



Effect of an odor eliminator on feline litter box behavior

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Decreasing litter box odor may be an important treatment component in addressing feline inappropriate elimination. A three-phase study was conducted to determine if the use of Zero Odor litter box spray increases the preference of litter boxes to cats, presumably by its odor-eliminating quality. In the first phase, cats were given a litter box preference test between a litter box sprayed with Zero Odor and one without. In the second phase, the number of occurrences of behaviors indicative of a cat's dissatisfaction with the litter box (scratching at the sides of the box, floor or wall, hesitating when entering the litter box, balancing on the side of the box and eliminating outside of the litter box) was compared before and after the use of Zero Odor. Last, the frequency of eliminations that occurred outside the litter box was measured during a baseline phase and a test phase, in which Zero Odor was sprayed into all litter boxes in the home. Significantly fewer behaviors associated with feline litter box dissatisfaction and fewer undesirable eliminations were observed in phases 2 and 3, respectively. These findings suggest that use of Zero Odor litter box spray appears to decrease litter box odor and increases the attractiveness of litter box to cats.

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Inappropriate elimination, the most common feline behavior problem presented to veterinarians and behaviorists (Borchelt 1991), is the feline behavioral problem associated with the highest risk of relinquishment (Patronek et al 1996). Inappropriate elimination is used to describe urine/fecal marking as well as litter box aversions and preferences ('house soiling'). According to Crowell-Davis (2001), one out of 10 cat-owning households has some degree of inappropriate elimination and Voith (1985) found that 24% of 800 surveyed cat owners reported inappropriate elimination. European studies have reported the incidence of house soiling to be as high as 32% in France, 35% in Germany and 35% in the UK (Heath 2001). House soiling is associated with any number of litter box attributes, such as location of the box(es), number of box(es), type of litter/litter box, depth of litter, cleanliness of the box, and odor, while urine/fecal marking has been associated with stressors such as addition of a new cat or person to the household (Skerrit and Jemmett 1980), and

the sight/scent of outdoor neighborhood cats (Cooper 1997).

Treatment of feline inappropriate elimination that has a house-soiling component involves increasing the attractiveness of the litter box facilities within the owner's home (Hart 1996) and properly neutralizing the scent of previously soiled areas (Pryor et al 2001), which may serve as an attractant to some cats. Behaviorists have offered a number of recommendations to improve a cat's litter box situation and usage, such as insuring that there are an appropriate number of boxes per cat ($n + 1$, where n = the number of cats), discontinuing use of a plastic litter liner; using a fine-grained litter that is unscented and clumps, discontinuing use of perfumed/ammonia-based cleaning products to wash the box; and regular scooping (Borchelt 1991, Horwitz 1997, Neilson 2001). Decreasing odor of feces and urine by regular scooping or dumping of old litter is an important component in the treatment of inappropriate elimination (Crowell-Davis 2001).

Zero Odor, a new litter box spray, was tested by an independent laboratory (Crane Engineering, 3905 Annapolis Lane North, Plymouth,

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NM 55447-5473) to determine its ability to decrease litter box odor by measuring the concentration of ammonia and sulfur compounds (hydrogen sulfide, methyl mercaptan, dimethylsulfide, dimethyldisulfide) in the ambient headspace above soiled cat litter. Ion chromatography detected 0 µg/l of ammonia and 0 µg/l of each sulfur compound 6 h after use of Zero Odor. The odor elimination mechanism thought to result from the application of Zero Odor to the litter box is attributable to an irreversible change in the molecular structure of the odor-causing molecules from both urine and fecal matter. This irreversible molecular change eliminates the possibility of odor reoccurrence until new urine or fecal matter is presented to the litter box. Subsequent application of Zero Odor to the litter box will eliminate the odor of these new deposits in the same way.

To test whether Zero Odor changes cats' use of litter boxes, three open-label studies were conducted. Study 1 measured the preference of cats for a box sprayed with Zero Odor vs one without. Study 2 measured the frequency of 'dissatisfied' litter box behaviors (Table 1) with and without Zero Odor application. Study 3 measured the effectiveness of the product as a treatment for inappropriate elimination.

