of this study, we observed a reduction in the number of dogs engaged with the  
383 items: 20.6% of dogs did not engage with their preferred unscented toy, 11.8% of dogs did not  
384 engage with their preferred scented toy, 47.1% of dogs did not engage with their least preferred  
385 unscented toy, and 23.5% of dogs did not engage with their least preferred scented toy.

386           Nevertheless, we found that on Day 2, dogs continued to spend more time engaging with  
 387 their preferred toy than their least preferred toy, indicating that individual preferences appear to  
 388 be somewhat stable from one day to another. Previous research by Wells (2004b) indicated that  
 389 dogs are slower to habituate to toys that they prefer, and our observations here would align with  
 390 that finding. The addition of scents on toys might also help prevent habituation. We found that  
 391 dogs spent significantly more time engaging with scented toys than unscented toys on Day 2.  
 392 Similarly, Pullen et al. (2012) found that dogs lost interest in the same toy after several  
 393 presentations, but regained interest if the toy looked or smelled differently (Pullen et al., 2012).  
 394 Additionally, Wells and Egli (2004) recommend rotating between a variety of scents or offering  
 395 scents occasionally to decrease the likelihood of habituation. A direction for future research  
 396 might be exploring what parameters of toys, scents, and their combinations lend themselves to  
 397 the most engagement by shelter dogs, thereby increasing their enriching properties.

398           In the current study, a number of variables might have impacted the dog's engagement  
 399 with the offered enrichment items. Although the kennel area of the shelter where the study was  
 400 conducted was closed to the public during data collection, staff and volunteers were occasionally  
 401 present in the area, which may have altered dogs' attention or interaction with the enrichment  
 402 items. Second, although care was taken to prevent scent contamination, it is impossible to  
 403 remove all other scents from the environment. For example, when sniffing the cloth, a dog could  
 404 have been engaging with the scent of the fabric or the scent of the detergent used to wash the  
 405 cloth and not with the scent under investigation. Although these variables may have impacted  
 406 duration of engagement, the purpose of this study was to investigate scented toy enrichment in a  
 407 naturalistic environment. Conducting this study in situ, despite the possible influence of these  
 408 and likely other variables, allows our findings to be more easily applied to the shelter setting.

409 Overall, this study points to dogs' preferences for stuffed toys and highlights an  
 410 imperative for shelters to find ways to safely provide dogs with those types of toys. Additionally,  
 411 while we observed individual differences between scents, the addition of a preferred scent to a  
 412 non- preferred toy, will likely increase its salience for the dog, engagement, and improve its  
 413 function as an enrichment item. Our study also corroborates the use of free operant preference  
 414 assessments of toys and scents as an effective way to determine individual preferences. In order  
 415 for enrichment programs to be successful, the animal must not only engage with the provided  
 416 items in such ways that improve its welfare, but the program must be time efficient and cost  
 417 effective to implement (Hoy et al., 2010; Tarou & Bashaw, 2007). The same requirements of  
 418 enrichment and programmatic ease and affordability apply to the animal shelter. The free operant  
 419 preference assessments used in this study were relatively time efficient (15 min) but could be  
 420 shortened as most dogs engaged with the enrichment items at the beginning of each assessment.  
 421 The assessments used in this study were also economical as they utilized donated toys and  
 422 donated or found scents.

423 Finally, a number of future research directions present themselves from our results,  
 424 including: 1) investigating the use of scented toys as enrichment items on physiological welfare  
 425 measures, such as cortisol, which is elevated in shelter-living dogs (Hiby et al., 2006; Stephen &  
 426 Ledger, 2006); 2) whether the use of toys, scents, or their combination impacts adoption  
 427 likelihood as has been found in other studies (Binks et al., 2018; Graham et al., 2005; Wells &  
 428 Hepper, 2000); and 3) whether providing dogs with preferred toys, scents, or their combination  
 429 might improve behavior, similar to the results of Binks et al. (2018), or increase species-specific  
 430 behaviors (Mellen & MacPhee, 2001) and discourage animals from engaging in abnormal  
 431 behaviors (Murtagh et al., 2020). This could be accomplished by measuring more behaviors than

432 just engagement with the enrichment. In general, more research is needed to determine how toys  
433 and scents in combination may affect both dog's proximate and distal welfare in the shelter.

