Association between increased behavioral persistence and stereotypy in the pet dog

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Abstract

The aim of the present study was to evaluate whether dogs that exhibit stereotypy also show higher behavioral persistence in an extinction-learning task. Thirteen pet dogs with stereotypy and 13 breed-matched control dogs were assessed on a resistance to extinction test. Each dog was trained for 40 trials using a food reinforcer to nose-touch the experimenter's hand on a continuous reinforcement schedule. After acquisition, the dogs entered an extinction phase, during which food was no longer delivered. The numbers of nose-touches as well as inter-response times during this phase were recorded. A linear regression found that stereotypy status ($t = -2.46$, $P = .027$) and breed type ($t = 2.44$, $P = .023$) were significant predictors of the number of responses in extinction. Dogs with stereotypy responded more in extinction than control dogs. The mean number of responses was 13.4 (SD = 14.7) in the control group and 26.0 (SD = 15.3) in the stereotypy group. These results suggest a link between previous laboratory and zoo animal findings on the neurophysiology of stereotypy and the pet dog population. They also have implications for the use of extinction procedures to reduce stereotypic behaviors in pet dogs, as these dogs show enhanced resistance to extinction.

Key words: Dog; behavioral persistence; extinction learning; stereotypy.

1. Introduction

Repetitive and unvarying behaviors without an apparent goal, hereafter "stereotypy," occur in both human and non-human animals. Stereotypy is common and widely studied in captive animals housed in zoos and laboratories. Furthermore, stereotypy is widely considered an indicator of poor welfare, deprived environments, and/or the result of CNS dysfunction (for a review see Mason et al., 2007).

Pet dogs have also been reported to engage in stereotypy such as excessive circling, tail chasing, flank-sucking, fly biting, self-mutilation, pacing, spinning, some repetitive vocalizations, and fabric sucking (Moon-Fanelli & Dodman, 1998). About 3.4% of dogs presenting at a Cornell University veterinary behavior clinic from 1991 to 2001 were diagnosed with Canine Compulsive Disorder (CCD) (Bamberger et al., 2006), in which the above described stereotypies represent the main clinical symptom. Furthermore, the American Kennel Club (AKC) Canine Health Foundation listed CCD as a top health concern for some breeds of dogs, such as Bull Terriers and Border Collies (AKC, 2012). In most cases, canine stereotypies significantly decrease the welfare of both the affected dog and its owner. Owners report that such repetitive behaviors interfere with the daily functioning of their dogs, preventing them from being able to eat, play, and interact normally with people (Moon-Fanelli & Dodman, 1998; Overall & Dunham, 2002). In addition, these dogs typically show some tendency to mutilate themselves, for example by biting their tails, wearing out their paw pads, and circling until complete exhaustion, leaving owners to explore undesirable treatments such as tail amputation and even euthanasia of their pet (Moon-Fanelli & Dodman, 1998).

At this time, however, our understanding of the causes and factors related to canine stereotypy is limited. The question remains whether dogs with stereotypy show systemic and

fundamental behavioral differences from normal dogs. Alternatively, dogs with stereotypy and normal dogs may not show any general behavioral differences, but instead may only differ in the presence or absence of stereotypy. The fact that animals that exhibit one stereotypy are likely to exhibit other seemingly unrelated problem behaviors and siblings often share a predisposition toward stereotypic behaviors (Hewson et al., 1998), suggests that there may be more fundamental behavioral differences between normal and affected dogs. These observations support the assumption that there are some underlying predispositions among dogs with stereotypy.

