

Effect of a Synthetic Feline Pheromone for Managing Unwanted Scratching

Beck A.^{1*}

De Jaeger X.¹

Collin J.-F.¹

Tynes V.²

¹ CEVA Sante Animale, 10 Avenue La Ballastière, 33500 Libourne, France

² CEVA Animal Health, 8906 Rosehill Rd, Lenexa, KS 66215, USA

*To whom correspondence should be addressed:

@: alexandra.beck@ceva.com Tel: +33 5 57 55 42 07

KEY WORDS: Scratching, cat, pheromone, feline interdigital semiochemical, behaviour, claw marking

ABSTRACT

Objectives

The scratching of objects in the environment is a normal part of the feline behavioural repertoire, but it appears to be one of the more disturbing problems reported by cat owners. In fact, even in the presence of a scratching post, a large majority of owners still observe scratching on unwanted locations in the home.

Methods

The present study tested a solution containing a synthetic analogue of a pheromone - the feline interdigital semiochemical - to determine if it was sufficiently attractive to redirect any scratching behaviour to a scratching post. Cat owners facing unwanted scratching in the home were instructed to follow a protocol consisting of the application of this pheromone directly on the scratching post.

Results

We demonstrated that 74% of the cats with established unwanted scratching completely stopped scratching on vertical surfaces in

the home, other than the treated scratching post after 28 days of application. Moreover this treatment also decreases scratching on horizontal surfaces in these cats. This treatment also appears to have a preventative effect when applied in homes with a recently adopted cat.

Conclusion

In summary, the application of a synthetic analogue of the feline interdigital pheromone appears to be an innovative and effective solution to overcome the frequent behavioural scratching problem in cats.

INTRODUCTION

Scratching of objects in the environment is a normal part of the feline behavioural repertoire. Cats scratch to condition their claws by removing the frayed outer layers, to stretch and exercise their muscles, as well as to mark both with visual and chemical cues (1,2). When performed in the home on the owner's furniture, this behaviour can be highly destructive and can be a cause of great frustration for owners. This can happen either on vertical (wall, door frame, chair,...) or horizontal surfaces (carpet, sofa, bed,...) as cats may choose to scratch any surface, whether considered

“appropriate” or acceptable to their owner (vertical or horizontal scratching posts) (3) or not (4). Owner responses may range from physically removing the cat so as to interrupt the sequence and redirect it to another location, to yelling or hitting the cat. This will make the environment even more stressful for the cat, possibly contributing to an increase in anxiety-related behaviours, avoidance behaviour, fear and ultimately owner directed aggression, and damage to the human companion animal bond. If the bond becomes too severely damaged, the owner may relinquish the cat to a shelter or may simply stop allowing the cat access to the indoors and maintain it as an “outdoor only” cat. This leaves the cat vulnerable to all of the dangers associated with outdoor living such as injuries and diseases from fighting with other cats, trauma from vehicle strikes or predation by larger carnivores, all of which negatively impact the cat’s quality of life and life span.

According to a survey, 60% of the owners report problem scratching from their pet cats (3). Scratching furniture is also associated with an increased risk of relinquishment (5). When cat owners do discuss the condition with their veterinarians, the options that are offered may include education about environmental enrichment, performing regular nail trimming or placing plastic nail covers. Another option, common in the US especially for cats kept indoors, is surgical declawing (onychectomy). One study demonstrated that approximately 20% of cats in the US have undergone this procedure (6). Depending on methodology, over the past 10 years, different surveys have found 20-45% of cats in different populations within the US had been declawed (5,7,8). Declawing is a highly controversial procedure and many countries (most of the European countries, Brazil, Australia, New Zealand, Israel, Japan and Turkey) have outlawed the procedure or authorized it only under extreme circumstances. It is considered a needless mutilation not performed for the animals benefit, and not consistent with the principles of good animal welfare. In the United States,

some cities and municipalities have made it illegal to perform this procedure unless medically necessary. In 2015, two American organizations published new position statements regarding declawing. Both the American Veterinary Medical Association (AVMA) and the American Association of Feline Practitioners (AAFP) state that declawing is not a “medically necessary” procedure for the cat and that scratching is a normal feline behaviour and clients should be better educated regarding the variety of other options besides surgical mutilation of their pets.

