

1 The role of environmental and owner-provided consequences in canine stereotypy and  
2 compulsive behavior

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14 Abstract

15 The present study evaluated whether environmental variables can reinforce and  
16 maintain canine stereotypic behavior and whether the removal of these variables can  
17 reduce the rate of the behavior. We first present an online survey in which owners were  
18 asked to report the environmental antecedent and consequent events related to stereotypy  
19 in their dogs. The survey results indicated that stereotypy, as reported by the owners, was  
20 not restricted to specific antecedents, and Principal Component Analysis identified four  
21 ways the owners usually responded to stereotypy. In a case study of 5 dogs, Functional  
22 Analysis methodology was used to evaluate whether environmental or owner-provided  
23 consequences maintained stereotypic behavior. We demonstrate that owner-provided  
24 consequences maintained circling and licking in two of the dogs, light-movement alone  
25 maintained light chasing in two of the dogs, and one dog showed little to no responding  
26 during sessions preventing further analysis. We subsequently manipulated the  
27 consequences of stereotypy found to maintain the behavior for three of the case study  
28 dogs, which led to a reduction in stereotypic behavior for all three dogs. The present  
29 study provides evidence that the consequences of stereotypy, such as attention from the  
30 owner, can reinforce and maintain high rates of the behavior. Our results also suggest that  
31 the specific owner-dog dynamic might be an important influence on canine stereotypy.  
32 We also show that manipulating the relevant reinforcer found to maintain stereotypy  
33 leads to a reduction in the problematic behavior.

34 **Keywords: Canine; Domestic dogs; Stereotypy; Stereotypic behavior**

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37 Canine Compulsive Disorder (CCD) is diagnosed when dogs present with a  
38 variety of stereotypic behaviors including but not limited to: repetitive licking or flank-  
39 sucking, tail-chasing or spinning, light or shadow chasing, fly-biting at no apparent fly, or  
40 extended fixation or staring (Luescher, 2000; Overall & Dunham, 2002). Stereotypic  
41 behaviors are typically defined as repetitive behaviors that appear to serve no obvious  
42 function (for a review of terminology see Low, 2003). These behaviors can range from a  
43 mild annoyance to owners to severe behavioral problems requiring veterinary  
44 intervention (Luescher, 2000). The focus of the present study is on the readily observable  
45 stereotypic behavior associated with Canine Compulsive Disorder.

46 Several studies have found that in combination with behavioral modification,  
47 pharmaceuticals can reduce stereotypy (Overall & Dunham, 2002; Seksel & Lindeman,  
48 2001; Veremie et al., 2010). Although stereotypy can be reduced pharmacologically, the  
49 etiology and motivation of canine stereotypic behavior remains unclear. Exploring the  
50 environmental conditions which may motivate and exacerbate canine stereotypic  
51 behavior may enable improved forms of treatment.

52 Several hypotheses have been proposed to explain canine stereotypy. One  
53 hypothesis is that canine stereotypy is the result of frustration or conflict generalizing to  
54 situations where conflict is no longer apparent or appropriate (Overall & Dunham, 2002).  
55 This hypothesis provides a plausible explanation for the development of canine  
56 stereotypy; however, it remains unclear what exact mechanism leads to the conflict and  
57 frustrations generalizing to other situations, which thereby maintain canine stereotypic  
58 behavior.

59 An alternative account for canine stereotypy is that underlying biological  
60 differences separate dogs with stereotypy from normal dogs. Dodman et al. (2010)  
61 identified a candidate gene associated with compulsive behavior in Doberman pinschers  
62 (CDH2; for a review see Hall and Wynne, 2012). Tiira et al. (2012) attempted to extend  
63 this finding in a population of Bull terriers, Staffordshire Bull Terriers, and German  
64 Shepherds but found no significant genetic associations with tail-chasing using candidate  
65 gene analysis with CDH2. Instead, they found a significant effect of vitamin intake: dogs  
66 that took a multivitamin were significantly less likely to develop tail-chasing. Additional  
67 study with Doberman pinschers has shown that dogs with CCD have structural brain  
68 differences from control dogs (Ogata et al., 2013). In addition, dogs with stereotypic  
69 behavior were shown to be, in general, more perseverative on an arbitrary task than dogs  
70 that do not show stereotypic behavior (Protopopova et al., 2014). Together, there is  
71 growing evidence for a genetic contribution to canine stereotypic behavior; however, no  
72 clear biological mechanism has been identified. More recent research investigating  
73 excessive licking has suggested that many such cases may be caused by undiagnosed  
74 digestive issues (Bécuwe-Bonnet et al., 2012). These results suggest there are likely  
75 biological contributions to canine stereotypic behavior but leave open the question  
76 whether environmental factors may also play a causal role in the development and or  
77 maintenance of canine stereotypic behavior.

78 Few studies have investigated the potential influence of environmental variables  
79 on stereotypic behavior, although such a role is often assumed when behavior  
80 modification is recommended to help reduce stereotypies. Behavior modification can  
81 only work if the behavior is sensitive to environmental factors. One notable study

82 exploring the potential role of environmental factors analyzed 400 videos of tail-chasing  
83 in dogs (Burn, 2011). The author reported that owner encouragement of the dog was  
84 observed in 43% of the videos and one of the most common descriptors of the behavior  
85 by owners was ‘funny’ (46%). These results suggest that humans may intentionally or  
86 unintentionally reinforce the behavior with attention and that changes in the owner’s  
87 behavior might reduce the dog’s stereotypy.

88           Empirically assessing whether laughter and encouragement might actually  
89 reinforce tail-chasing, as suggested by Burn (2011), requires additional evidence.  
90 Although people may provide attention contingent on tail-chasing, this may have little or  
91 no effect on the dog’s behavior. In order to assess the effects of human attention on  
92 stereotypic behavior, we must determine whether the attention serves as its maintaining  
93 reinforcer. Researchers working with humans with diverse developmental disabilities  
94 have pioneered a single-subject methodology to assess the environmental variables that  
95 reinforce an individual’s problem behavior. This method, termed “Functional Analysis,”  
96 was first reported by Iwata et al. in 1982 (re-printed in 1994a) and has been successful in  
97 identifying the environmental determinants of behavior in many cases (1994b) and cited  
98 in over 1200 publications in Google scholar. This technique has recently been extended  
99 to identify the reinforcers of problem behaviors in animal in zoos (Dorey et al., 2009;  
100 Martin et al., 2011), and unwanted jumping up in pet dogs (Dorey et al., 2012).