Phenotypes, such as an individual's general sensitivity to reinforcement, have previously been associated with complex behavioral disorders such as Attention Deficit Hyperactivity Disorder in people (Murray & Kollins, 2000). In addition, researchers have identified other general phenotypes such as impulsivity (Neef et al., 2005) that differentiated their target population from typically functioning individuals. Furthermore, Frith and Done (1983) found that schizophrenic patients differed from others in their perseveration of responding. These patients displayed a very low switch-over rate on a concurrent choice task (Frith & Done, 1983). Such perseverative responding and problems with response inhibition largely characterize people with autistic spectrum disorders (see review by Russo et al., 2005; but also see Geurt et al., 2009 and Van Eylen et al., 2011). Numerous animal studies, spanning a wide variety of species, have investigated behavioral disinhibition as a behavioral process that may separate animals that show stereotypic behaviors from those without behavioral stereotypies. Disinhibition of behavior may result in elevated rates of switching behaviors, perseveration of behavior in tasks that require inhibition, and shorter latencies to initiate behaviors (Garner et al., 2003). Whereas stereotypic behavior, as we have described it above, refers to the behavior of the animal outside of an

experimental procedure, repetitive responding within an experiment is termed perseveration (Garner et al., 2003). Perseveration, as measured through resistance to extinction (a measure of the continuation of responding after reinforcement is discontinued), was found to correlate with presence or severity of stereotypic behavior in a study with bank voles (Garner & Mason, 2002), two species of tits (Garner et al., 2003), Asiatic black bears (Vickery & Mason, 2003), Malayan sun bears (Vickery & Mason, 2005), horses (Hemmings et al., 2007), and rhesus macaques (Lutz et al., 2004; Pomerantz et al., 2012). Tanimura and colleagues (2008) found frequency of stereotypy in mice was positively correlated with the number of errors in a reversal-learning task. In other studies, perseveration was assessed through an analysis of change-over patterns in a concurrent choice task with equal schedules of reinforcement on both choices (e.g. Campbell et al., 2013; Dallaire et al., 2011; Gross et al., 2011; Garner et al., 2003); however, Gross and colleagues (2011), unlike other studies reviewed here, did not find a correlation between stereotypy and perseveration. Furthermore, a correlation between perseverative behavior and the frequency of self-directed behavior or displacement activity (such as self-touching, scratching, manipulating objects, etc.) was found in lion-tailed macaques, squirrel monkeys, and capuchin monkeys (Judge et al., 2011).

The aim of this study was to extend the large literature on the association between behavioral persistence and stereotypy to the pet dog population. We set out to examine whether resistance to extinction is a fundamental behavioral phenotype that distinguishes pet dogs that exhibit stereotypy from those that do not. We predicted that dogs with stereotypy would show higher resistance to extinction on an arbitrary novel task than dogs from a normal population. As previous research has differentiated between topographies of canine stereotypies and indicated

that certain breeds have different topographies (Mills & Luescher, 2006), we also aimed to explore these additional variables in our data set.

2. Materials and methods

Twenty-six dogs were recruited through advertisements online, social networking sites, local veterinary clinics, and dog parks. All owners completed a questionnaire describing the dog's form, frequency, and intensity of the stereotypy. After completion of the questionnaire, a consultation was conducted (by AP and NH) to verify that the dogs exhibited the reported stereotypy. Dogs in the control group were matched to dogs with stereotypies by breed. If possible, dogs were further matched by other criteria in the following order: dogs were siblings, shared the same household, similar age, and same sex. Table 1 lists the subjects that participated in the experiment. The different forms of stereotypy were classified into five categories: licking (excessive licking and/ or sucking on part of the dog's body or inanimate objects), circling (repeatedly spinning in one direction), light chasing (excessively following shadows or reflections), light fixating (starring at a light source for a prolonged time), and fly snapping (snapping at the air as if catching invisible flies).