While the evidence that declawing results in any long term negative behavioural or emotional problems is ambiguous at best (9), it is a major surgery, an amputation of digits, resulting in acute pain that is performed primarily for the convenience, or in some cases, the safety of the owner. By one author’s estimation, about 40% of the owners of declawed cats would probably no longer have their cat if they had not had it declawed but current peer reviewed data regarding the risk of euthanasia for destructive cats remains limited (2).

A 2015 survey conducted of over 4000 cat owners demonstrated that while most of them recognized their cats need for a scratching post, the traditional types offered were not usually the types preferred by the cats. The study also demonstrated that when cats were rewarded for appropriate scratching behaviour, they were more likely to use their scratching posts (3). These data suggest that deeper knowledge about cat preference in a scratching post and more information about how to encourage cats to use scratching posts, could prevent many unnecessary surgeries and improve feline welfare.

When scratching on a surface, cats produce a visible mark but they also leave a chemical message from secretions produced by the sebaceous glands in their interdigital area (10,11). One of these chemical cues, a type of pheromone, is a mixture of fatty acids, and has been described as the feline interdigital semiochemical (F.I.S) (12). A

semiochemical is a chemical substance or mixture of substances used by animals for the purpose of communication. Pheromones are a type of semiochemical used for communication between members of the same species. The presence of the pheromone in this case, likely allows any passing cat to recognize that another cat has been here recently. It is theorized that the emitting animal (the cat which marked the area) is more likely to scratch again in the same areas, to reinforce evidence of its presence to other cats (13).

This study assessed the efficacy of a solution containing a synthetic analogue of F.I.S (marketed as FELISCRATCH by FELIWAY®) in managing feline scratching behaviour on undesired surfaces at home. The coloured product when applied on a post actually mimics both the chemical (F.I.S. component) and visual (lacerations) cues naturally left by scratch marks, to encourage cats to scratch again on the post.

We hypothesized that the application of the product to a scratching post would stimulate the use of the post and focus cat's scratching behaviour on this designated area, while concomitantly limiting or even stopping scratching on undesired surfaces.

MATERIALS AND METHODS

Selection of Cats

In total 195 cats were included in the study. It was an in-home study performed in the UK. Study participants were recruited by a market research agency which provided them with all instructions and performed the phone interviews. Recruited cats were of any sex, age or breed, living in households of one or two healthy, non declawed cats, without any lesions on the feet or pain in the limbs or back that could impair scratching behaviour (as assessed by owners). All selected cat owners granted their informed consent to the research agency for their cat(s) to participate into this study. Selected cats received no medication within the last 3 months nor any pheromone-based product within the last 4 weeks to manage or prevent cat behavioural problems. The use of other,

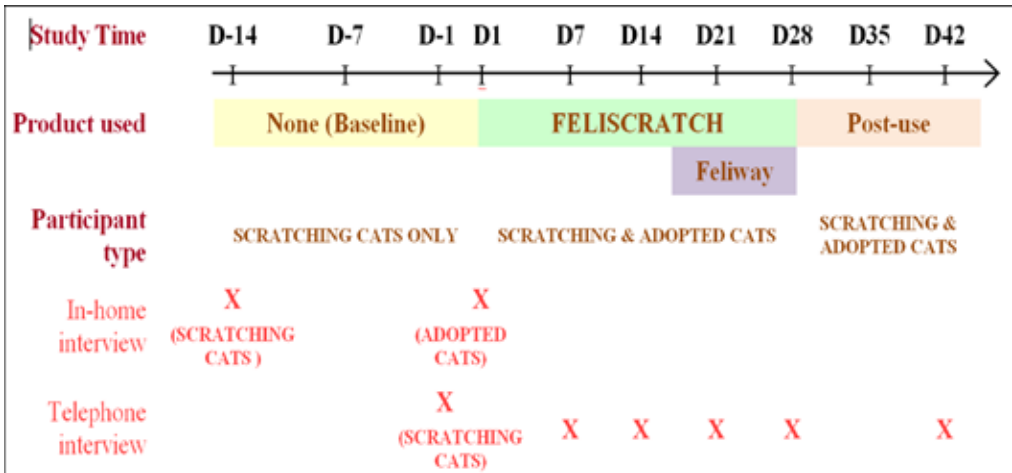
additional calming products was not allowed at any time during the study. No treatment product was applied on the animals and the assessment only focused on their behavior. Cats were not submitted to any particular procedure, handling or visits to the veterinarian. All cats were client-owned and stayed in their own home before, during and after the study. Only households with cats which already exhibited vertical scratching behaviour on unwanted surfaces were recruited. In addition, a separate population of recently adopted cats (less than 14 days) was also evaluated, to assess if the tested solution could also help manage the development of unwanted scratching over time in recently adopted cats or kittens. In total 166 "scratching cats" were included in the study from 117 households that had all experienced unwanted scratching on vertical surfaces (such as on fabrics, furniture, carpeted stair-risers) within the last year. Some of these cats demonstrated unwanted scratching on horizontal surfaces in the household as well.