101           Functional Analysis was designed to identify how the consequences of problem  
102 behavior may influence the rates of that behavior. Reinforcers, for the purpose of this  
103 study, are any environmental stimuli that when presented as a consequence of a behavior,  
104 lead to increased rates of that behavior. To identify these reinforcers with a Functional

105 Analysis, a single subject is exposed to several conditions. Each condition tests whether a  
106 putative reinforcer sustains a problem behavior or is unrelated to the rates of occurrence  
107 of that behavior. This is tested by delivering the putative reinforcer whenever the problem  
108 behavior occurs during the session. If delivering the putative reinforcer increases the rate  
109 of the behavior compared to a control condition, the consequence is confirmed as a  
110 reinforcer for the behavior. If, however, experimentally delivering a putative reinforcer  
111 when the problem behavior occurs does not increase rates of the behavior compared to a  
112 control condition, the putative reinforcer is considered not to be a reinforcer of the  
113 behavior. The control condition for a Functional Analysis is designed so that all putative  
114 reinforcers are delivered regardless of the occurrences of problem behavior. Thus, low  
115 rates of problem behavior are expected in the control condition because reinforcers are  
116 delivered without the subject needing to engage in problem behavior.

117 The aim of this set of studies is to evaluate the impact of environmental variables  
118 on canine stereotypic behavior. In the first study, we utilized a survey to assess owner-  
119 reported antecedents (events preceding a behavior) and consequences of stereotypic  
120 behavior in pet dogs. We then in Study 2 utilized a single-subject assessment of  
121 reinforcers, a Functional Analysis, with five dogs to assess whether and which  
122 environmental variables maintain canine stereotypic behavior. Last, in Study 3, we  
123 manipulated the environmental variable found to reinforce behavior from the Functional  
124 Analysis in Study 2 for each dog, in an attempt to reduce canine stereotypic behavior.

### 125 **Study 1**

126 The aim of Study 1 was to identify owner-reported antecedent events to  
127 stereotypy and owner-reported responses to their dog's stereotypic behavior with a brief

128 survey. Thus, this experiment was exploratory and cannot be taken to identify valid  
129 predictor variables of stereotypy – only owner impressions.

130

### **Materials and Methods**

131 A custom survey was created using Google docs ([www.docs.google.com](http://www.docs.google.com), see  
132 Appendix A for the complete survey). Dog owners answered basic questions about their  
133 dog followed by questions on whether it engaged in stereotypic behaviors. These  
134 behaviors were described as follows: “spinning” or “circling” was defined as “repeated  
135 turning (4 or more times in single bout) when the dog is not trained or commanded to do  
136 so or there was no apparent reason for the activity; “fixation” was defined as an excessive  
137 attention to an item or no apparent specific item; “light chasing” was defined as an  
138 intense focus or chasing of lights to which most dogs would not usually attend; “licking”  
139 was defined as the licking of objects for extended bouts with no obvious purpose or  
140 function, and “other” invited owners to report any other problem behaviors that were  
141 repeated at least four times in a single bout. Finally owners were asked to report on the  
142 conditions under which the behavior occurred and how they responded to it.

143 Owners were given multiple-choice options (they could select more than one),  
144 and an optional fill in box. To assess antecedent events that may lead to stereotypy,  
145 owners were asked to indicate under which conditions stereotypy occurred: “only when  
146 crated, and never under other conditions,” “when there is a lack of stimulation (i.e.  
147 bored). This can include when being crated but is not limited to crating,” “when I give  
148 lots of attention,” “after or during play,” “after I give a command,” “when I have  
149 something my dog wants (e.g. a toy or food),” “following a loud noise or after being  
150 startled,” “when stressed or anxious,” “under all conditions and/or does not seem

151 predictable,” and “other” with a textbox for an open-ended answer. To assess owner-  
152 reported consequent events that may reinforce stereotypy, owners were asked how they  
153 usually respond to stereotypic behavior and given the following options: “I give my dog  
154 attention,” “I try to block the repetitive behavior (e.g. prevent them from circling or  
155 engaging in repetitions),” “give the dog desired objects like toys or food,” “if the dog is  
156 in a crate, I let it out,” “ I tell the dog to stop,” “ I do nothing and ignore the behavior,”  
157 and “other” with a textbox.

158         The initial survey was administered online to the senior author, a veterinarian, and  
159 two dog owners (one with a dog with stereotypic behavior). Appropriate clarifications  
160 and changes were made. The survey was then distributed through websites  
161 (www.caninecognition.com), social-networking sites (Facebook), online dog related  
162 forums (e.g. Rottweileronline.net), and via email.

### 163 *Subjects*

164         A total of 128 responses were received. Of the 128 responses, 99 responses were  
165 included in the analysis. Twenty-nine responses were excluded as the owners responded  
166 that their dogs did not engage in stereotypy. Owners of various breeds and mixed breeds  
167 responded to the survey, with a majority of responses pertaining to sporting, working and  
168 herding breeds.

### 169 *Analysis*

170         Data are presented as the percentage of owners reporting for that question along  
171 with sample sizes. Only the results for questions which at least fifty owners provided  
172 interpretable responses are described. Given the exploratory nature of the survey, null  
173 hypothesis significance testing was not appropriate. To identify patterns in how owners

174 respond to their dog's behavior, an exploratory Principal Component Analysis (PCA)  
175 with a varimax rotation was performed in the statistical package SPSS® (International  
176 Business Machines Corp., Armonk, NY, USA). Factor loadings greater than .4 were  
177 considered meaningful for this analysis.

178

179

## **Results and Discussion**

180 *Sample demographics*

181 Of the 99 responses, forty percent of owners reported their dog to spin or circle,  
182 46% to repetitively lick, 18% to light chase, 47% to fixate, 19% to engage in other  
183 stereotypic activities, and 45% to engage in more than one form of stereotypy. Thirty-  
184 three percent of the sample reported seeking professional help for the stereotypy  
185 (veterinarian or behaviorist), with 21% of the sample reporting their dogs self-injured.

186 Figure 1 shows owner-reported frequency of their dog's stereotypic behavior. The  
187 reported frequency is summarized as monthly, weekly (occurring between 1-6 times per  
188 week), low daily (once or twice per day), and high daily (three or more times per day).  
189 Except for light chasing, all distributions of the frequency of behavior are skewed with a  
190 majority of owners reporting the behavior occurring more than three times daily. Light  
191 chasing is the exception with a large percentage of dogs engaging in the behavior only  
192 monthly.

193

194 *Environmental Antecedents*

195 Table 1 outlines the percentage of owners reporting each antecedent event that led  
196 to stereotypy for the four major classes of behavior surveyed. Interestingly, the dog

197 being “stressed” was reported as the major antecedent for circling in 34% of the cases.  
198 “Stressed” was reported as an antecedent for the remaining three stereotypies by 0 to 15  
199 % of the dog owners. It should be noted, however, that the dog’s state of “stress” may  
200 not have been accurately identified by the owners leading to a potential underreporting of  
201 stress as an antecedent. Light chasing was most often reported as being unpredictable or  
202 occurring under any situation by 64% of the respondents. Forty percent of owners with  
203 dogs that licked reported that beginning or finishing play was an antecedent. Fixation was  
204 reported most often when the owner had something desirable and during the  
205 commencement or termination of play.