Each dog was tested in its home by one experimenter, either the first author (AP), who was not bind to the hypothesis of the study (n = 22) or the dog's owner, who was blind to the hypothesis, if the dog was fearful towards AP (n = 4). All sessions were videotaped. Each dog received one continuous session, which was divided into two phases: acquisition and extinction. During the whole session, the experimenter stood still with her left hand down by her side with the palm facing the dog, and her right hand behind her back. During the initial learning phase, the dog was given a small piece of hot dog (~ 0.5 cm^3) every time it touched the experimenter's palm with its nose. Upon a nose-touch, the experimenter withdrew the left hand and placed it

behind her back and, with her right hand, reached into a container with food and delivered one food item. If 1 min passed with no response during this phase, the experimenter re-presented the left hand while calling the dog by name once. If three presentations of the hand with no response passed, the experiment was concluded and the dog's data not included in the analysis (three dogs were excluded this way: two dogs in the stereotypy and one in the control group). The initial learning phase lasted until the dog received 40 treats. After the 40th treat, the extinction phase began. During this phase, no more treats were given to the dog for touching the hand. Upon a nose-touch, the experimenter withdrew her left hand, placed it briefly behind her back, reached into the container with her right hand, placed her right hand behind her back, and then re-presented her left hand. The extinction phase ended when 1 min passed without a response from the dog. Behavioral persistence was quantified as the number of responses in the extinction phase of the session. In order to investigate differences in time to learn the task or any motivational differences between dogs, inter-response times in both the learning and extinction phases were also calculated. Data was collected through an analysis of video recordings by a coder blind to the hypothesis of the study. In order to assess inter-observer reliability, 9 out of 26 (35%) videos were coded by two independent observers. Agreement was scored when two observers concurred on the occurrence of a nose-touch within 1 s of each other. The median interobserver agreement was 98.5%, ranging from 74.4 to 100%.

The study was conducted with the approval of the University of Florida Institutional Animal Care and Use Committee.

2.1. Statistical analysis

The 10 different breeds of the subjects were combined into four breed types. Breed Type 1 consisted of terrier breeds (Bull Terriers, American Pit Bull Terriers, and Terrier mixes). Breed

Type 2 consisted of herding breeds (Australian Shepherds, Shetland Sheepdogs, Australian Cattle Dogs, and Border Collies). Breed Type 3 consisted of hounds (Miniature Dachshunds). Breed Type 4 consisted of working and guarding breeds (Blackmouth Curs and Dobermans). A linear regression model through Wald backward elimination with criteria for inclusion set at $P < 0.25$ and for removal at $P > 0.05$ (Mickey and Greenland, 1989) was used to investigate the effect of stereotypy status, breed type, age, sex, and experimenter type (AP or owner) on the number of responses in extinction. To further explore breed differences, two contrasts were conducted: (1) to evaluate the differences between breeds typically implicated in exhibiting stereotypy (herders and terriers compared to hounds and working dogs) and (2) to compare terriers to herders. Topography of the stereotypy was not included in the model as only half of the dogs exhibited stereotypy; therefore, differences in the number of responses in extinction by the topography of the stereotypy were assessed using a one-way analysis of variance. To assess time to acquisition, speed of responding and motivation to respond in extinction, the differences in inter-response times were evaluated with separate paired-sample t-tests. All statistical calculations were conducted with the statistical package SPSS® (International Business Machines Corp., Armonk, NY, USA).

3. Results

A linear regression analysis was conducted to predict the number of responses in extinction using sex, age, breed type, experimenter used, and stereotypy status as predictors. The final model consisted of breed type and stereotypy status as statistically significant predictors of the number of responses in extinction ($F(2) = 5.76$, $P = .009$) (Table 2). The adjusted R^2 value was 0.276. The mean number of responses was 13.4 (SD = 14.7) in the control group and 26.0 (SD = 15.3) in the stereotypy group (Fig. 1). Breed Type 1 (terriers) had a mean number of responses

of 14.2 (SD = 14.8), Breed Type 2 (herders) had a mean number of responses of 17.3 (SD = 14.9), Breed Type 3 (hounds) had a mean number of responses 30.5 (SD = 6.4), and Breed Type 4 (working dogs) had a mean number of responses of 34.0 (SD = 18.4). Herders and terriers responded significantly less in extinction than hounds and working dogs ($t = 2.19$, $df = 20$, $P = .0.041$), whereas no differences were found between terriers and herders ($t = 0.36$, $df = 20$, $P > .05$),

There were no differences between the dogs with stereotypy and the control dogs in inter-response times in either acquisition (mean was 15.9 in the stereotypy group and 11.3 in the control group; $t = 1.45$, $df = 12$, $P > .05$) or extinction (mean was 7.8 in the stereotypy group and 8.8 in the control group; $t = -0.49$, $df = 12$, $P > .05$).