"Recently Adopted cats" (N=29) were all adult cats or kittens that had been introduced into a single or multi-cat home less than 2 weeks prior to the study start and the treatment initiation. To be included, cats had to have demonstrated unwanted scratching behaviour on vertical surfaces at least once in the household and be the sole recently adopted cat.

Study Phases and Product Application

In-home visits occurred for "scratching cats" at Day -14 (D-14) for global instructions and at Day -1 (D-1) for scratching post and treatment product placement (see Figure 1). In-home visits occurred on Day 1 (D1) for the recently adopted cats. All assessments and data collection were performed by phone (more details under subtitles Behavioural assessment and Statistics and data collection). Cat owners were instructed how to record scratching marks on a daily log, for use during phone interviews. A 14 day baseline was included for "scratching cats"

Figure 1: Study schedule



to compare it to the treatment application period, while “recently adopted cats” scratching behaviour was just compared with D1, due to the recent adoption and need to introduce the product as soon as possible following adoption. Since having a scratching post at home has been described as not being effective enough to prevent cats from scratching in the home(3), the authors decided not to include a placebo control group in this study that would consist of an untreated scratching post and preferred enrolling a larger treatment group where each cat was assessed compared to baseline values. Moreover, the product has already been shown to effectively induce scratching in one placebo controlled study performed on laboratory housed cats11. In consequence this study was an open, uncontrolled study and further controlled studies might be needed.

New post introduction and treatment application started from D1 in both groups. Owners were all provided with the same pole type scratching post covered in rope (selected based on published recommendations on cat’s preferences for different posts (3), and were asked to remove any previous posts from their home at that time, in order to homogenize environmental conditions between homes. New posts were placed either near a frequently used area for scratching, or

close to a cat’s sleeping or relaxing area. This location may or may not have been the same location as the previous post. The pheromone product was supplied as ten single-dose pipettes and was to be applied as instructed, by drawing a single vertical line on the scratching post once daily on Days 0, 1, 2, 3, 4, 5, 6, 14, 21, and 28 (re-applying along the same lines to reinforce the visual cue represented by the previous application). Owners were instructed to not change the location of the scratching post and were asked not to try to attract their cat to the treated post in any other way than applying the product. The test product consisted of 0.5% of a Feline Interdigital Semiochemical Analogue (together with a colorant and 0.1% of catnip to further contribute to attract the cat to the post), in a 5 ml pipette/per application.

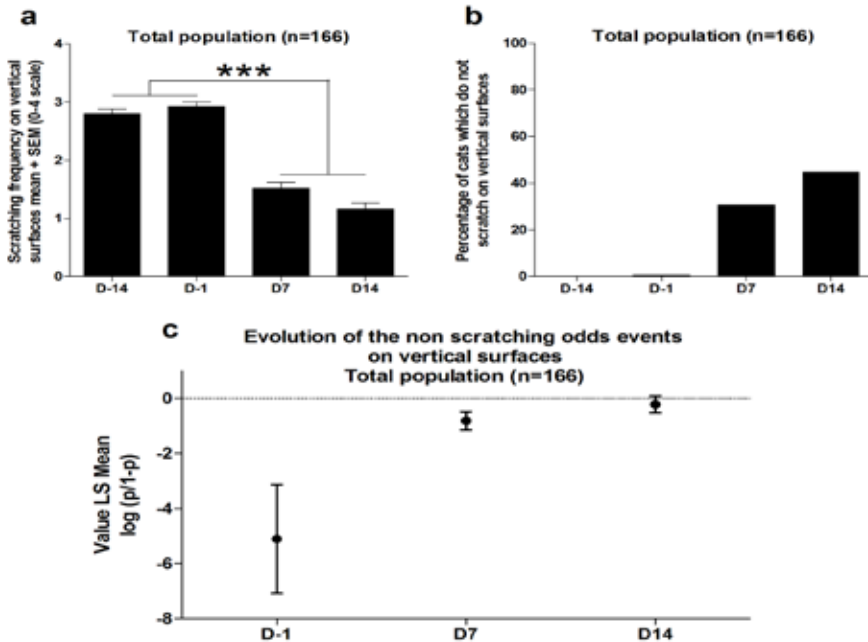
Additionally, if no visible improvement in scratching was observed at D14 (minimal or no decrease in the frequency of unwanted scratch marks recorded by the owners, assessed by investigator judgment), owners were offered to use the F3 Feline Facial Pheromone Fraction (marketed as Feliway® Classic spray) as an additional treatment. Considering the time needed to send the product to the owners who agreed with this option, the treatment usually started around D19. The rationale for this additional treatment was to provide comforting facial