Materials and methods

Study 1

Owners of single cats were recruited by placing an advertisement (Fig 1) for paid volunteers on cat-associated websites (Catfancy.com; Isoldmypet.com; Petlovers.com; Craigslist.org; Aboutcat.com; Catforum.com; and Ilovemypet.com). Owners

CAT OWNER?? Participate in study, make some \$\$\$

ATTENTION CAT OWNERS in NEWTON, MA area:

A PAID study on the litter box behavior of cats will be conducted by a renowned veterinarian from the vicinity. If you have a cat and are interested in participating, please contact us with the following information:

1. How many cats are in your household?
2. Are they indoor or outdoor cats?
3. Do your cats ever 'go' outside the litter box or display any other strange behavior around the litter box?

Please reply to research@strickman-ripps.com
(212)-966-3211
fax (212)-966-4455

Fig 1. Internet advertisement used to find study participants.

were told that they would be testing a product that might increase the attractiveness of a litter box to their cat. All recruited owners had an indoor cat that did not urinate or defecate outside the litter box, showed four or less 'dissatisfied' litter box behaviors (Table 1), and had one open or closed litter box containing clumping litter. Cats older than 14 years were not eligible to participate to increase the chance of enrolling physically and mentally healthy cats.

Ten subjects were found. Nine of the 10 subjects were neutered. The sex ratio was exactly 1:1. Three cats (30%) in the study were domestic longhairs and the remaining seven (70%) were domestic shorthairs. The average age of cats in study 1 was 3.1 years (± 2.5 SD).

Owners were asked if their cat showed any of the following behaviors thought to indicate a cat's dissatisfaction with its litter box: scratches sides of litter box, scratches floor or a wall near litter box, balances on sides of box when exiting or entering the litter box, raises a paw or places paw(s) on side of litter box while eliminating, approaches litter box, hesitates and walks away without using it, approaches litter box, gets into it, and jumps out without using it, and absence of digging, circling, or covering waste while using the litter box. Absence of digging was chosen as a behavior that indicates litter box dissatisfaction because cats that dig for 4 s or less prior to eliminating may be candidates for elimination problems (Sung 1998). Failure to cover waste material was chosen because cats with inappropriate elimination are less likely to cover their waste, according to owner reports (Horwitz 1997). Another study used sniffing or pawing the litter box, or the area immediately around the litter box, but not immediately using for eliminative behaviors, as a behavioral measure of stress in cats (Griffith et al 2000). The cats in study 1 displayed a mean of 2.5 (± 1.2 SD) 'dissatisfied' litter box behaviors. Three of the preceding

Table 1. 'Dissatisfied' litter box behaviors used as a behavioral inclusion criteria

1.	Scratch sides of litter box.
2.	Scratch floor or a wall near litter box.
3.	Balance on sides of box when exiting or entering the litter box.
4.	Raise paw or place paw(s) on side of litter box while eliminating.
5.	Approach litter box, hesitate and walk away without using it.
6.	Approach litter box, get into it, and jump out without using it.
7.	Absence of digging, circling, or covering waste while using litter box.

dissatisfied litter box behaviors (hesitating to enter the box; balancing on the sides of the box; and scratching at the sides of the box, floor or wall) were used as dependent variables in study 2.

Participating owners were instructed to permit a 2-week soiling period of their cat's litter box before the formal study to ensure that their cats' litter boxes accumulated urine and fecal odor. To accomplish this, owners were instructed to empty the litter from their cat's box and refill it with their favored brand of fresh clumping litter to a depth of 4". They were instructed to scoop the litter regularly but not to add any new litter or change the litter in the box for 2 weeks. Following the soiling period, a researcher delivered two identical hoodless litter boxes (length 18" × width 15" × depth 5.5") labeled 'control' and 'Zero Odor' and two different colored litter box scoopers. The boxes were placed in the location of the original box, 1.5 ft apart. Scooped litter from the previously soiled box was then divided between the two test boxes, each of which was weighed to ensure equal amounts of litter per box.

Owners were instructed to spray six squirts of Zero Odor into the box labeled 'Zero Odor' twice daily and to record the total number of urine and fecal clumps scooped from each of the boxes over a 4-day period. They were asked a 'yes' or 'no' question concerning the difficulty of counting and differentiating the clumps. The owners were instructed to switch the position of the two boxes after 2 days and continue to use the corresponding scooper. Four days after the beginning of the study, a researcher returned to the owners' homes to ensure that the owners had followed the protocol; to recover the data sheets; and to weigh the boxes. One cat's litter box trips were videotaped using the methodology in study 2 (data not used in analysis).