The number of responses in extinction did not differ by the form of the stereotypy ($F(3) = 3.03$, $P > .05$). Dogs that engaged in excessive licking responded on average 28.0 times, dogs that engaged in chasing lights responded on average 23.3 times, and dogs that engaged in circling or spinning responded on average 26.8 times.

Discussion

As predicted, pet dogs that engaged in stereotypic behaviors responded more in extinction indicating higher behavioral persistence than normal dogs. The results suggest that dogs with stereotypy differ from the normal population in their resistance to extinction or perseverance. The finding that dogs with stereotypy differ on a more general behavioral phenotype independent of stereotypic behavior might explain why Overall and Dunham found that 75% of dogs with CCD also suffered from other, seemingly unrelated behavioral problems, such as aggression and separation anxiety (Overall & Dunham., 2002). Dogs that emit stereotypy in the home continue

to emit behaviors after the reinforcer has been removed longer than other dogs. This insensitivity to changes in reinforcement likely has broad behavioral impacts on these dogs.

Interestingly, greater resistance to extinction was a general finding across our entire sample of stereotypic dogs. We found that breed type, along with the presence of stereotypy, had an effect on resistance to extinction. Hounds and working breeds responded more in extinction than did terriers or herders. Although some breeds are thought to be prone to stereotypy and even specific topographies of stereotypy, resistance to extinction appeared to uniformly distinguish between presence and absence of stereotypy across both breeds and type of stereotypy.

These results suggest that dogs with stereotypy behave similarly to other animals with stereotypy. Dogs, just like bank voles, tits, Asiatic black bears, Malayan sun bears, horses, and old world monkeys showed a correlation between higher behavioral persistence on an extinction learning task and stereotypy (Garner et al., 2003; Garner & Mason, 2002; Vickery & Mason, 2003; Vickery & Mason, 2005; Hemmings et al., 2007; Lutz et al., 2004; Pomerantz et al., 2012). Behavioral persistence, or recurrent perseveration, has been linked to basal ganglia disruption in people, rodents, and monkeys (Garner, 2006) and may thus suggest treatment with dopaminergic agents (Rapoport et al., 1992).

There were no differences between the dogs with stereotypy and the control dogs in inter-response times in either acquisition or extinction. Dogs with stereotypy took just as long to learn the task. Furthermore, the speed of responding in extinction did not differ between the two groups. This suggests that both groups of dogs were equally motivated to learn the task and that time during learning could not have been responsible to the differences in resistance to extinction.

One limitation of this study was that the presence or absence of stereotypy was determined from owner-reports and a brief visit to the dog's home by the experimenters. No quantification of the severity or specific topography of the stereotypy was attempted. Future research can evaluate whether correlations exist in the frequency, intensity, or duration of stereotypy and behavioral persistence. Such an analysis would be possible in laboratory or shelter-housed animals. A second limitation was that the majority of the subjects were assessed by an experimenter not blind to the hypothesis of the study. The video coders were blind to the hypothesis, however, a possibility remains that the experimenter may have unconsciously cued the dogs to either respond or stop responding. However, the type of experimenter (AP or owner) did not predict differences in the number of responses in extinction. Future experiments should verify the results of this study by using an experimenter, blind to both the hypothesis and the stereotypy status of the dogs.

The specific form of the stereotypy in animals might arise as a normal behavior that has been reinforced at some point either through natural environmental consequences, such as itching the tail in the case of tail chasing, but has persevered even in the current absence of reinforcement. Our results provide support for this hypothesis by showing that extinction learning is impaired in this population. An interesting future study may be to examine the ability to experimentally create specific forms of artificial behavior analogous to stereotypy using such reinforcement methods. In humans, perseverative responding (repetitive sequences of button presses) was induced through reinforcement procedures (Schwartz, 1982).