Figure 2: Results of scratching on vertical surfaces, total “scratching cats” population (n = 166)

a) Frequency of unwanted scratching behaviour in the period since the last interview, *** = $p < 0.001$

b) Percentage of cats who stopped scratching on vertical surfaces.

c) Graphic representation of the statistical model results used to detect significant differences in figure b. Evolution over time of the probability to stop scratching on vertical surfaces compared to the probability of still scratching. A significant difference is observed when the error bars do not overlap.



pheromone analogues to prevent cats from marking with claws, as a pilot study demonstrated improved efficacy when combining the two pheromonal messages to control scratching behaviour(14). If they were willing to proceed, owners were advised to clean the inappropriately scratched locations (curtains, furniture, door frames, etc) with a mild product such as soap and warm water and allow them to dry, before applying about 4 to 6 sprays of Feliway® Classic to fully cover the area. The spray was to be applied twice a day every day between D19 and D28 onto the areas where unwanted scratching continued to occur, while continuing to apply the F.I.S to the scratching post once weekly (see Figure 1).

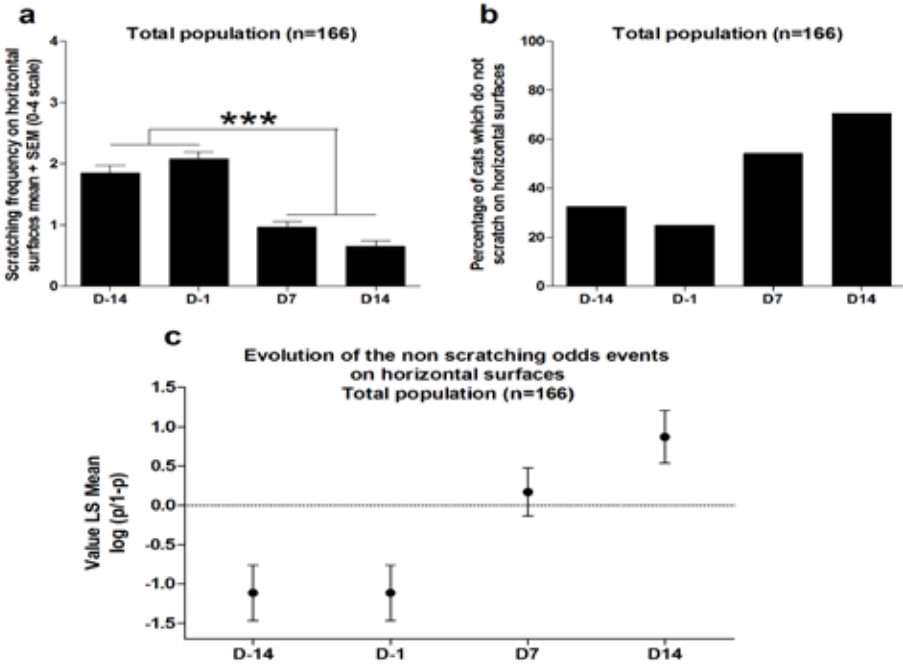
Then, after the last application on D28, a final assessment was made on D42, to evaluate any possible relapse during this 14-day period without any product use.