206 Overall, commencement and termination of play, lack of stimulation, and  
207 “unpredictable” were the most frequently reported antecedents to stereotypy. Together,  
208 the results suggest that stereotypy in our sample is not limited to conditions of  
209 deprivation (i.e. lack of stimulation) but also occurs at high rates under conditions of  
210 enrichment (e.g. before and after play or when giving attention). This suggests that in the  
211 population we surveyed, stereotypy may not simply be a response to deprivation, but  
212 rather that stereotypy can be controlled by various antecedent events in different dogs.

213

#### 214 *Environmental Consequences*

215 A total of 83 owners reported their response to their dog’s stereotypy (Figure 2).  
216 Of the 83 owners reporting, the most common response was to tell the dog to “stop”  
217 (50.6%), followed by ignoring the dog (48.2%), and blocking or preventing the dog from  
218 engaging in stereotypy (44.6%: percentages do not sum to 100 because of the possibility  
219 of multiple responses). Other responses included giving their dog a desired object (26%

220 of the 83 owners) or attention (24% of the 83 owners). Several owners provided other  
221 responses. The three most common responses were coded and are shown in Figure 2.  
222 Giving their dog a command to do something else was reported by 10.8% of the 83  
223 owners responding to this question. A small percentage of owners (4.8%) reported  
224 distracting their dog, but not explicitly giving it a command to do something else. Some  
225 owners reported removing an item related to the stereotype (3.6%). After removing these  
226 responses from “other,” only one response remained unclassified. This owner responded  
227 that he used DogLeggs™, which could be considered a form of response blocking.

228         Several owners indicated responding to their dog’s stereotype in multiple ways.  
229 To uncover whether there were systematic patterns of responding, an initial PCA with a  
230 direct oblimin rotation was performed. The “other” category was removed as it contained  
231 only one response. Four components with eigenvalues greater than one were obtained.  
232 We therefore re-ran the PCA, this time restricting the analysis to only these four  
233 components. The component correlation matrix showed little correlation among  
234 components (all correlations < .2), indicating that an orthogonal rotation was appropriate  
235 (Brown, 2009). A final PCA was performed with a varimax rotation to provide  
236 orthogonal components, which is shown in Table 2. Component loadings greater than .4  
237 are in bold.

238         Four components were identified. The first component consisted of the owner  
239 ignoring the dog, and giving the dog attention. Although attending and not attending to  
240 the dog simultaneously is impossible, an owner may ignore the dog on some occasions  
241 and give the dog attention on others. This could create an intermittent schedule of  
242 reinforcement with attention for stereotypy. Component 2 consisted of saying, “stop”

243 and attempting to block the dog from the behavior, showing that use of verbal reprimands  
244 and physical prevention of the stereotypy were associated. Although responding to  
245 stereotypy in this way may immediately terminate the behavior and give the owners the  
246 impression they have punished the behavior, telling the dog to “stop” or physically  
247 holding the dog may have an unintended consequence of increasing stereotypic behavior.  
248 One possible mechanism for this increase would be that the owner’s attempts to suppress  
249 stereotypy may unintentionally lead to anxiety, which may occasion more stereotypic  
250 behavior. An alternative mechanism for this increase is that the owners’ attempts to stop  
251 the behavior may unintentionally reinforce the stereotypy with attention. Thus,  
252 Component 2 may reinforce the dog with attention the owner believes is “negative”  
253 (“stop!”) and Component 1 may reinforce dogs with positive attention on an intermittent  
254 schedule. Component 3 showed highest positive loadings for giving a desirable object  
255 and highest negative loadings for taking objects away. This component appears to have  
256 highest loading for whether an owner manipulates the dog’s environment by adding or  
257 subtracting items. Component 4 shows highest loadings for the owner distracting the dog  
258 or giving the dog a command. Owners may respond to stereotypy in both of these ways to  
259 “re-direct” the behavior either by giving a command to do something else, or by trying to  
260 distract the dog.

261           Together these results indicate that owners report that stereotypy in our sample of  
262 dogs occurs under a variety of antecedent circumstances, ranging from playing and  
263 giving the dog attention to boredom. Thus, stereotypy does not appear to be constrained  
264 to any particular situation. Some stereotypies, however, did have more common

265 antecedents than others. For example, “being stressed” was only a common antecedent  
266 for circling, indicating a potential relationship.

267           The data also suggest that owners may reinforce stereotypy by providing  
268 attention in the form of scolding or blocking the dog as well as providing direct attention  
269 on intermittent schedules (Component 1). It is important to note, however, that although  
270 owners may respond to stereotypy by giving the dog attention, this does not imply that  
271 the behavior is reinforced by attention. The owner’s attention, although a consequence of  
272 stereotypy, may not be a functional reinforcer. To identify whether the consequences  
273 identified in the survey function to reinforce stereotypy, a more detailed analysis of  
274 individual subjects is necessary. In the following study, we conduct a case study of five  
275 subjects using a Functional Analysis to assess the reinforcers of stereotypy in six dogs.

276

277

## **Study 2**

278           This study aimed to identify the environmental consequences that reinforce and  
279 maintain stereotypic behavior using the Functional Analysis methodology for individual  
280 subjects. Because different dogs engaged in different forms of stereotypy, unique  
281 assessments were developed for each dog and form of stereotypy in a case study  
282 approach.

283

284

## **Methods and Materials**

285 *Subjects*

286           Dogs with owner-reported stereotypy were evaluated for inclusion in this study.  
287 Owners were asked to fill in the survey previously discussed (Study 1) that asked them

288 about the conditions under which stereotypy occurred, and how they responded to it.  
289 Additional open-ended questions were asked to identify whether there were conditions  
290 that lead to stereotypy not identified in the survey. Six dogs with stereotypy that owners  
291 considered problematic and abnormal were recruited. Two dogs chased lights (Maisey  
292 and Norman), three dogs chased their tail or circled (Jimmie, Dan, and Shellie), and one  
293 dog repetitively licked the floor (Tina). One dog (Dan), never showed stereotypy during  
294 any of three visits to the owner's house and was excluded from the study (see Table 3 for  
295 subject information). Maisey was reported to chase ambient lights (sunlight) for large  
296 portions of the day. The owner removed the dog's tags to prevent the dog from chasing  
297 reflections. Norman was reported to chase bright lights. The owner reported her  
298 veterinarian had previously diagnosed Norman with mild compulsions. Jimmie and  
299 Shellie were reported to show repetitive tail-chasing. Tina was reported to repeatedly lick  
300 the floor while walking in circles for large portions of the day. Throughout Study 2 and 3,  
301 all dogs were tested in the dog's home or a place familiar to the dog (dog daycare).

