

Does previous use affect litter box appeal in multi-cat households?



J.J. Ellis^{*}, R.T.S. McGowan, F. Martin

Behavior and Welfare Section, Nestlé Purina Research, Saint Joseph, MO, USA[†]

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ABSTRACT

It is commonly assumed that cats actively avoid eliminated materials (especially in multi-cat homes), suggesting regular litter box cleaning as the best defense against out-of-box elimination. The relationship between previous use and litter box appeal to familiar subsequent users is currently unknown. The purpose of this study was to investigate the relationship between previous litter box use and the identity of the previous user, type of elimination, odor, and presence of physical/visual obstructions in a multi-cat household scenario. Cats preferred a clean litter box to a dirty one, but the identity of the previous user had no impact on preferences. While the presence of odor from urine and/or feces did not impact litter box preferences, the presence of odorless faux-urine and/or feces did – with the presence of faux-feces being preferred over faux-urine. Results suggest neither malodor nor chemical communication play a role in litter box preferences, and instead emphasize the importance of regular removal of physical/visual obstructions as the key factor in promoting proper litter box use.

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1. Introduction

Out-of-box elimination is cited as the number one behavioral reason owners relinquish cats to shelters (Salman et al., 2000). Once in a shelter, “behavioral abnormalities” (primarily out-of-box elimination) has been cited as the number one behavioral reason cats are selected for euthanasia (Gorodetsky, 1997). There are an estimated 74.1 million pet cats in the United States (Shepherd, 2012), 8.8 million pet cats in Canada (Canadian Animal Health Institute, 2016), and 97.6 million pet cats in Europe (FEDIAF, 2014). It is estimated that 10% of pet cats have exhibited an elimination behavior problem at some point in their lifetime (Borchelt and Voith, 1996). If the factors contributing to the exhibition of out-of-box elimination can be better understood, there is the potential to help reduce the number of cats being relinquished to and euthanized in shelters.

The term “cat elimination” can refer to both scent marking and toileting. Both behaviors are not only forms of eliminating waste, but also have a communicative function. However, the intentionality of this communication is quite different. Scent marking is a type of signal, which is a specific and deliberate message intended to influence the behavior of the receiver (Lehmann et al., 2014). Assuming a signal is honest (e.g., scent mark claiming territory), a change in behavior in response to the signal (e.g., potential competi-

tor avoiding area) should convey some benefit to both the sender and receiver (e.g., reducing likelihood of physical altercation). Toileting on the other hand, provides information via cues. Cues also convey information to the recipient, but this information transfer is incidental rather than intentional on the part of the sender (Laidre and Johnstone, 2013). Cues often convey information (e.g., who was here and when) as a byproduct of other behavior (e.g., eliminating in a communal latrine/litterbox). This paper focuses on toileting behavior.

When a cat is exhibiting inappropriate toilet behavior, the first recommendation is often to have the cat examined by a veterinarian for any potential medical causes. Barring medical causes, the next recommendation is usually to try to make the litter box as appealing as possible to the preferences of the cat. There have been several studies investigating factors influencing litter box preferences. Some of these focused on the specifics of the litter product. Neilson (2001) found that shelter cats prefer clumping litter to silica gel litter substrate. Out of 15 different litter substrates offered, Borchelt (1991) found that cats preferred fine-grain clumping cat litter. Horwitz (1997) found that scented litter could be a risk factor for out-of-box elimination, while Sung and Crowell-Davis (2006) and Neilson (2011) found cats exhibited no preference between scented and unscented litter. Other studies focused on the specifics of the litter box environment. Grigg et al. (2012) found that while some individual cats exhibited preferences for covered or uncovered litter boxes, overall most cats did not have a preference. In separate studies, both Guy et al. (2014) and Neilson (2008a) found that cats prefer a larger litter box. Mills and Munster (2003) found

^{*} Corresponding author.

E-mail address: Jacklyn.ellis@rd.nestle.com (J.J. Ellis).