Behavioural Assessment

At each assessment point, owners had to assess their cat’s scratching behaviour in the period since the last phone call. Assessments were done at D-14, D-1, D7, D14, D21, D28 and D42 (see Figure 1). Owners owning two cats had to separately consider each individual cat based on their observations. Questions covered if cats had been using the post to scratch, if they still scratched on unwanted locations (vertical and/or horizontal surfaces; in the same room as the one where post was located, and/or in

Figure 3: Results of scratching on horizontal surfaces, total “scratching cats” population (n = 166)

- a) Frequency of unwanted scratching behaviour in the period since the last interview, *** = $p < 0.001$
- b) Percentage of cats who stopped scratching on horizontal surfaces.
- c) Graphic representation of the statistical model results used to detect significant differences in figure b. Evolution over time of the probability to stop scratching on horizontal surfaces compared to the probability of still scratching. A significant difference is observed when the error bar do not overlap.



other rooms), how often, and where they had stopped unwanted scratching on vertical and/or horizontal surfaces. Questions about product application were also included.

Statistics and Data Collection

Data was acquired from daily questionnaires completed by the owners and phone interviews conducted every week. The analyzed sub-populations were: 135 cats exposed to the test product only and 31 cats exposed to the test product + Feliway® Classic spray. Only two data were missing for two cats (none of them being treated with Feliway® Classic) at D28 due to the uncertainty of their owners concerning the cat’s scratching.

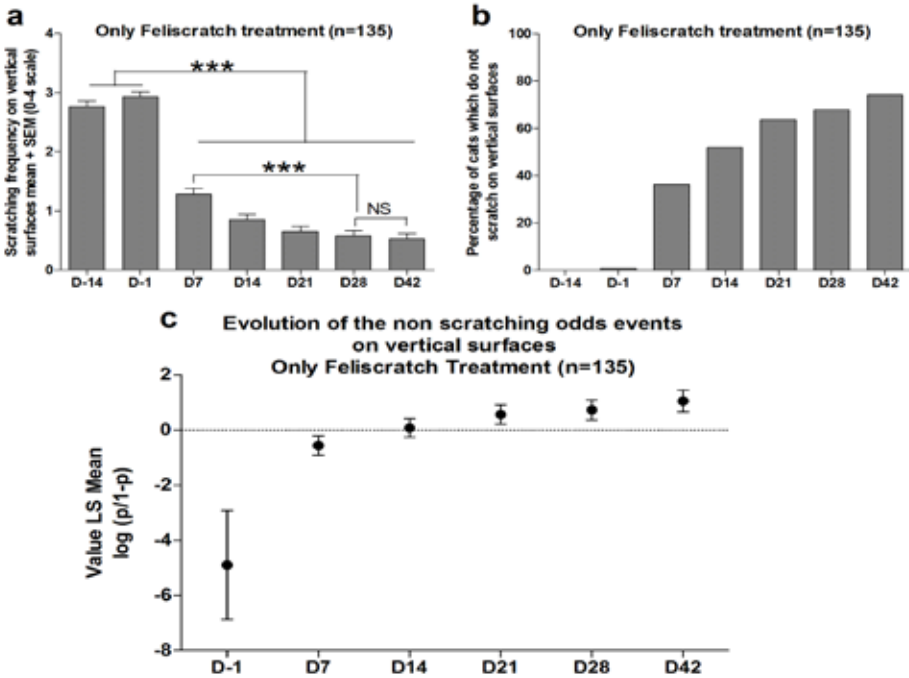
During the weekly phone interviews the owners were asked to estimate the scratching frequency on a 5-point scale (0=No, 1=Yes, once a week, 2=Yes, once every 2-3 days, 3=Yes, once a day, 4=Yes, several times a day). To assess the change over time in unwanted scratching on vertical surfaces in the home, we used the weekly evaluation of the scratching frequency instead of using daily reports because this question was confirmed as properly reflecting the daily quantification (see supplementary 1). In fact we demonstrated that there is a strong correlation between the answers to the daily and the weekly questionnaires concerning the severity of scratching.