Study 2

Owners were recruited via in-person interviews on various streets in Newton, MA. Eligible participants had one or more cats that displayed at least two 'dissatisfied' litter box behaviors (Table 1). The cats had to use one litter box preferentially (to facilitate video capture). Cats older than 14 years were ineligible to participate. Owners had to agree to remove hoods from their litter boxes for 2 weeks prior the 48-h study and to keep their cat(s) indoors during the study. Seven owners of 11 eligible cats were included in the study. The mean number of dissatisfied litter box behaviors exhibited by these cats,

according to owner reports, was 3.2 (± 1.3 SD). All 11 cats were neutered. Four cats (36%) were domestic longhairs, seven cats (64%) were domestic shorthairs and six cats (55%) were male. Their mean age was 5.4 years (± 3.6 SD).

A researcher set up video equipment in each home to observe the cats' litter box behavior. The video camera used was a CE model CIP-913 black and white only (dimensions: 4.25" × 2.75" × 1.75"). The camera-VCR setup was motion-activated to record for a 3-min period. If motion continued, the camera continued to record, stopping 3 min after all motion ceased. The camera was mounted on an elevated physical structure 1–2 ft from the litter box at a 0–45° angle to the box. The VCR was placed in a convenient location nearby. Overhead lighting, positioned approximately 5 ft above the box, was utilized in each home.

The cameras were set to record for 48 consecutive hours. The first 24 h was considered the baseline phase and the second 24-h period was the test phase. Owners were instructed to scoop the litter box at the beginning of the baseline period and again at the beginning of the test phase. They were also instructed to spray the product into the litter box (six squirts) at the beginning of the test phase and again 12 h later. Cats' filmed litter box visits were scored according the rules in Table 2. Three easily-scored dissatisfied litter box behaviors thought to demonstrate a cat's dissatisfaction with its litter box were used to generate the score. These behaviors were: hesitating to enter the box; balancing on the sides of the box; and scratching at the sides of the box, floor or wall. A cat needed to earn a baseline behavior score of at least 0.5 per litter box visit to qualify for inclusion into the study. The Wilcoxon signed ranks test was used to detect a difference between the mean baseline and test scores.

Study 3

As in study 2, owners were recruited via in-person interviews in Newton, MA. In order to have their cat enrolled in the study, owners had to find urine or feces outside of the litter box at least once per week. Twelve owners of 26 cats agreed to test Zero Odor litter spray. The mean number of cats/home was 2.2 (range was 1–4 cats/home). The mean age of the cats was 7.9 years (± 5.2 SD) and 14 cats (54%) were female. Nineteen cats (73%) were domestic shorthairs and seven cats (25%) were domestic longhairs. In six homes (50% of homes), clumping litter was used, and there were 1.5 litter boxes/home (± 0.7 SD). In

Table 2. Scoring system for study 2

Behavior	Score	
1) Does cat scratch at the sides of the box, floor or wall?	Yes = 1	No = 0
2) Does cat hesitate when entering the box?	Yes = 1	No = 0
3) Does cat balance on the sides of the box during its litter box visit? (Balancing = at least two paws involved)	Yes = 1	No = 0
4) Does cat use litter box during that phase of the test?	Yes = 0	No = 4

Score is based on 0–4

0 = No variables were witnessed
 1 = One of the three variables was witnessed (scratching, balancing on sides or tentative approach to box)
 2 = Two of the three variables were witnessed
 3 = All three variables were witnessed
 4 = Cat doesn't use box at all during that phase

► For each phase of the study in which the cat used the box for elimination, the number of times the cat demonstrated behaviors 1, 2 or 3 (above) was totaled and divided by the total number of eliminations in that phase. If the cat did not use the box in a particular phase, his/her score is 4 for that phase. If the same cat used the box in another phase, its score was 0 for that phase, independent of the litter box behavior he/she demonstrated.

► For cats that eliminated twice during one litter box trip, the number of eliminations was counted as one.

four of the 12 homes (33%) hooded litter boxes were used. The mean number of dissatisfied litter box behaviors/cat reported by the owners before the study began was 3.8 ± 1.3 SD. This was significantly different from the number of dissatisfied litter box behaviors reported by owners of cats in study 1 ($P = 0.005$) but not significantly different from those reported by owners of cats in study 2 ($P = 0.178$). The participants were instructed not to change the type of litter used, the frequency with which they scooped their litter boxes, the type/number of litter boxes in their home, the product used to clean soiled areas, or to acquire another cat for the 1-month duration of the study.