[†] Present address.

that cats preferred greater litter depth when defecating but not urinating. Some studies have also investigated the impact malodor may have on litter box preferences. In a series of studies Neilson found a carbon enhanced litter was preferred to a regular clumping litter or one enhanced with baking soda (Neilson, 2007, 2008b). Additionally, Cottam and Dodman (2007) found that the frequency of behaviors associated with dissatisfaction and out-of-box elimination decreased when Zero Odor litter box spray (an odor elimination product) is used. It is assumed, that if aversive litter box factors can be reduced, and preferred litter box factors can be increased, inappropriate toilet behavior will diminish or cease altogether.

Notably, most of these studies are conducted in singly housed cats, and few consider how the complex dynamic of the multi-cat environment can contribute to inappropriate toileting. The most common recommendation for reducing inappropriate toileting is frequent litter box cleaning (Neilson, 2004). It is reasonable to assume frequent removal of waste is a key part of encouraging proper litter box use, and its importance should not be undervalued. However, it is likely that there are other environmental and social factors which contribute to the exhibition of out-of-box elimination, especially in a multi-cat household. It is common for feline behaviorists to recommend that people with multi-cat households provide $n + 1$ litter boxes, where n = the number of cats, and to ensure that these litter boxes are spaced throughout the house instead of placed next to each other (Neilson, 2004). It is often unclear if this suggestion is intended to merely accommodate the increased amount of eliminated materials, or if it implies that cats do not like to share litter boxes. Investigation of whether cats are averse to litter boxes previously used by another individual has never been conducted. Approximately 30% of households in the USA have a cat, and of those households, the average number of cats per household is 2.1 (Shepherd, 2012). If the cats are averse to sharing litter boxes, these statistics suggest there could be millions of cats impacted in this country alone. Understanding the factors influencing the association between inter-cat relationships and out-of-box elimination could be key in developing solutions in affected households.

Considering the link between out-of-box elimination and the relinquishment of cats to shelters, there is a notable lack of research investigating litter box appeal in multi-cat households. The current study aims to assess whether previous litter box use affects the appeal of the box for future familiar users, and if so, what aspects of the use are driving this appeal. Particular factors being considered include: (1) the identity of the previous user (themselves or a familiar cat), (2) the type of previous use (urine, feces, or a combination), or (3) the aspect of the previous use (malodor, chemical cue, or physical/visual obstruction).

2. Materials and methods

2.1. Cats, housing, and care

Litter box preferences were investigated using healthy, spayed or neutered cats between 1 and 12 years of age, none of which regularly exhibited elimination problems (e.g., out-of-box elimination). All cats were domestic shorthairs, born and raised at the Nestlé Purina PetCare facility in Missouri, USA. For each test, an attempt was made to employ an equal number of male and female cats. For research questions in which it is specified that two cats are familiar with each other (i.e., Objectives 1 and 2), cats were defined as familiar if they spent at least 4 h per day in the same social group when not on test. These social groups were stable and experienced limited agonistic encounters. No attempt was made to determine the hierarchical relationships within these groups.

During data collection cats were housed in individual enclosures ($l \times w \times h$; $1.4 \text{ m} \times 1.4 \text{ m} \times 2.5 \text{ m}$), with visual access to other cats and the outdoors. Additionally, all cats were socialized in activity rooms ($12.1 \text{ m} \times 2.1 \text{ m} \times 2.5 \text{ m}$) in their pre-established playgroups of 7–8 compatible cats for 2–3 h each day, and received regular individual interaction with human caregivers. Cats were fed once daily (between 0900 h and 1100 h), a complete and balanced diet in quantity necessary to keep them in optimal body condition. Fresh water was provided ad libitum. Uncovered litter boxes ($61.0 \text{ cm} \times 48.3 \text{ cm} \times 25.4 \text{ cm}$) were cleaned with AC-101 (sodium hydroxide) and AC-3 (phosphoric acid) (Ecolab, St Paul, MN, USA) in an industrial case washer at 185°F and treated with the test conditions once daily (between 0800 h and 1000 h).