302

### 303 *General Procedures*

304 From each owner interview, several potential reinforcers for the stereotypy were  
305 hypothesized. This was done by examining the circumstances that led to stereotypy and  
306 identifying events that may occur after the behavior and thus are potential consequences  
307 of the stereotypy. Generally, the potential consequences of stereotypy included attention,  
308 verbal scolding, light movement (for light chasing), and other owner delivered reinforcers  
309 such as access to the outdoors. All the potential reinforcers that owners reported might  
310 occur after stereotypy were included in the assessment. Each reinforcer was tested in a

311 single condition. Each dog was tested in two to five conditions and a control condition.  
312 Each condition lasted 10 min (unless otherwise noted) with either the experimenter or the  
313 owner delivering the reinforcer contingent on stereotypy. Each condition was repeated  
314 four times for each dog. During each reinforcer test condition, if stereotypy occurred, the  
315 putative reinforcer was delivered for 10 s. During a control condition, putative reinforcers  
316 were provided on a time-based schedule that was not contingent on stereotypy. To assess  
317 whether a putative reinforcer reinforced stereotypy, rates in the reinforcer test conditions  
318 were compared to the control. If data remained ambiguous after four sessions of each  
319 condition (e.g. overlapping data points between all test and control conditions, or  
320 successively decreasing and increasing data points across the four sessions), additional  
321 sessions were conducted to clarify trends. Between two and six 10 min sessions were  
322 conducted per day. A total of 15 to 32 sessions were run for each dog, which required  
323 between three and eight days of assessment. Occurrences of the behavior were recorded  
324 in each session by a live coder using a partial interval recording method. Each session  
325 was divided into 10 s bins. The percentage of bins in which stereotypy occurred was  
326 calculated to estimate the proportion of the session the dog engaged in stereotypic  
327 behavior. Inter-observer agreement was assessed for the target behavior of each dog by  
328 having a second observer score at least 20% of each dog's video-recorded behavior.  
329 Percent agreement was assessed on an interval-by-interval basis by scoring the number of  
330 bins for which the two observers agreed divided by the total number of bins. Mean  
331 percent agreement across all sessions was 95%.

332

333 *Light Chasing*

334 Three potential reinforcers for light chasing were tested: movement of the light,  
335 removal of the light, or human attention. When a dog chases and approaches the light,  
336 the dog may block the light (the light is ‘removed’), the dog might manipulate something  
337 that moves the light when the dog chases it (e.g., a reflection), or light chasing may cause  
338 a human to attend to the dog, and provide attention. Each of these reinforcers was tested  
339 in separate conditions.

340 To test whether *light movement* was the maintaining reinforcer, a 134 lumen  
341 MAGLITE® LED 2-cell D flashlight (Ontario, CA, USA) was used to shine a light onto  
342 the ground. If the dog ran after the light, pounced on the light, or touched the light or  
343 light source (the flashlight), the experimenter moved the light in a slow circular pattern  
344 for 10 s. The light was then presented without motion until the next occurrence of the  
345 behavior. The *light removal condition* was identical to the light movement condition  
346 except that contingent on engaging with the light or flashlight, the light was turned off for  
347 10 s. The *attention condition* was similar to the other conditions, but the light was  
348 presented on the ground. If the dog engaged with the light or flashlight, the owner called  
349 the dog back for 10 s. *The control condition* consisted of the flashlight being held on the  
350 ground and facing upward to point the light up. This was done so that engaging with the  
351 flashlight or light would not make the light disappear (by blocking the source) or move  
352 (the flashlight was held steady).

353 Minor modifications to the procedure were made for Maisey. First, after each  
354 condition was conducted once, the attention condition was discontinued due to difficulty  
355 in running the session and because very high rates of the behavior were observed in the  
356 absence of the owner, indicating that the owner was unlikely a reinforcer of the behavior.

357 Second, after conducting four sessions of the remaining conditions, additional sessions  
358 were conducted to clarify whether movement of the light *and* removal of the light  
359 reinforced the stereotypy. Further details are described in the results.

360

### 361 *Circling*

362 Two test conditions and a control condition were conducted to assess Jimmie's  
363 circling. To test whether circling may be reinforced by owner attention, rates of circling  
364 were compared across conditions in which the owner either provided attention contingent  
365 on circling, provided non-contingent attention (attention on a fixed-time 15 sec schedule),  
366 or was absent (the dog was alone). If the circling was reinforced by the owner, we would  
367 expect circling when the owner provided contingent attention, and little to no circling  
368 when the owner was absent or providing attention every 15 seconds.

369 For the *attention* condition, the owner started the session by petting the dog for 10  
370 s, then stood up and started working on a computer or reading a book while ignoring the  
371 dog. If the dog engaged in circling, the owner stopped the dog and attended to it for 10 s.  
372 In the *alone condition* the dog was left alone and observed via video camera for instances  
373 of circling. The *control condition* controlled for the possibility that owner presences or  
374 the presentation of attention alone (and consequent excitement) may initiate circling. In  
375 this condition, the owner provided non-contingent attention by playing with the dog on a  
376 fixed-time 15 s schedule.

377 Shellie's circling was greatest when the owners approached the door of their  
378 house to exit. We therefore developed several conditions related to the owner  
379 approaching the door. In the first condition we tested whether the dog may circle because

380 by circling as the owner approached the door, the owner became more likely to take the  
381 dog with them (i.e. going outside as a reinforcer). Another condition tested whether the  
382 circling was reinforced by owner attention. The owner reported that when approaching  
383 the door, if the dog started to circle, the owner would tell the dog to “sit” and would then  
384 stop the process of exiting and would give the dog attention for sitting. Alternatively,  
385 circling could be controlled by the owner’s absence. To test this possibility, the dog was  
386 observed after the owner had left (i.e. the dog was alone). A control condition was  
387 conducted in which the owner provided attention on a fixed time schedule (15 s) and  
388 provided a continuous availability to go outside by leaving the door open. If circling was  
389 controlled by variables other than the owner’s behavior, we would expect circling to be  
390 maintained when the owner was absent and when the owner provided attention and  
391 access to the outdoors non-contingently on circling.

392         Throughout each condition, the experimenter approached the door every 30 s  
393 (except during the alone condition in which the dog was left alone). For the *attention*  
394 *condition*, the experimenter approached the door ignoring the dog, and if the dog engaged  
395 in circling, the experimenter told it to “sit.” The experimenter then gave the dog 10 s of  
396 praise. If the dog did not circle as the experimenter approached the door, the  
397 experimenter opened and then shut the door, and returned to the start location. For the  
398 *walk condition*, the experimenter approached the door, and if the dog engaged in circling  
399 the experimenter led it outside for 10 s. If the dog did not circle, the experimenter opened  
400 the door briefly and shut the door without going outside or allowing the dog to leave.