These findings have implications for the management and behavioral treatment of stereotypy; extinction procedures that withhold reinforcement might not be as effective in this population as in others not showing stereotypy. However, it remains to be seen whether these

250 animals are insensitive to procedures that include reinforcement for alternative behaviors or
251 punishment for the stereotypic behavior.

252 Future research should continue to investigate other behavioral correlates with stereotypy,
253 aside from resistance to extinction. For example, Parker and colleagues (2008) showed that
254 stereotypy in horses correlates with impairment in learning to choose a more immediate
255 reinforcer in a choice task. Future research may evaluate whether similar behavioral phenomena
256 exist in pet dogs.

257 **4. Conclusions**

258 Dogs that exhibit stereotypy in the home also show higher resistance to extinction in a
259 reversal learning task. Dogs with stereotypy took longer to extinguish responding than the breed-
260 matched control dogs. No differences were seen in inter-response times in either acquisition or
261 extinction, suggesting that motivation or impaired learning ability cannot explain these results.
262 No systematic differences were seen between the topographies of stereotypy. These findings
263 extend the literature from zoo and laboratory housed animals to pet dogs.

264 **Acknowledgements**

265 This project was funded in part by the American Kennel Club Canine Health Foundation.
266 The authors thank Cassandra Vazquez for assistance in video coding and the devoted owners of
267 our subjects for their commitment and flexibility.

268

References

American Kennel Club Canine Health Foundation website. Breed health concerns and research interests. Available at: http://www.akcchf.org/research/research-priorities/breed-health-concerns. Accessed March 6, 2012.

Bamberger, M., & Houpt, K. A. (2006). Signalment factors, comorbidity, and trends in behavior diagnoses in dogs: 1,644 cases (1991–2001). *Journal of the American Veterinary Medical Association*, *229*(10), 1591-1601.

Campbell, D. L., Dallaire, J. A., & Mason, G. J. (2013). Environmental enrichment reduces perseveration in the American mink, but enhances spontaneous alternation. *Behavioral Brain Research, 239*, 177-187.

Dodman, N. H., Karlsson, E. K., Moon-Fanelli, A., Galdzicka, M., Perloski, M., Shuster, L., Lindblad-Toh, K., & Ginns, E. I. (2010). A canine chromosome 7 locus confers compulsive disorder susceptibility. *Molecular psychiatry*, *15*(1), 8-10.

Frith, C. D., & Done, D. J. (1983). Stereotyped responding by schizophrenic patients on a two-choice guessing task. *Psychol Med*, *13*(4), 779-786.

Garner, J. P. (2006). Perseveration and stereotypy: systems-level insights from clinical psychology. *Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare*, 121- 152.

Garner, J. P., & Mason, G. J. (2002). Evidence for a relationship between cage stereotypies and behavioural disinhibition in laboratory rodents. *Behavioural Brain Research*, *136*(1), 83-92.

290 Garner, J. P., Mason, G. J., & Smith, R. (2003). Stereotypic route-tracing in experimentally
291 caged songbirds correlates with general behavioural disinhibition. *Animal Behaviour*,
292 *66*(4), 711-727.
293 Gross, A. N., Engel, A. K. J., Richter, S. H., Garner, J. P., & Würbel, H. (2011). Cage-induced
294 stereotypies in female ICR CD-1 mice do not correlate with recurrent perseveration.
295 *Behavioural brain research*, *216*(2), 613-620.
296 Geurts, H. M., Corbett, B. and Solomon, M. 2009. The paradox of cognitive flexibility in autism.
297 *Trends in Cognitive Sciences*, 13(2): 74–82.
298 Hemmings, A., McBride, S. D., & Hale, C. E. (2007). Perseverative responding and the
299 aetiology of equine oral stereotypy. *Applied Animal Behaviour Science*, *104*(1), 143-150.
300 Hewson, C. J., Luescher, U. A., Parent, J. M., Conlon, P. D., & Ball, R. O. (1998). Efficacy of
301 clomipramine in the treatment of canine compulsive disorder. *Journal of the American*
302 *Veterinary Medical Association*, *213*(12), 1760-1766.
303 Judge, P. G., Evans, D. W., Schroepfer, K. K., & Gross, A. C. (2011). Perseveration on a
304 reversal-learning task correlates with rates of self-directed behavior in nonhuman
305 primates. *Behavioural brain research*, *222*(1), 57-65.
306 Lutz, C., Tiefenbacher, S., Meyer, J., & Novak, M. (2004). Extinction deficits in male rhesus
307 macaques with a history of self-injurious behavior. *American journal of primatology*,
308 *63*(2), 41-48.
309 Mason, G., Clubb, R., Latham, N., & Vickery, S. (2007). Why and how should we use
310 environmental enrichment to tackle stereotypic behavior? *Applied Animal Behaviour*
311 *Science*, 102, 163-188.