2.2. Base litter

For all research questions, the same unfragranced clumping clay base litter was provided. For research questions in which it was important to eliminate the potentially confounding effect of any lingering odor of box usage from the previous day (i.e., Objectives 2 and 3), approximately 2 kg of fresh litter (approximately 2 cm) was provided daily in all test and control litter boxes. For research questions in which odor of box usage lingering from the previous day was central to the treatment condition (i.e., Objective 1), 3 kg of base litter (approximately 3 cm) was provided at the beginning of the test, eliminated materials were scooped from litter boxes daily, and litter was topped up as needed. In these experiments, 3 kg of fresh litter (approximately 3 cm) was provided daily in control litter boxes.

2.3. Experimental design

Assessment of whether previous litter box use influences the appeal of the box for future familiar users was conducted in three objectives, each addressed with between two and four research questions. Table 1 summarizes the objectives, research questions, and provides a summary of each experiment including the panel used, days of study, number of cats, litter provision/maintenance strategy, and the treatment conditions employed. The details of each of these summaries are described below.

Most questions were assessed using a 4-day preference test, in which each cat is provided with two litter boxes each presenting a different treatment condition. The placement of these boxes varied daily between left and right in an A/B, B/A, B/A, A/B pattern. A previous study (unpublished) had determined that monitoring box use of 16 cats over 4 days was the optimal sample size for addressing questions of preference. Visual determination of the presence or absence of feces and urine in each litter box was recorded daily during cleaning. The number of defecations or urinations per day was not recorded. One question (Objective 1, Question 2) was assessed using a 1-day preference test, because identification of which cat deposited the urine and feces was too difficult on subsequent days. Fig. 1 provides a visual representation of the experimental set-up within each individual enclosure.

2.3.1. Objective 1 – To assess if previous litter box use influences box preference

The aim of this first Objective was to assess the common assumption that cats prefer a clean litter box to a used litter box (Question 1), and then assess if this preference is influenced by the identity of the previous user (i.e., themselves or a familiar conspecific; Question 2). The treatment conditions employed in Question 1 were: (A) urine and feces collected from a familiar cat which was excreted in the previous 24 h and collected the same morning of the

Table 1

Summary of each objective and research question, including the conditions employed for investigation.

Objective	Research question	# of test days	# of cats	Quantity of litter and maintenance of litter box	Treatment Condition A	Treatment Condition B
1: To assess if previous litter box use affects box preference	1: Do cats prefer to use a litter box with the urine and feces of a familiar cat, or a clean litter box?	4	29	≈3 kg litter, daily scooping, topped up as needed	Urine and feces from a familiar cat	Nothing added
	2: Do cats prefer to use a litter box with urine and feces from a familiar cat, or urine and feces from themselves?	1	27	≈3 kg litter	Urine and feces from a familiar cat	Urine and feces produced by themselves
2: To assess if odor alone affects litter box preference	1: Do cats prefer to use a litter box with 1 ml urine from a familiar cat, or 1 ml distilled water?	4	28	≈2 kg litter, completely changed daily	1 ml urine from a familiar cat	1 ml distilled water
	2: Do cats prefer to use a litter box with 1 ml fecal scent from a familiar cat, or 1 ml distilled water?	4	28	≈2 kg litter, completely changed daily	1 ml liquefied feces from a familiar cat	1 ml distilled water
	3: Do cats prefer to use a litter box with 1 ml urine and 1 ml fecal scent from a familiar cat, or 2 ml distilled water?	4	28	≈2 kg litter, completely changed daily	1 ml urine and 1 ml of liquefied feces from a familiar cat	2 ml distilled water
	4: Do cats prefer to use a litter box with 1 ml urine from a familiar cat, or 1 ml of fecal scent from a familiar cat?	4	28	≈2 kg litter, completely changed daily	1 ml urine from a familiar cat	1 ml liquefied feces from a familiar cat
3: To assess if obstructions alone affect litter box preference	1: Do cats prefer to use a litter box with a faux-urine clump, or unobstructed?	4	16	≈2 kg litter, completely changed daily	1 clump of 25 ml saline solution 3 clumps of 60 ml saline solution	Nothing added Nothing added
	2: Do cats prefer to use a litter box with a faux-fecal log, or unobstructed?	4	16	≈2 kg litter, completely changed daily	1 gelatin log 3 gelatin logs	Nothing added Nothing added
	3: Do cats prefer to use a litter box with a faux-urine clump and faux-fecal log, or unobstructed?	4	16	≈2 kg litter, completely changed daily	1 clump of 25 ml saline solution and 1 gelatin log 3 clumps of 60 ml saline solution and 3 gelatin logs	Nothing added
	4: Do cats prefer to use a litter box with a faux-urine clump, or a faux-fecal log?	4	16	≈2 kg litter, completely changed daily	1 clump of 25 ml saline solution 3 clumps of 60 ml saline solution	1 gelatin log 3 gelatin logs