434

435 **CRedit authorship contribution statement**

436 **Skyler Howard:** Conceptualization, methodology, formal analysis, investigation,  
437 resources, data curation, writing - original draft, writing - review & editing, visualization. **Lisa**  
438 **M. Gunter:** Methodology, formal analysis, writing - review & editing, visualization,  
439 supervision. **Erica N. Feuerbacher:** Methodology, writing - review & editing, visualization,  
440 supervision.

441

442 **Declaration of competing interest**

443 None of the authors has any financial or personal relationships that could inappropriately  
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445

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449

450

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DRAFT

575 **Figures**

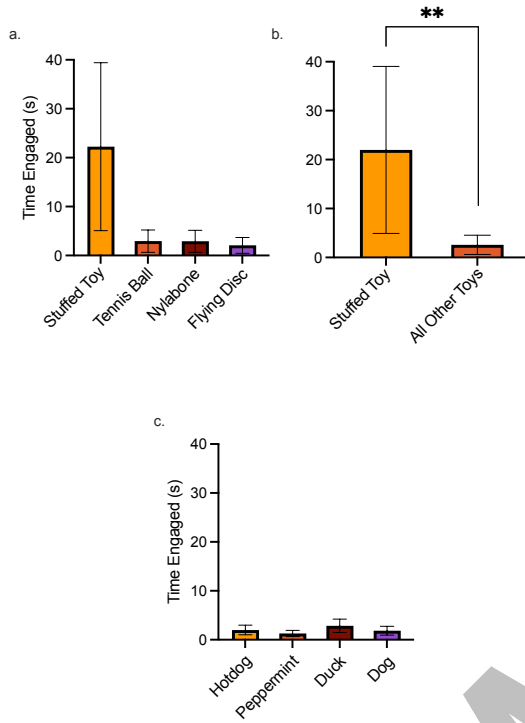


576

577 Figure 1. Kennel arrangement for the preference assessments. Shown are the toys; the cloths with

578 scents on them were arranged similarly.

# RUNNING HEAD: SHELTER DOG TOY, SCENT, & SCENTED TOY PREFERENCES



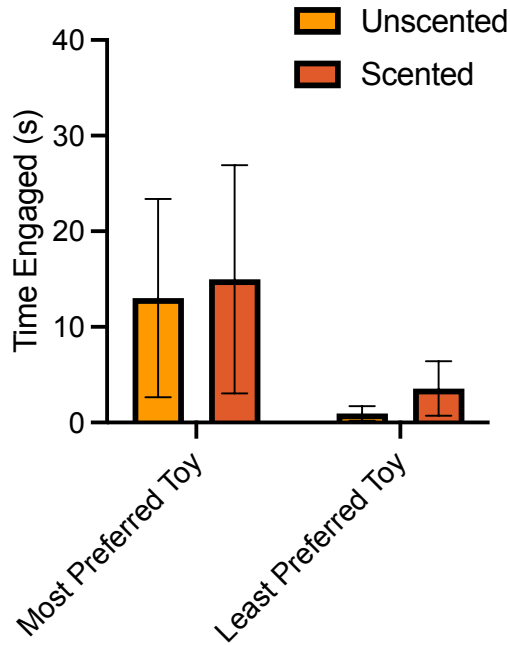
579

580 Figure 2. Estimated marginal means (bar) and standard errors (whiskers) of time engaged with *a.*

581 toys, *b.* toys grouped by stuffed toy and all others, and *c.* scents. \*\*  $p < .01$

582

583



584

585 Figure 3. Estimated marginal means (bar) and standard errors (whiskers) of time engaged with  
586 the most preferred and least preferred toys when unscented or scented. We found statistically  
587 significant main effects for preference,  $p < .001$ , and scent  $p < .01$ , and a significant preference-  
588 by-scent interaction,  $p < .05$ .