Figure 4: Results of the scratching on vertical surfaces for the “scratching cats” treated with F.I.S only (n = 135).

a) Frequency of unwanted scratching behaviour in the period since the last interview, *** = $p < 0.001$

b) Percentage of scratching cats who stopped scratching on vertical surfaces.

c) Graphic representation of the statistical model results used to detect significant differences in figure b. Evolution over time of the probability to stop scratching on vertical surfaces compared to the probability of still scratching. A significant difference is observed when the error bars do not overlap.



To analyze the value of the scratching frequency given by the owner, due to the ordinal nature of this score, two models were used. The first one adjusted a mixed model with a time effect as fixed covariate with order one autoregressive variance-covariance structure and a random animal effect. The second method adjusted a multinomial generalized mixed model with a time effect as fixed covariate and a cumulative link function with no variance-covariance structure. Since the two methods lead to the same conclusions, we only present here the first option: the mixed model. To evaluate the proportion of cats who stopped scratching, we fitted a logistic model with a time effect as fixed covariate and a random animal ef-

fect with a logit link function (p =probability of not scratching). To test if the introduction of the scratching post per se could influence the results, it was considered as a variable and introduced into the model. The ANOVA and Student t-tests were derived from those models. All pairwise comparisons were tested and adjusted for post-hoc hypothesis with Bonferroni method.

RESULTS

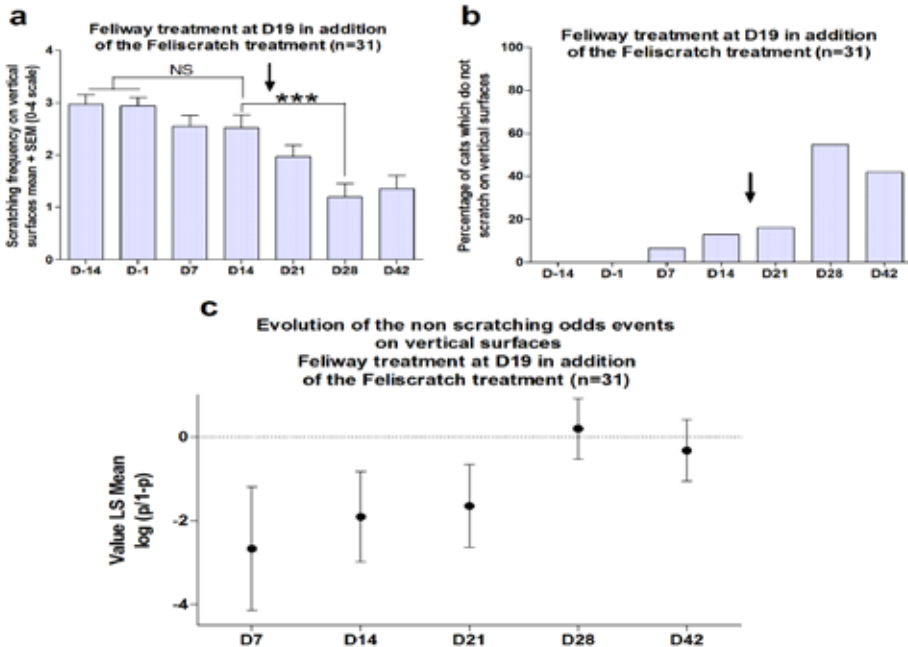
First, we tested whether some parameters could influence the scratching on vertical surfaces reported by owners. For this, we used an unsupervised Bayesian Network Model to find the potential relation between all the variables available from

Figure 5: Results of the scratching on vertical surfaces for the “scratching cats” who additionally received Feliway® Classic from D19 (n = 31)

a) Frequency of unwanted scratching behaviour in the period since the last interview, *** = $p < 0.001$

b) Percentage of cats who stopped scratching on vertical surfaces.

c) Graphic representation of the statistical model results used to detect significant differences in figure b. Evolution over time of the probability to stop scratching on vertical surfaces compared to the probability of still scratching. A significant difference is observed when the error bars do not overlap.