Fig. 1. The experimental set-up within each individual enclosure.

test day in which it was employed as a treatment condition, and (B) a control litter box, consisting of nothing other than the base litter.

2.3.2. Objective 2 – To assess if odor alone influence litter box preference

The aim of this second Objective was to isolate the odor of urine and feces from the physical/visual obstruction it presents, in order to investigate the influence of odor alone on litter box preferences. The research questions were designed to investigate the impact of urine odor (Question 1), the impact of fecal odor (Question 2), the impact of a combination of urine and fecal odor (Question 3), and if cats' litter box preferences differ between urine odor and fecal odor (Question 4). In order to create the treatment conditions required for these questions, it was necessary to craft three substances: (1) a liquid that has the odor of the urine of a familiar cat, but is small enough in volume to avoid making large litter clumps, (2), a liquid that smells like feces from a familiar cat, but does not leave large clumps or log-like obstructions, and (3) a control treatment that has the same properties as substances 1 and 2, but without any odor. In order to generate substances 1 and 2, urine and feces were collected from one male cat per social group in the 48 h prior to the test period. Substance 1 simply consisted of 1 ml of urine from this cat. Substance 2 consisted of 1 ml of a solution of homogenized water and feces from the familiar cat in a 2:1 ratio. Substance 3 was 1 ml distilled water.

2.3.3. Objective 3 – To assess if obstructions alone influence litter box preference

The aim of this third Objective was to isolate the physical/visual obstruction presented by urine and feces from the odor of these

substances, in order to investigate the influence physical/visual obstructions have on litter box preferences. The research questions were designed to investigate the impact of faux-urine clumps (Question 1), the impact of faux-fecal matter (Question 2), the impact of a combination of faux-urine clumps and faux-fecal matter (Question 3), and if cats' litter box preferences differ between the obstructions presented by faux-urine clumps and faux-fecal matter (Question 4). In order to create the treatment conditions required for these questions, it was necessary to craft two substances: (1) a liquid capable of forming litter clumps that have the obstructive properties of urine clumps, but not the odor, and (2) log-like obstructions that have the obstructive properties of fecal logs, but not the odor. Saline solution (25-ml small clumps, 60-ml large clumps) was used as substance 1. Unflavored gelatin (Knox Gelatin, E.D. Smith Foods) was formed into the basic shape of actual fecal obstructions using silicone molds (7.25" L × 0.5" W) to create substance 2. Base litter alone (no obstructions) served as the control. The experiments designed to assess Objective 3 were conducted at two levels, mimicking (1) sharing a house with 1 small cat (1 25 ml saline or 1 gelatin log), or (2) sharing a house with 3 large cats (3 60 ml saline clumps or 3 gelatin logs). If cats have an aversion to obstructions in their litter box, litter box use should decrease as the amount of obstruction increases. Sharing with 1 small cat or 3 large cats represent realistic extremes of common multi-cat households. Fig. 2 provides a pictorial representation of the faux-urine and faux-fecal treatment conditions.