Owners were asked to comment on the areas where they found eliminations in the past to distinguish house soiling from urine marking, though cats with both of these problem behaviors were permitted into the study. In all homes a house-soiling problem was evident and in two homes a concurrent urine marking problem was apparent. Owners were mailed a bottle of Zero Odor, an instruction sheet, and data collection sheets. During the first 2-week baseline phase, owners were asked to record the total number of inappropriate urine and fecal eliminations found and when these eliminations were believed to have occurred (ie, that day, the previous day, or not known). On day 15, owners were instructed to start spraying all litter boxes in the house with

Zero Odor (six squirts every 12 h) for a 2-week period and to continue recording the number of inappropriate eliminations found. At the conclusion of the study, owners were asked to mail in their data collection sheets to the study monitor.

The data for studies 1, 2 and 3 were analyzed using SPSS version 10.1. Non-parametric tests were used to analyze the non-normally distributed data. The Wilcoxon signed ranks test was used to test for significant differences in: (1) the total number of clumps, urine clumps, fecal clumps and weights of the litter boxes used in study 1, (2) the pre- and post-behavioral scores used in study 2, and (3) the number of inappropriate eliminations (urine and fecal) reported per study phase and per day in study 3. Analysis of Variance (ANOVA) and post hoc test Least Significant Difference (LSD) were used to detect significant differences in the number of 'dissatisfied' litter box behaviors between the cats in studies 1, 2 and 3. Alpha was set at $P < 0.05$.

Results

Study 1

The mean number of urine and fecal clumps scooped from the Zero Odor boxes and control boxes during the 4-day test period was $15.1 (\pm 7.2$ SD) and $17.2 (\pm 9.3$ SD), respectively. The

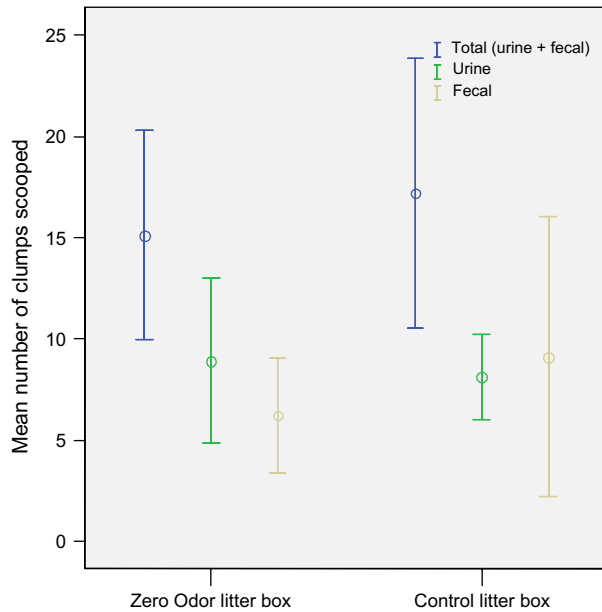


Fig 2. Mean number of total (urine + fecal), urine, and fecal clumps scooped from each litter box during 4-day study ($n = 10$). Error bars reflect 95% confidence intervals.

difference between these scores was not significant ($P = 0.646$) (Fig 2).

The mean number of urine clumps scooped from the Zero Odor boxes and control boxes was $8.9 (\pm 5.7 \text{ SD})$ and $8.1 (\pm 3.0 \text{ SD})$, respectively. The difference between these scores was not significant ($P = 0.798$).

The mean number of fecal clumps scooped from the Zero Odor boxes and control boxes was $6.2 (\pm 4.0 \text{ SD})$ and $9.1 (\pm 9.7 \text{ SD})$, respectively. This difference was not significant ($P = 0.385$).

There was no significant difference between pre- and post-study weights of litter remaining in the two boxes. The mean weight loss of litter in the Zero Odor boxes was $301 \text{ g} (\pm 105.4 \text{ SD})$ at the conclusion of the 4-day study period; the mean weight loss of control boxes was $352 \text{ g} (\pm 72.8 \text{ SD})$. This difference was not significant ($P = 0.374$).

The number of eliminations recorded on video for one study cat, over the 4-day period, was 12. The number of clumps reported by this cat's owner, over the 4-day period, was 22.