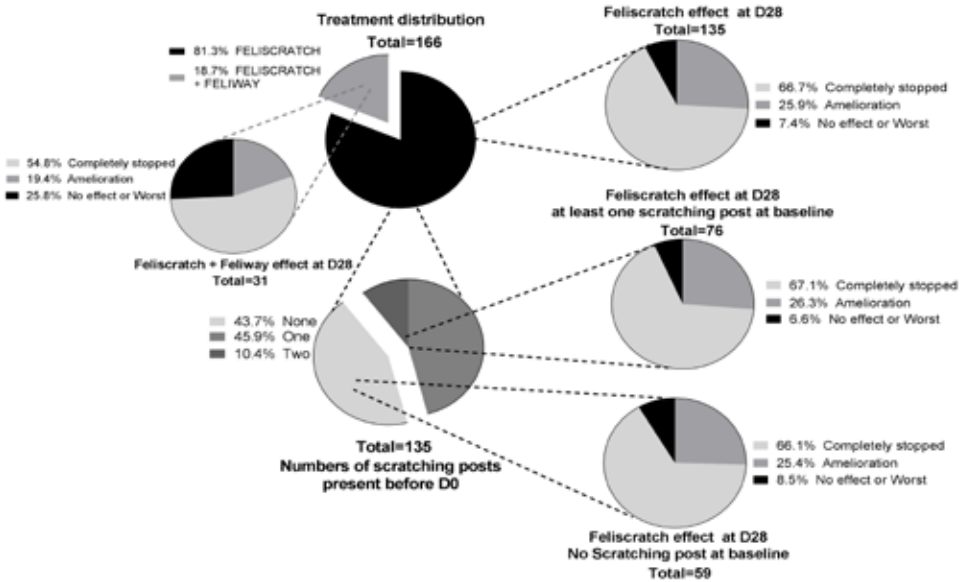


the questionnaire (supplementary 2). The algorithm identified one single network. No relationships were found between any demographic data and scratching reported on vertical or horizontal surfaces. This means that scratching frequency reported at any time was correlated with the value at the next assessment time, but neither the cat’s gender, breed, sexual status, age nor the number of cats in the home did influence the results.

Then we assessed the effect of a solution with synthetic interdigital pheromone on the unwanted scratching in the home. The results are first presented on the full “scratching cats” population (166 cats) on the period of time from baseline to D14, where cats were exposed to the new

pheromone treatment only (before the possible addition of Feliway® Classic spray). The number of cats that used to scratch beside the scratching post decreased with the treatment application, with a significant increase ($p < 0.01$) in the number of cats who stopped scratching on vertical surfaces between the baseline (D-1) and the first 2 weeks of treatment (D7 and D14) (Figures 2 b and c). For the total cat scratching population, the ANOVA revealed that their frequency of scratching decreased significantly with time [$F(3,379) = 128.23, p < 0.001$]. The post-hoc Bonferroni tests demonstrated that this decrease was already effective from D7 since significant differences between (D-14 and D-1) and (D7 and D14) were observed (Figure 2

Figure 6: Evolution of the vertical scratching after 28 days of treatment in function of the presence of a scratching post in the household, prior to treatment application. This figure clearly shows that the percentage of cats that decreased or stopped vertical scratching (on the scale 0-4) between D0 and D28 is similar in the two sub-populations. Amelioration is defined as a lower score at D28 compared to score at D0. If score at D28 is equal to 0, case was classified as “completely stopped”.



a; $p < 0.001$). At the same time as vertical scratching observed in unwanted places drastically decreased, we observed that cats broadly used their new scratching post treated with F.I.S. product: after only 7 days of treatment, 79% of the cats had scratched on their new post.

The use of this pheromone appears to be also effective in managing the inappropriate scratching on horizontal surfaces (Figures 3), with the number of cats presenting this particular behaviour decreasing significantly after two weeks of treatment (Figures 3 b and c). From D7 the proportion of cats who did not scratch anymore was significantly different from D-14 and D-1 ($p < 0.001$). Moreover the frequency of scratching on horizontal surfaces assessed by the owners through the weekly scale presented a significant decrease with time [ANOVA; $F(3,369) = 46.05$, $p < 0.001$]. The Bonferroni post-hoc analysis showed a significant difference between (D-14 and D-1) and (D7

and D14) (Figure 3 a; $p < 0.001$).