2.4. Statistical analyses

For most research questions, Generalized Linear Mixed models were conducted to model the likelihood of a cat urinating or defecating on any given day with treatment condition and the side (i.e., left or right) as fixed effects and cat as random factor in the model.

As Objective 1, Question 2 collected data from only one day per cat, the total number of urinations and defecations per treatment condition were analyzed using chi-square tests for statistical significance.

All analyses were conducted with SAS 9.3 (Copyright (c) 2002–2010 by SAS Institute Inc., Cary, NC, USA).

3. Results

For all research questions, estimates and *P*-values are provided in Table 2. In summary, cats preferred to both urinate and defecate in a clean litter box to one containing urine and feces from a familiar cat. However, when presented with a litter box containing the urine and feces produced by themselves or a litter box containing urine and feces from a familiar cat, cats showed no significant preference when either urinating or defecating. Similarly, when presented with a litter box containing only the odor of urine, feces, or a combination of urine and feces from a familiar cat, cats showed no significant preference for where to either urinate or defecate. However, when presented with a litter box containing substances mimicking only the physical/visual obstruction of urine, feces, or a combination of urine and feces, some preferences emerged. Cats preferred a clean litter box in all cases in which this was presented as an option, except one (no significant preference was exhibited for which box to use for defecation, when presented with a clean litter box or a litter box with 1 faux-urine gelatin log). When presented with a litter box containing faux-urine clumps or one containing faux-fecal logs, cats preferred to eliminate on the faux-fecal logs whether urinating or defecating, at the 1-cat level or 3-cat level.

No out-of-box elimination was exhibited at all during the study.