Study 2

A significant difference was found between the mean baseline behavioral score ($1.8 \pm 1.2 \text{ SD}$) and the mean test phase behavioral score ($0.70 \pm 0.89 \text{ SD}$) ($P = 0.036$) (Fig 3). One cat's test phase behavioral score was higher than its

baseline behavioral score and another cat's baseline and test phase scores were the same. The remaining nine cats (82%) had test phase scores that were lower than their baseline scores. On average, the test phase score was lower than the baseline score by 61%, representing a 61% decrease in 'dissatisfied' litter box behavior.

The mean number of litter box visits made by cats during the 48-h period was 4.9, which is within the limits of the expected frequency of elimination in published reports (Horwitz et al 2002, Overall et al 2005). Two cats in the only indoor/outdoor cat household did not use the litter box at all during the baseline phase. The owner reported that she found urine outside the litter box that day. These same two cats did use the litter box during the test phase.

Study 3

Eleven of 12 owners reported a decrease in the number of inappropriate eliminations during the test phase. In no instance did the number of inappropriate eliminations increase during the test phase.

There was a significant difference in the number of inappropriate eliminations found by owners during the test and baseline phases ($P = 0.003$, $n = 12$). During baseline, owners found an average of $13 (\pm 7.8 \text{ SD})$ inappropriate eliminations whereas in the test phase an

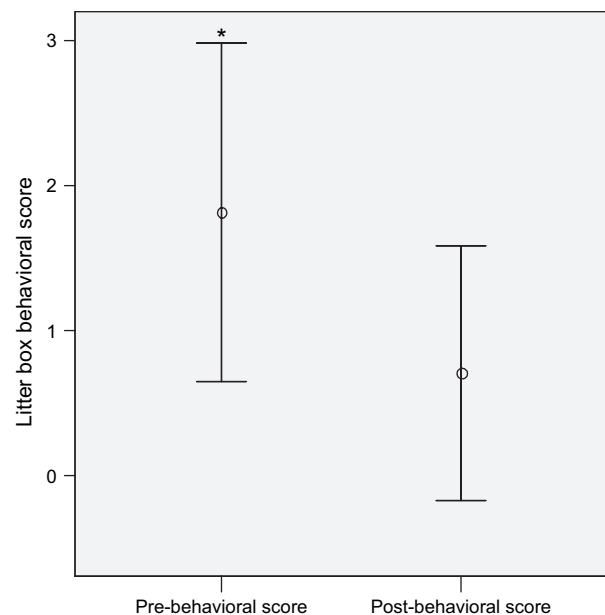


Fig 3. Mean pre- and post-behavioral scores ($\pm \text{SD}$) for cats that used litter boxes with and without Zero Odor treatment ($n = 11$). *Denotes significant difference at $P = 0.036$.

average of 7.8 (± 4.9 SD) inappropriate eliminations were found. This represents a 40% decrease in the mean number of inappropriate eliminations, ie, a mean of 5.3 fewer eliminations outside of the litter box during the 2-week test period than in the baseline phase.

When inappropriate elimination was broken down into urination and defecation, a significant difference ($P = 0.003$) was detected between the mean number of inappropriate urinations found during the baseline (7.9 ± 5.8 SD) and the test phases (4.8 ± 4.5 SD), but not between the mean number of inappropriate defecations found in the baseline (5.2 ± 5.8 SD) and the test phases (3.0 ± 3.9 SD) ($P = 0.057$).

The mean number of inappropriate eliminations per day was used to detect significant differences because some owners failed to record the number of inappropriate eliminations they found on a particular day. The mean number of inappropriate eliminations per day during the baseline period (0.9 ± 0.5 SD) was significantly different from the number reported during the test period (0.6 ± 0.4) ($P = 0.003$) (Fig 4). There was a significant difference between the mean number of inappropriate urinations/day found during baseline (0.6 ± 0.4 SD) and the test phases (0.3 ± 0.3 SD) ($P = 0.003$). The difference between the mean number of inappropriate defecations/day (0.4 ± 0.4 SD baseline phase and 0.2 ± 0.3 SD test phase) found in the two phases was not statistically significant ($P = 0.057$).

Owners were asked if they knew whether the inappropriate elimination occurred on the day they found the soiled area because of the possibility that eliminations found on day 15 (test phase) may have occurred on day 14 of the baseline period. One owner reported that she was 'not sure' when an inappropriate elimination found on day 15 occurred so this day was not used in the analysis.