401         For the *alone condition*, the experimenter approached the door and went outside  
402 and around the yard for the duration of the session. The dog’s behavior was recorded to

403 observe if the circling was maintained in the person's absence. In the *control condition*,  
404 the door was opened to allow the dog to be inside or outside and the experimenter  
405 provided non-contingent attention. This controlled for the possibility that simply being  
406 near the door, going outside, or providing attention led to increased circling.

407 *Modifications:* After 4 sessions of each condition, the results remained ambiguous  
408 and the rate of stereotypy did not match the owner's reported experience. Additional  
409 sessions were conducted with the owner taking the role of the experimenter after  
410 necessary training. The first author guided the owner during each session. The session  
411 lengths were shortened to 5 min each for the convenience of the owner.

412

#### 413 *Licking*

414 To assess whether human-delivered consequences maintained licking, rates of  
415 licking were recorded when the experimenter provided contingent attention for it,  
416 provided non-contingent attention for it, and when the dog was alone. If licking was  
417 reinforced by attention, we expect the highest rates of it when attention was provided  
418 contingent on licking and lower rates when attention was presented non-contingently  
419 (control condition). If licking was influenced by variables other than attention (e.g. a  
420 medical condition), we would expect it to occur during the control condition and/or when  
421 alone.

422 For the *attention condition*, the experimenter engaged in everyday activities while  
423 ignoring the dog. If the dog engaged in floor licking, the experimenter called the dog's  
424 name in a scolding tone as modeled by the owner. If the dog stopped, the dog was given  
425 10 s of attention for stopping. If the dog did not stop, the experimenter touched the dog to



449 session data suggested that responding in the light removal condition decreased within a  
450 session implying the behavior was extinguishing. To further test whether light removal  
451 was a reinforcer, we conducted repeated light removal sessions to see if responding  
452 would decrease (sessions 15 through 18). To confirm that any decrease was not a  
453 function of exhaustion, immediately following the repeated light removal conditions, a  
454 light movement condition was conducted (session 19). This pattern of three repeated  
455 light removal sessions and one movement session was repeated in sessions 21 through 24  
456 to confirm whether light removal was a reinforcer for Maisey. Figure 3A shows that after  
457 two or three light removal sessions, the rates of the behavior were indistinguishable from  
458 the control condition. Rates of behavior in the light movement condition remained high  
459 suggesting this was not an effect of exhaustion, but rather the behavior was extinguishing  
460 during repeated light removal conditions. Thus, light removal was not a reinforcer for  
461 Maisey, but light movement was.

462         Like Maisey, Norman was reinforced by light movement, but not the removal of  
463 light (as shown in Figure 3B). Attention from the owner (being called back) had no effect  
464 on the rate of the behavior compared to the control condition. These data suggest that  
465 Norman's behavior was only reinforced by light movement. Thus, both dogs' light  
466 chasing stereotypy was reinforced by light movement, not its removal, nor owner  
467 attention. Low rates of the behavior in the control condition indicated that when the light  
468 remained stationary as the dog engaged with it, contact with the light was not reinforcing  
469 to the dogs. This suggests that light chasing may be related to chasing prey or other types  
470 of chasing that result in the movement of the chased item. Potentially, an exaggerated  
471 chase drive may predispose dogs to engaging in light chasing. In addition, given that light

472 chasing was reinforced by properties of the light itself, this may explain why owners  
473 viewed light chasing as “unpredictable.”

474

#### 475 *Circling*

476           The first four sessions of each condition for Shellie were inconclusive with  
477 relatively low rates of responding (see sessions 1-16, Figure 4A). After this initial  
478 assessment, the owner was trained to conduct the analysis and guided through the  
479 procedures during each condition (sessions 17-32). These sessions a showed a clear  
480 pattern of results in which circling was highest in the attention condition. Thus, the  
481 highest rates of stereotypy were observed when circling was contingent on *owner*  
482 attention in the form of the owner telling the dog to “sit,” which was followed by praise.  
483 Rates of stereotypy were low in the condition in which Shellie was given access outdoors  
484 contingent on stereotypy (walk condition) or when simply left inside when the owner  
485 went outside (alone condition). This walk and alone condition was indistinguishable from  
486 the control condition. Thus, the behavior was maintained by the owner’s effort to reduce  
487 stereotypy by providing attention in the form of telling the dog to “sit” and giving praise  
488 contingent on stereotypy.

489           Jimmie showed very low rates of stereotypy during all sessions (see Figure 4 B).  
490 Only two instances of stereotypic behavior were recorded, both in the attention condition,  
491 however the overall low rate prevented an interpretation of the function of the stereotypy.  
492 Thus, the data suggest the behavior may have an attention function; however, the results  
493 for Jimmie were inconclusive.

494

495 *Licking*

496 Tina showed high rates of licking in the attention condition (Experimenter said  
497 “Tina” to interrupt the behavior and praised for 10 s when the dog stopped), but not in the  
498 alone or the control condition (see Figure 5). Tina, however, showed a decreasing trend  
499 in the rate of licking in the attention condition (sessions 1-15). To test whether this was  
500 an artifact of the attention coming from the experimenter, the owner was trained to  
501 conduct the sessions under the guidance of the experimenter. During these sessions  
502 (sessions 17-24), high rates of licking were observed in the attention condition, and zero  
503 rates during the alone and control conditions, indicating licking was reinforced by the  
504 *owner* calling the dog’s name to interrupt the behavior and providing attention for  
505 stopping.

506 We identified reinforcers for stereotypic behavior in four of five dogs, showing  
507 that this behavior can be controlled by environmental consequences. For two of these  
508 dogs, the behavior was incidentally reinforced by the owner trying to stop the behavior  
509 (telling the dog to “sit,” or “stop”). The remaining two dogs were reinforced by light  
510 movement, which was independent of the owner’s behavior. Here, the reinforcer was  
511 related to the behavior itself: when the dog chased and approached the light, the light  
512 moved. By identifying reinforcers of the stereotypic behavior, it should be possible to  
513 manipulate these reinforcers to decrease the behavior. Disrupting the contingency  
514 between the behavior and reinforcer should cause the behavior to extinguish.

515

516

### Study 3



540 appropriate novel behavior to reinforce. Second, we utilized a stimulus fading procedure  
541 that began with a low intensity flashlight that was gradually increased across sessions to  
542 the highest intensity light (the light intensity used during Functional Analysis sessions).