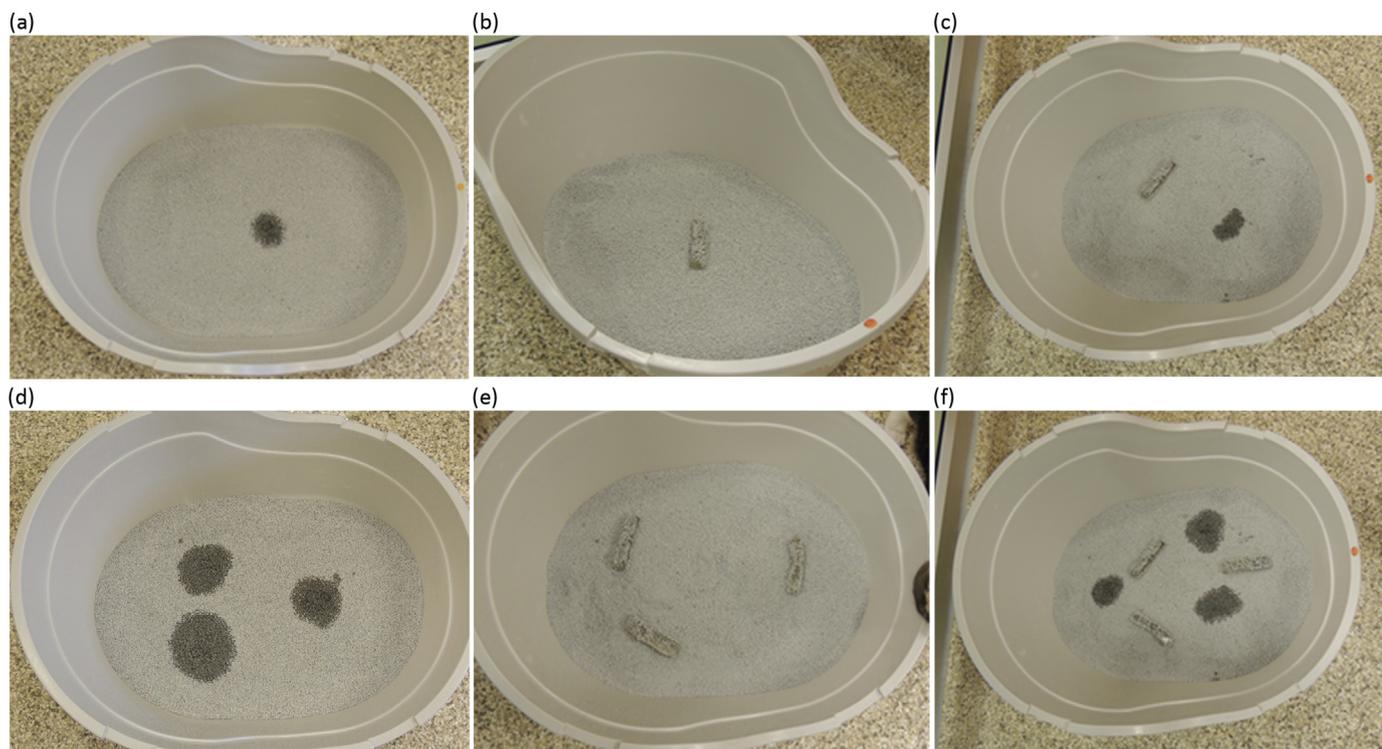


Fig. 2. Images of the faux-urine and faux-fecal treatment conditions. A-c mimic sharing a litter box with 1 small cat ((a) shows 1 faux-urine clump comprised of 25 ml saline solution, (b) shows 1 faux-fecal log comprised of 1 gelatin log, and (c) shows 1 faux-urine clump comprised of 25 ml saline solution and 1 faux-fecal log comprised of 1 gelatin log). D-f mimic sharing a litter box with 3 large cats ((d) shows 3 faux-urine clumps comprised of 60 ml saline solution each, (e) shows 3 faux-fecal logs comprised of 3 gelatin logs, and (f) shows 3 faux-urine clumps comprised of 60 ml saline solution each and 3 faux-fecal logs comprised of 3 gelatin logs).

4. Discussion

Results of this study reveal that cats prefer a clean litter box to a dirty litter box. Whether the previous box user was themselves or another familiar cat had no impact on preference. The presence of just the odor from urine and/or feces of a familiar cat in a litter box did not impact the litter box preferences of subsequent cats. Cats preferred a clean litter box to a litter box with the obstructive presence of odorless faux-urine and/or faux-feces (except in one instance). The presence of the faux-feces logs was preferred over the faux-urine clumps. Where experiments were conducted examining the presence of obstructions at two levels (mimicking sharing a house with 1 small or 3 large cats), preference for a clean box increased as the amount of obstruction increased, indicating an additive effect.

Based on the results of this study, there is no evidence cats were averse to sharing a litter box. There are several reasons why this may be.

Natoli (1985) emphasizes the importance of familiarity for cats living in a group, and show how this is illustrated in the investigation of feline marking. Cats spent longer investigating the marks of strange individuals than they did investigating the marks of familiar individuals. Although this does not prove that the presence of urine or feces of unfamiliar individuals would be more likely to either deter or attract subsequent users to a litter box, it does show that these marks are perceived differently and that the perceiver's behavior is influenced as a result, emphasizing the importance of familiarity. Crowell-Davis et al.'s (2004) findings that most or all members of a feral cat colony exhibit aggression toward unfamiliar individuals suggest that the difference in reaction to the marks of unfamiliar individuals may be paired with an aggressive reaction upon meeting. Therefore, it is reasonable to suspect that if the urine and feces presented in the litter box had been from an unfa-

miliar individual, a stronger relationship with box preference of subsequent users may have been expected. However, as this was not a fair representation of the conditions in a multi-cat home, this research question was not addressed. We recognize that in some circumstances a house cat may need to eliminate in the same box as an unfamiliar individual (e.g., if an unfamiliar cat has entered the house through a cat flap), but this is rare and outside the scope of this paper.