Mickey, R.M., & Greenland, S. (1989). The impact of confounder selection criteria on effect estimation. *Amerian Journal of Epidemiology, 129*, 125-137.

Mills, D. & Luescher, A. (2006). Veterinary and pharmacological approaches to abnormal repetitive behavior. In G. Mason, & J. Rushen (Eds.), *Stereotypic Animal Behavior: Fundamentals and applications to welfare* (2nd edition, pp. 286-324). Oxfordshire, UK: CABI.

Moon-Fanelli, A. A., & Dodman, N. H. (1998). Description and development of compulsive tail chasing in terriers and response to clomipramine treatment. *Journal of the American Veterinary Medical Association*, *212*(8), 1252.

Murray, L. K., & Kollins, S. H. (2000). Effects of methylphenidate on sensitivity to reinforcement in children diagnosed with attention deficit hyperactivity disorder: An application of the matching law. *Journal of Applied Behavior Analysis*, *33*(4), 573-591.

Neef, N. A., Marckel, J., Ferreri, S. J., Bicard, D. F., Endo, S., Aman, M. G., Miller, K. M., Jung, S., Nist, L., & Armstrong, N. (2005). Behavioral assessment of impulsivity: A comparison of children with and without attention deficit hyperactivity disorder. *Journal of Applied Behavior Analysis*, *38*(1), 23-37.

Overall, K. L., & Dunham, A. E. (2002). Clinical features and outcome in dogs and cats with obsessive-compulsive disorder: 126 cases (1989-2000). *Journal of the American Veterinary Medical Association*, *221*(10), 1445-1452.

Pomerantz, O., Paukner, A., & Terkel, J. (2012). Some stereotypic behaviors in rhesus macaques (*Macaca mulatta*) are correlated with both perseveration and the ability to cope with acute stressors. *Behavioural brain research*, *230*(1), 274-280.

Rapoport, J. L., Ryland, D. H., & Kriete, M. (1992). Drug treatment of canine acral lick: an animal model of obsessive-compulsive disorder. *Archives of general psychiatry*, *49*(7), 517.

Russo, N., Flanagam, T., Iarocci, G., Berringer, D., Zelazo, P. D. and Burack, J. A. 2007. Deconstructing executive deficits among persons with autism: Implications for cognitive neuroscience. *Brain and Cognition*, 65(1): 77–86.

Schwartz, B. (1982). Reinforcement-induced behavioral stereotypy: How not to teach people to discover rules. *Journal of Experimental Psychology: General*, *111*(1), 23.

Tanimura, Y., Yang, M. C., & Lewis, M. H. (2008). Procedural learning and cognitive flexibility in a mouse model of restricted, repetitive behaviour. *Behavioural brain research*, *189*(2), 250-256.

Tiira, K., Hakosalo, O., Kareinen, L., Thomas, A., Hielm-Björkman, A., Escriou, C., Arnold, P., & Lohi, H. (2012). Environmental effects on compulsive tail chasing in dogs. *PloS one*, *7*(7), e41684.