543 The design for Maisey's treatment was as follows. We first conducted baseline  
544 sessions for paw lifting to the cue "wave" to confirm the behavior was novel (see figure  
545 6: sessions 1-3). Next, Maisey was trained to lift her paw to the cue "wave," by  
546 reinforcing successive approximations with food. Following training, Maisey was tested  
547 for responding to the cue "wave" when given every 30 s during a session (sessions 4, 5,  
548 and 8). In separate sessions, Maisey's responding to the lowest intensity flashlight (9  
549 lumens- Rayovac<sup>®</sup> 2D Flashlight, Madison, WI) was recorded to serve as a baseline for  
550 subsequent manipulations (sessions 6, 7, and 9). Next, reinforcement for waving and  
551 extinction for light chasing (turning the light off contingent on engaging with the light)  
552 were combined until light chasing decreased to fewer than 10% of the intervals for two  
553 sessions. Next, the baseline level of stereotypy for the next higher intensity light (85  
554 lumens- Rayovac<sup>®</sup> Lantern) was obtained in two probe sessions, followed by the  
555 implementation of the treatment. Once the behavior had been reduced to criterion level,  
556 baseline for the highest intensity light was obtained through two probe trials. Treatment  
557 for the highest intensity flashlight was implemented to criterion. Thus, there were three  
558 replications of the treatment effect from baseline to treatment. Last, the schedule of  
559 reinforcement for "waving" was reduced to a fixed interval 5 s schedule.

### 560 *Circling*

561 The Functional Analysis in Study 2 indicated Shellie circled for attention. To  
562 reduce Shellie's circling, differential reinforcement of other behavior (DRO) was utilized

563 by providing owner attention for engaging in behaviors other than circling. If the dog  
564 circled, the owner ignored it. Identically to the Functional Analysis sessions, the owner  
565 approached the door every 30 s throughout the interval. If Shellie circled, the owner  
566 continued to proceed through the door and stayed outside for 10 s. If the dog allowed the  
567 owner to approach and open the door without circling, the owner praised it for 10 s.  
568 These sessions were conducted at the same door as the Functional Analysis sessions.  
569 Once the dog met criterion for progressing, sessions were conducted at a second door in  
570 the house (the door most often used by the owners) and the treatment was repeated to  
571 replicate the effect. If the dog did not meet criterion after several sessions (10 or more  
572 sessions), a time out contingency was added. A time out was used to remove all forms of  
573 owner attention contingent on circling. If, when the owner approached the door, the dog  
574 began to circle, the owner placed the dog into a separate empty room for 10 s. If, when  
575 the owner approached the door, the dog did not circle, the dog was given 10 s of owner  
576 attention. Once the dog met the criterion at the second door, the final treatment phase  
577 required the dog to not only not begin circling as the owner approached, but also to  
578 refrain from circling while the owner left. All contingencies from the previous condition  
579 remained in effect.

#### 580 *Licking*

581         The Functional Analysis for Tina in Experiment 2 indicated that her repetitive  
582 licking was reinforced by owner attention (calling her away). First, five baseline sessions  
583 were conducted in which the owner called the dog away contingent on floor licking.  
584 Next, the treatment condition was implemented using a 30 s momentary DRO. In this  
585 condition a timer was set for every 30 s throughout the session. If the dog was not

586 engaging in licking when the timer ended, the dog was given 10 s of attention. Otherwise,  
587 the dog was ignored. If the dog was licking the floor when the timer ended, she was  
588 ignored. If this did not sufficiently reduce floor licking, the next component was a time  
589 out where the dog was placed in the next room alone for 10 s contingent on floor licking.  
590 This removed all possible sources of owner attention that may occur when the dog and  
591 owner are in the same room. If the dog did not engage in floor licking the owner ignored  
592 the dog. In the following phase, the time out procedure and DRO were combined so that  
593 if the dog engaged in floor licking, it was placed in the next room for 10 s. If the dog was  
594 not licking the floor when the 30 s timer timed out, she was given 10 s of attention.

#### 595 *Analyses*

596 Treatment sessions were conducted until dogs met the minimum criterion of a  
597 reduction in behavior to less than 10% of intervals for two sessions before moving onto  
598 further treatment. Meeting this criterion for at least three consecutive sessions was  
599 considered successful for the final treatment phase. This criterion represents a minimum  
600 of a 78% reduction for Maisey, a 70% reduction for Shellie, and an 89% reduction for  
601 Tina.

602 Inter-observer agreement was assessed for the target behavior of each dog by  
603 having a second-observer score at least 20% of each dog's video-recorded behavior.  
604 Percent agreement was assessed on an interval-by-interval basis by scoring the number of  
605 bins for which the two observers agreed divided by the total number of bins. Mean  
606 percent agreement across all sessions was 88%.

607

608

## **Results and Discussion**

609 *Light Chasing Results*

610           During initial baseline sessions for paw lifting, Maisey showed no evidence of  
611 paw lifting to the cue “wave” (see Figure 6). When she was trained to paw lift to the cue  
612 “wave,” she showed moderate levels of waving (see sessions 4, 5 & 8). Sessions 6, 7 & 9  
613 show that Maisey pounced on the lowest intensity light at high levels (between 75% and  
614 90% of intervals). In the following sessions, reinforcement for waving while the light was  
615 on and extinction for pouncing on the light (the light was turned off) was implemented.  
616 Rates of pouncing decreased within five sessions (sessions 10 – 14) while rates of paw  
617 lifting increased. In the subsequent probe sessions for the next higher intensity of light,  
618 pouncing and chasing rebounded slightly (sessions 15 and 16). When treatment was  
619 implemented, pouncing decreased to zero immediately (sessions 17 and 18). Rates of  
620 pouncing rebounded when baseline conditions were reinstated with the highest intensity  
621 light, and then declined again once treatment conditions were implemented in sessions 21  
622 through 25. When the schedule of reinforcement was thinned for waving, there was a  
623 brief increase in pouncing which quickly declined. Overall, the effect of the treatment  
624 was replicated at each light intensity level. Once the behavior reduction package was  
625 implemented at each intensity, the rate of pouncing decreased. Visual inspection of the  
626 data suggest the treatment had a meaningful effect on the behavior because each  
627 treatment data point was lower than its respective baseline condition. The mean  
628 percentage of intervals with light chasing for baseline sessions was 47% whereas the  
629 mean for treatment sessions was 10%, with the mean of the last three treatment sessions  
630 at 2.2%. The overall reduction in behavior from baseline to the last three treatment  
631 sessions was 95%.