It is also possible that lack of litter box aversion by the odor of the urine and feces of a familiar cat in the litter box is because all of the cats in the current study were spayed/neutered. The levels of different compounds in the urine vary between intact and altered animals. Hendriks et al. (1995) found that urine from intact males contained significantly more feline than did the urine of altered males, and either intact or altered females. It is therefore also reasonable to suspect that if the urine and feces presented in the litter box had been from an intact individual (particularly an intact male), a stronger relationship with box preference of subsequent users may have been expected. However, as 90% of owned cats in the U.S. are spayed or neutered (American Pet Products Association, 2015) this would not have been a fair representation of the conditions in most multi-cat homes, and this research question was not addressed.

The relationship of the cats in the current study is another important factor to consider when reasoning why there was no evidence for litter box aversion as a result of the odor of urine and/or feces of a familiar cat in the litter box. Agonistic interactions (whether overt or subtle) were very rare within the groups of cats. If cats were able to match any cue in the urine or feces of a familiar cat with its donor, it is entirely possible that the cat receiving this message simply did not perceive it as a threat, since it came from a cat with which they were unlikely to enter into an agonistic interaction. Future studies investigating how the odor of

Table 2
Estimates and *P*-values for the urination and defecation of cats in each research question.

Objective #	Question #	Treatment Condition (TCA) A	Treatment Condition (TCB) B	Product preference		
				Statistic description	Urinations	Defecations
1	1	Urine and feces from a familiar cat	Nothing added	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.58 (0.04) 0.94 (0.04) <0.001	0.45 (0.05) 0.61 (0.05) 0.012
	2	Urine and feces from a familiar cat	Urine and feces produced by themselves	TCA total # of incidents TCB total # of incidents DF, Chi-square, <i>P</i> -value	22 17 1, 2.56, 0.109	16 15 1, 0.08, 0.778
2	1	1 ml urine from a familiar cat	1 ml distilled water	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.85 (0.04) 0.83 (0.04) 0.693	0.50 (0.05) 0.53 (0.05) 0.669
	2	1 ml of liquefied feces from a familiar cat	1 ml distilled water	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.81 (0.36) 0.88 (0.36) 0.174	0.54 (0.05) 0.55 (0.05) 0.888
	3	1 ml urine and 1 ml liquefied feces from a familiar cat	2 ml distilled water	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.85 (0.04) 0.86 (0.04) 0.840	0.50 (0.05) 0.53 (0.05) 0.674
	4	1 ml urine from a familiar cat	1 ml liquefied feces from a familiar cat	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.87 (0.03) 0.88 (0.03) 0.832	0.52 (0.05) 0.56 (0.05) 0.566
3	1a	1 clump of 25 ml saline solution	Nothing added	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.77 (0.04) 0.98 (0.04) <0.001	0.39 (0.06) 0.72 (0.06) <0.001
	1b	3 clumps of 60 ml saline solution	Nothing added	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.30 (0.05) 0.95 (0.05) <0.001	0.17 (0.05) 0.88 (0.05) <0.001
	2a	1 gelatin log	Nothing added	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.73 (0.05) 0.88 (0.05) 0.034	0.48 (0.06) 0.57 (0.06) 0.364
	2b	3 gelatin logs	Nothing added	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.52 (0.05) 0.94 (0.05) <0.001	0.25 (0.05) 0.77 (0.05) <0.001
	3a	1 clump of 25 ml saline solution, and 1 gelatin log	Nothing added	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.63 (0.05) 0.90 (0.05) <0.001	0.28 (0.05) 0.82 (0.05) <0.001
	3b	3 clumps of 60 ml saline solution, and 3 gelatin logs	Nothing added	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.33 (0.05) 0.95 (0.05) <0.001	0.09 (0.04) 0.84 (0.04) <0.001
	4a	1 clump of 25 ml saline solution	1 gelatin log	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.75 (0.05) 0.90 (0.05) 0.032	0.38 (0.06) 0.63 (0.06) 0.006
	4b	3 clumps of 60 ml saline solution	3 gelatin logs	TCA mean (SE) likelihood est TCB mean (SE) likelihood est <i>P</i> -value	0.45 (0.05) 0.98 (0.05) <0.001	0.16 (0.04) 0.89 (0.04) <0.001