Discussion

The findings in studies 2 and 3 indicate that Zero Odor may be a useful addition to standard treatment protocols for inappropriate elimination caused by litter box aversion. As none of the cats in the study exclusively urine marked, we could not determine whether Zero Odor would be helpful for treatment of this problem. However, treating urine marking as a house-soiling problem by cleaning soiled areas with an enzymatic product, adding extra litter boxes to the home, daily litter box scooping and regular litter

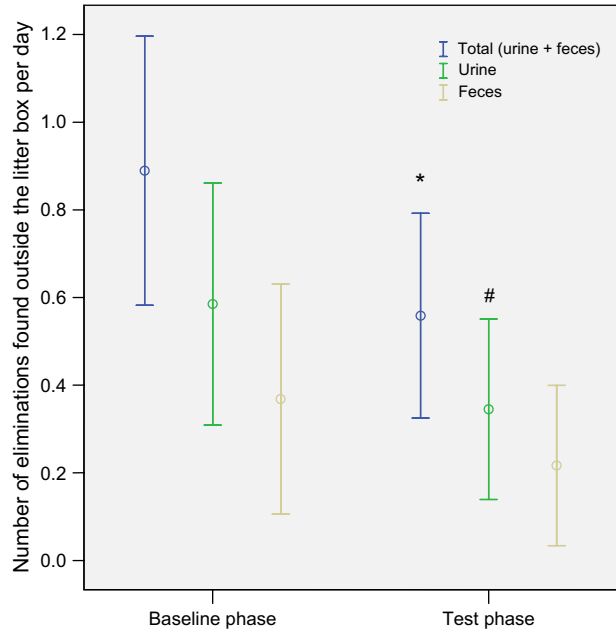


Fig 4. Mean total, urine, and fecal eliminations found outside the litter box per day during each 2-week study phase ($n = 12$). *#Denote significant difference at $P = 0.003$. Error bars reflect 95% confidence intervals.

box cleaning, has been shown to be partially effective (Pryor et al 2001).

Twenty-four out of 32 owners (75%) in this study reported that their cats' displayed three or more 'dissatisfied' litter box behaviors, which may imply that many cats are not fully satisfied with their existing litter box arrangements. Though not tested in these studies, Zero Odor may help prevent inappropriate elimination in cats that are not content with their litter box hygiene but have yet to progress from reluctant litter box usage to inappropriate elimination.

No preference for a litter box sprayed with Zero Odor was demonstrated in study 1. It could be that:

- Zero Odor did not increase the attractiveness of the sprayed litter box.
- Cats in this phase of the study did not have a serious litter box aversion problem.
- The number of owner-reported urine and fecal clumps did not accurately reflect the number of eliminations in the litter boxes. In support of this contention, the number of video recorded litter box visits was considerably less than the number of clumps reported by the owner. Also, 50% of owners reported that counting clumps was 'difficult'. The reasons given for this difficulty were that the

clumps tended to fall apart and multiple, fragmented fecal clumps were often dispersed within the box. Also, the expected number of eliminations over a 4-day period is approximately 12–20 eliminations per cat (Overall et al 2005). However, in this study, owners reported a mean of 32 eliminations per cat over this period.

Another limitation is that owners used various types of clumping litters. Standardizing the type of litter to one that clumps best may have reduced or eliminated the problem with counting clumps that break-up. It is possible that Zero Odor changed the clumping ability of the litter, though no owners reported a change in clumping efficacy. A further study utilizing video surveillance is warranted to make direct measurements of the number of eliminations and thus determine whether cats show preference for litter boxes treated with this product.

Due to monetary and time constraints, the cats in this study did not undergo a medical examination to determine their health status. It is possible that some cats in this study had an undiagnosed medical condition, which affected their behavior and influenced the results of this study.

Positive results in studies 2 and 3 could be a result of owners paying more attention to the litter boxes or a placebo effect. Another possibility is that application of Zero Odor caused a change in the texture of litter, however tactile and visual inspection of freshly sprayed litter by the researchers did not reveal any obvious texture change. More likely, as Zero Odor's only known chemical action is to combine with and eliminate odors, is that odor reduction was at the root of the observed alterations in the cats' behavior.

Zero Odor litter spray should not be used as a replacement for regular scooping and replacement of dirty litter. Used as a supplement to routine litter box care, application of Zero Odor litter spray could be a positive addition to standard litter box maintenance.

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