632

633 *Circling*

634           The first section of Figure 7 includes the results of the Functional Analysis in the  
635 attention condition from Figure 4A as baseline for comparison to treatment conditions.  
636 When the DRO procedure was implemented, we observed a steady decrease toward zero  
637 instances of circling per session (sessions 17-26). As the DRO procedure was  
638 implemented to decrease circling when the owner approached a different door, a  
639 resurgence in circling was recorded and little decrease in the behavior was observed  
640 across sessions. When a brief 10 s time out was implemented (session 43), a rapid  
641 decrease in the behavior was noted which was maintained even as the owner went all the  
642 way through the door (session 52-54). The rate of circling decreased from 32.5% of  
643 intervals during the Functional Analysis attention condition, to 5.5% of intervals across  
644 all of the time out sessions to the second door. Comparing the mean rate of circling in the  
645 baseline Functional Analysis to the mean of the last three sessions of treatment, an  
646 overall reduction in stereotypic behavior of 83.6% was observed.

647           These results indicate that the removal of attention contingent on circling by  
648 putting the dog in the next room significantly reduced behavior. This further confirms  
649 that the dog's circling was reinforced by attention, as the removal of attention contingent  
650 on circling led to a significant decrease in the behavior.

651

652 *Licking*

653           Figure 8 shows a high and stable baseline for Tina's licking (mean of 92% of  
654 intervals), which was obtained following the procedures for the attention condition from

655 the Functional Analysis in 5 min sessions. When the DRO was implemented, a small  
656 decrease was noted, however, the behavior remained at unacceptable levels. We  
657 attempted to reverse to baseline (sessions 28-30), however, no instances of licking were  
658 observed. These sessions functionally acted as ignore conditions (i.e. the dog was never  
659 instructed to stop licking because licking was never observed). Additional Functional  
660 Analysis sessions (Sessions 34-42, not shown) were conducted to confirm the licking  
661 behavior only occurred in the owner's presence and when attention was contingent on  
662 licking. These sessions confirmed the Functional Analysis data reported in Study 2:  
663 licking terminated once the owner left (the behavior was observed in 0% of intervals),  
664 resurged once the owner returned (70% of intervals), and terminated when the owner  
665 provided non-contingent attention (0% of intervals). The DRO treatment was again  
666 implemented but unacceptable levels of licking remained (see Figure 8). Next, the time-  
667 out treatment was implemented with a near immediate effect. Following multiple sessions  
668 of little to no licking, the DRO was introduced and licking remained low, occurring in  
669 fewer than 6% of intervals. The mean percent of intervals licking was observed across the  
670 last three treatment sessions was 0%. Comparing the baseline to the overall mean of the  
671 last treatment phase, a 98.5% reduction in behavior was observed.

672         The results suggest that Tina's licking can be controlled by manipulating the  
673 attention the owner provides the dog contingent on licking. When the owner contingently  
674 removed attention (by putting the dog in the next room), decreases in licking were  
675 observed. Licking decreased overall from the initial baseline of 92% of intervals to a  
676 mean of 1.3% of intervals in the final treatment phase. The results further confirm that  
677 Tina's licking was maintained incidentally by owner attention.

678

## General Discussion

679           The results of the three studies reported here indicate that canine stereotypy can  
680 be maintained by environmental consequences (Study 1 and Study 2), those consequence  
681 can be identified (Study 2), and manipulated to reduce stereotypy (Study 3).

682           Study 1 shows that stereotypy in our sample can occur under a variety of  
683 antecedent conditions, and is not specific to conditions of deprivation. Instead, owners  
684 report stereotypy even under conditions of enrichment such as play. The results of this  
685 survey cannot, of course, be generalized to the entire population of pet dogs because the  
686 owners who responded were self-selecting. However, the results serve to indicate some  
687 part of the range of possible contexts in which stereotypy is observed in pet dogs.

688           The PCA in Study 1 identified 4 independent components that described how  
689 owners reported responding to their dog's stereotypy. These components suggest that  
690 owners have different styles of responding to stereotypy. Attending to these styles of  
691 response would be useful to clinicians, as owners may incidentally reinforce the  
692 undesired behavior. Shellie's owner told her dog to sit and reinforced sitting, which  
693 corresponds to a "redirect" response (component 4), and incidentally reinforced the dog's  
694 problem behavior. Tina's owner also redirected by calling the dog's name to interrupt the  
695 behavior, which incidentally reinforced the behavior with attention.

696           Study 2 indicated that canine stereotypic behavior was reinforced by sensory  
697 consequences (light movement) for two dogs, and by owner attention for two more dogs.  
698 This is an interesting difference from the human literature that indicates that human  
699 stereotypic behavior (e.g. swaying, hand-flapping or vocal stereotypy) is rarely  
700 maintained by attention, but instead by the sensory consequences of the behavior (Iwata

701 et al., 1994b). Given that light movement was shown to reinforce light chasing, light  
702 chasing may be functionally similar to the chasing of other moving objects such as prey,  
703 which then might generalize to moving lights. This suggests light chasing may not be a  
704 conflict behavior, but rather a hypertrophied form of responding to moving objects.  
705 Additional dogs, however, would need to be evaluated to assess whether object  
706 movement is the most common reinforcer for light stereotypies.

707         In Study 3, we showed that breaking the contingency between a behavior and the  
708 reinforcer identified in Study 2 led to a decrease in the behavior. For example, we  
709 observed decreases in chasing and pouncing at a light when such behavior no longer led  
710 to light movement and an alternative behavior was reinforced. We also showed that  
711 attention maintained behaviors could be reduced when the behavior led to the owner's  
712 removal. This extends prior research suggesting that owners reinforce tail-chasing (Burn,  
713 2011) by providing the first direct evidence that owner attention reinforces stereotypy.  
714 Interestingly, for both of the dogs whose behavior was reinforced by attention, the  
715 reinforcer was specifically attention from their owners and not from strangers. Tina  
716 showed a decreasing trend when the experimenter was not the owner, but an increasing  
717 trend when the owner acted as experimenter. Similarly, Shellie showed an  
718 undifferentiated pattern of behavior when the owner was not the experimenter, but a clear  
719 attention function when the owner was the experimenter. This suggests that the specific  
720 owner-dog dynamic might be important in canine stereotypy.

721         In addition, our finding that stereotypic behavior in different dogs may be under  
722 the control of different reinforcers suggests that therapeutic recommendations for canine  
723 stereotypy may be too broad. It may not be advisable to make general behavioral

724 treatment recommendations for canine stereotypy if the behavior could be under the  
725 control of different reinforcers. For example, re-direction procedures have been shown to  
726 be effective in treating humans with stereotypy (e.g. Cassella et al., 2011; Schumacher  
727 and Rapp, 2011). However, human stereotypy is rarely maintained by attention (e.g.  
728 Iwata et al., 1994b), making it unlikely that a therapist may incidentally reinforce the  
729 stereotypy while re-directing the behavior. In some of the dogs we tested here, however,  
730 we found that stereotypic behavior was reinforced with attention, and thus re-direction  
731 procedures (e.g. telling the dog to sit), exacerbated the problem behavior. For other dogs,  
732 however, attention was not a reinforcer and re-direction procedures may be effective for  
733 these dogs, without incidentally reinforcing the problem behavior. This individually-  
734 tailored treatments hypothesis, however, requires further testing because our sample size  
735 was too limited to estimate whether the fact that reinforcers for stereotypy varied in our  
736 sample represented the norm for the population or rather was an exception.