Van Eylen, L., Boets, B., Steyaert, J., Evers, K., Wagemans, J., & Noens, I. (2011). Cognitive flexibility in autism spectrum disorder: Explaining the inconsistencies?. *Research in Autism Spectrum Disorders*, *5*(4), 1390-1401.

Vickery, S. S., & Mason, G. J. (2003). Behavioral persistence in captive bears: implications for reintroduction. *Ursus*, 35-43.

Vickery, S. S., & Mason, G. J. (2005). Stereotypy and perseverative responding in caged bears: further data and analyses. *Applied Animal Behaviour Science*, *91*(3), 247-260.

Figure 1. The average number of responses in extinction and the standard error in the stereotypy and the control are presented. Dots represent individual data.

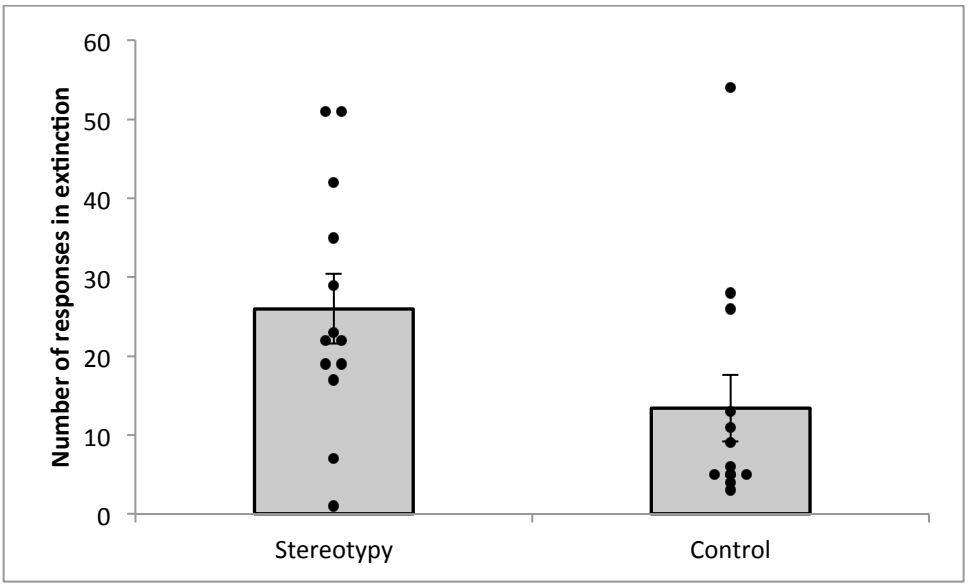
Table 1. The form and frequency of stereotypy (for experimental dogs, as reported by the owner), age and sex of each dog. Control dogs that lived in the same household as their counterparts are represented with an asterisk. Control dogs that were siblings of their counterparts are represented with a dagger sign. Dogs shaded in gray were tested by the owner.

STEREOTYPY GROUP					CONTROL GROUP	
Breed	**Age**	**Sex**	**Stereotypy**	**Frequency of Stereotypy**	**Age**	**Sex**
Bull Terrier	9	M	Licking	1/ day	9	M
	1	M	Circling	10/ day	2	F
	1	M	Circling	1/day	4	M
Border Collie	4	F	Light chasing, light fixating	1/day	4	M
Shetland Sheepdog	7	M	Circling	3/ day	8	M
	8	F	Circling	1/day	8	F* †
Australian Shepherd	2	F	Circling, light fixating, fly snapping	3/day	6	F*
Cattle Dog mix	5	F	Circling	5/day	5	F
American Pit Bull Terrier	5	M	Light chasing	1/ day	2	M
Blackmouth Cur	3	F	Light chasing	1/day	3	M*†
Miniature	3	F	Licking, circling	5/day	9	M*

Dachshund					
Doberman	2	M	Licking	1/day	5 M
Terrier mix	3	F	Light chasing	1/day	3 F

5

6


Number of responses in extinction
60
50
40
30
20
10
0
Stereotypy
Control