Note: In test statistic columns green cells indicate a significant preference was identified.

a familiar cat influences box choices in pairs known to have less positive relationships may provide different results, and may more closely mimic multi-cat households in which litter box aversion and out-of-box elimination are due to inter-cat aggression. Furthermore, although the cats in the current study were socialized in their groups for 2–3 h a day, the bulk of their eliminations took place when they were individually housed. This means that the cats in this study did not compete for the litter box, a potentially valuable resource. Access to valuable resources can be highly related to dominance relationships (Crowell-Davis et al., 2004), which in turn can be highly related to marking behavior (Natoli and De Vito, 1991). Most multi-cat homes have free access to litter boxes, and thus the lack of competition for access to litter boxes in our study may not truly represent what occurs in home.

The lack of relationship between urine and fecal odor and litter box preferences also suggests that cats, contrary to the findings of Neilson (2007, 2008b) and Cottam and Dodman (2007), may not be deterred by malodor. However, there was evidence that the presence of physical/visual obstructions in the litter box did have an effect on litter box preferences. Although this is clearly not a result of scent marking, it is possible that this is a result of visual marking. MacDonald (1980) suggested that dominant individuals were more likely to leave feces uncovered than subordinates. If so, these non-covered physical/visual faux-obstructions could have deterred use by cats who wished to avoid previous (presumably dominant) users. However, if this hypothesis was to match the findings of MacDonald (1980), it would be expected that this aversion would be stronger for the faux-fecal logs than for the faux-urine clumps, and this was not the case. It is likely that aversion to litter

boxes with physical/visual obstructions was due to the increased difficulty in expressing the behaviors in their natural elimination sequence, such as digging which is hypothesized to deliver some tactile/kinesthetic feedback from the paws (Borchelt and Voith, 1996). It has also been suggested that aversion to litter boxes with physical/visual obstructions may result from a cat's previous experience with soiling its paws while using a litter box containing diarrhea (Borchelt and Voith, 1996).

The findings of this study lend no support to the idea that cats are averse to sharing litter boxes. Cats seemed deterred by physical/visual obstructions, but the identity of the cat that produced these obstructions did not seem relevant. However, these findings reemphasize the importance of regular litter box maintenance as the key factor in promoting proper litter box use.

4.1. Conclusions

Cats prefer to eliminate in unused litter boxes over used litter boxes. However, this does not appear to result from signals communicated chemically, as the identity of the previous user had no impact on box use. It is important to note that these were all familiar users which had little to no agonistic interactions. It is possible that urine or feces from unfamiliar individuals might elicit different responses, but this would not really be representative of the conditions in a multi-cat household. It is also possible that urine or feces from individuals with whom they experience particular inter-cat aggression might also elicit different responses. This scenario may accurately describe the conditions in a multi-cat household. Further investigation of this scenario may be revealing. The preference to eliminate in unused litter boxes also does not appear to be influenced by malodor, as the presence of the odor of urine or feces did not result in a preference over a control litter box. Elimination preferences do appear to be influenced by physical/visual obstructions. Cats preferentially avoid litter boxes with obstructions, faux-fecal obstructions were preferred to faux-urine clumps, and results intensify as amount of obstruction increases. It is likely that this aversion to physical/visual obstructions was due to the increased difficulty in expressing the behaviors in their natural elimination sequence. Results emphasize the importance of litter box maintenance as the key factor in promoting proper litter box use. This may be especially important in multi-cat households, due to the increased amount of eliminated materials.

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