737         Generalizations to the larger population of dogs with stereotypy from the present  
738 study are limited given the sample size. Our direct assessment of putative reinforcers  
739 (Study 2), and subsequent manipulation of the reinforcer contingency to decrease  
740 stereotypy (Study 3) were limited to five and three dogs respectively. Therefore, we  
741 cannot generalize the prevalence of various reinforcers and environmental consequences  
742 to the broader population. Additional study will be required to assess the prevalence of  
743 different reinforcers maintaining stereotypy. Importantly, the present study demonstrates  
744 that the Functional Analysis methodology is a viable method for assessing possible  
745 environmental reinforcers of stereotypy for individual dogs, and can lead to individual  
746 tailored treatments to reduce stereotypy.

747           This study provides some of the first empirical evidence demonstrating that  
748 environmental variables can and do influence canine stereotypic behavior. It is important  
749 to note, however, that the present analysis does not exclude the biological hypothesis, but  
750 instead adds to it. The stereotypic behavior in our present analysis may also be influenced  
751 by genetic factors or may have started as a medical condition. Identifying the  
752 environmental determinants of the behavior helps further our understanding of the  
753 variables maintaining canine stereotypic behavior that are susceptible to direct  
754 manipulation.

755           In sum, the environmental consequences of stereotypy should be considered as  
756 potential reinforcers for stereotypy. The Functional Analysis procedure can be utilized to  
757 assess whether stereotypy is reinforced by any of its consequences. Once the reinforcer is  
758 identified, programs can be designed to target it and thereby reduce the behavior. This  
759 may be preferable to treatments not tailored to individual circumstances, such as  
760 redirection, that may have the unintended consequence of reinforcing the behavior.  
761 Future research exploring the environmental antecedents and consequent events of  
762 stereotypy will help further understanding of the variables controlling canine stereotypy.  
763

764

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770 **Conflict of Interest Statement**

771 The authors declare no conflict of interests.

772 **Authorship**

773 N.H, A.P. and C.D.L.W all contributed to the idea for the paper, the design of the  
774 experiments, analysis of the data, and the writing of the paper. The experiments were  
775 conducted by N.H. and A.P.

776 **Ethical Statement**

777 This study was approved by the University of Florida Institutional Animal Care and Use  
778 Committee (IACUC).

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854

	<b>Have something</b>	<b>Lots of Attention</b>	<b>Play</b>	<b>"Stressed"</b>	<b>stimulation</b>	<b>Crated</b>	<b>Command</b>	<b>Noise</b>	<b>Unpredictable</b>	<b>Other</b>	<b># Reporting</b>
Circling	26.8	19.5	19.5	34.1	26.8	4.9	2.4	0.0	14.6	12.2	37
Licking	13.6	20.5	40.9	15.9	25.0	18.2	0.0	4.5	25.0	11.4	41
Light											
Chasing	0.0	7.1	28.6	0.0	0.0	0.0	7.1	0.0	64.3	0.0	14
Fixation	37.5	6.3	33.3	12.5	29.2	0.0	6.3	6.3	22.9	14.6	43

855

856

857 **Table 1.** Owner-reported antecedent events for each stereotypy. Numbers indicate the  
858 percentage of owners reporting each antecedent. The last column indicates the number of  
859 owners reporting antecedents for that stereotypy.

860

861

862

	<b>Component</b>			
	1	2	3	4
Ignore	<b>.745</b>	-.033	-.080	-.125
Give Attention	<b>.848</b>	.120	.099	.054
Say “stop”	-.022	<b>.820</b>	-.053	-.263
Block (prevent)	.152	<b>.701</b>	.300	.231
Remove Something	.386	.048	<b>-.635</b>	-.137
Give Desirable	.163	.194	<b>.710</b>	-.062
Other: distract	-.267	.325	-.391	<b>.543</b>
Command	.001	-.150	.108	<b>.829</b>

863

864 **Table 2.** Correlation matrix for Principal Component Analysis. The correlation in  
865 each component for each behavior is indicated. Component loadings greater than .4 are  
866 indicated in bold.

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<b>Subject</b>	<b>Breed</b>	<b>Age</b>	<b>Sex</b>
Maisey	Boxer	2	F
Norman	Labrador retriever mix	6.5	M
Shellie	Shetland sheepdog	7	M
Jimmie	Cattle dog mix	4	M
Tina	Miniature dachshund	4	F

870

871           Table 3. Subject Information. Breed, sex and age for each subject in Experiment 2  
872 and 3 are given.

873

874

875 **Figure Legends**

876 **Figure 1.** Owner-reported frequency of stereotypy. Each graph indicates the  
877 frequency of each behavior reported in the survey. Low Daily indicates between one and  
878 two times daily, whereas as High Daily indicates three or more times a day.

879

880 **Figure 2.** Prevalence of responding for owner responses to stereotypy.  
881 Percentages reflect the number of owners responding to each response of the 83 owners  
882 that responded to this question. Owners could select more than one response.

883

884 **Figure 3.** Functional Analysis results for Maisey (A) and Norman (B) for Light  
885 chasing. Each data path is labeled with the appropriate condition.

886 **Figure 4.** Functional Analysis for Shellie (A) and Jimmie (B). Each data path is  
887 labeled with the respective condition. Gap in data path for Shellie indicates where the  
888 owner acted as the Experimenter.

889 **Figure 5.** Functional Analysis for Tina. Each data path is labeled with the  
890 appropriate condition. The breaks in the data paths indicate when the owner became the  
891 experimenter.

892 **Figure 6.** Treatment for Maisey's light chasing. Dashed line indicates a change in  
893 procedure. BL represents Baseline and DRA indicates when differential reinforcement of  
894 alternative and the removal of the light contingent on pouncing was in effect. Intensity 1  
895 stands for the 9 lumen light, Intensity 2 is the 85 lumen light, and Intensity 3 is the 134  
896 lumen light.

897           **Figure 7.** Treatment for Shellie’s circling. Dashed line indicates a change in  
898 procedure. DRO stands for differential reinforcement of other behavior. The DRO  
899 procedure for both doors is shown. TO stands for timeout. TO Step outside indicates  
900 when the owner would fully step outside.

901           **Figure 8.** Treatment for Tina’s licking. Dashed lines indicate changes in  
902 procedure. Double dashed line on the x axis indicates where additional Functional  
903 Analysis sessions were conducted (see results). BL stands for baseline, DRO stands for  
904 differential reinforcement of other behavior, TO stands for timeout.