As from D14 some cats were also exposed to another pheromone treatment, the results on the full study period are then presented separately for the two subpopulations, respectively:

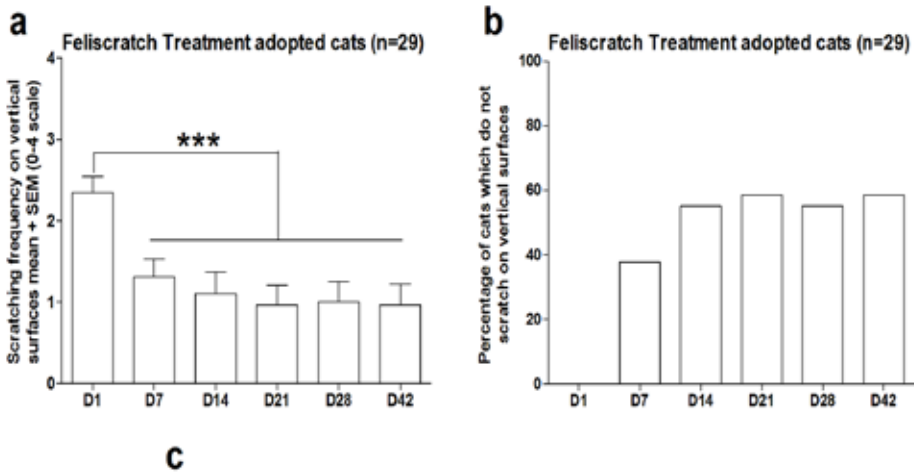
- 135 cats (81.3%) treated with the F.I.S. solution only (see Figures 4)
- 31 cats (18.7%) treated with F.I.S. solution + Feliway® Classic spray (see Figures 5).

On Figure 4 c, a significant difference between D-1 and D7 is shown ($p < 0.001$) and interestingly there is a further significant decrease in the number of cats who stopped scratching on vertical surfaces between D7 and D28 ($p < 0.001$) when exposed to F.I.S. solution only. Furthermore, to test whether cats would relapse after the cessation of the treatment, they were followed two weeks after the end of the interdental pheromone application (Figures 4). The post hoc analysis on the mean frequency score did

Figure 7: Vertical scratching in recently adopted cats (n=29).

a) Frequency of unwanted scratching behaviour: *** = $p \leq 0.001$

b) Percentage of cats reported with no episodes of unwanted vertical scratching in the period since the last interview.



not show a significant difference between the last day of treatment and the end of the study period, nor any difference in the number of cats who stopped scratching on vertical surfaces (Figure 4 a; $p=1$). On D42, 74% of cats completely stopped scratching on vertical surfaces which is similar to the result at the end of the treatment at D28 (68%) (Figure 4 b). In fact, there was no difference between D28 and D42 in the number of cats not presenting scratching (Figure 4 c; $p=1$).

In households who added Feliway® Classic spray from D19 to D28, the behaviour of the cats receiving both treatments was observed in order to detect the benefit of adding Feliway® Classic (Figure 5) in these cats. A significant increase on the percentage of cats who stopped scratching on vertical surfaces was detected between D14 and D28 (Figure 5 c, $p < 0.05$). There was also a significant difference detected with the ANOVA of the mean frequency score [$F(6,180)=17,51$; $p < 0.001$] and the post hoc revealed a significant difference between the mean frequency scores at D14 and D28 (Figure 5a, $p < 0.001$). Conversely, as these cats

were “resistant” to the F.I.S. treatment, no significant difference was observed between (D-14 and D-1) and D14 ($p=1$).

Within the full “scratching cats” population (166 cats), 44.6% of cats had no scratching post prior to the study, while 55.4% had at least one scratching post at home. Amongst these, 70.7% had a “pole scratching post”, similar to the type used in our study. Within the population treated with F.I.S. solution only, 43.7% of cats had no scratching post prior to the study, while 56.3% had at least one scratching at home, consisting in 71.1% of a “pole scratching post” (Figure 6). For cats exposed to F.I.S. product only, the ANOVA results show that the preceding presence of a scratching post did not significantly influence the amount of reported inappropriate vertical scratching ($p=0.87$) and this is true at any time of the trial ($p=0.89$). Even in the cat population who previously had a “pole scratching post” at home, results did not differ, supporting the observed effects resulting from the application of the product.

In the 29 “recently adopted cats”, the number of cats scratching on vertical unwanted surfaces decreased with treatment

(Figure 7 b). The ANOVA demonstrated a difference on time [$F(5,100)= 3.61$; $p<0.001$) and the post hoc test adjusted with Bonferroni confirmed the decrease in the frequency of scratching on vertical surfaces between D-1 and D7 or even D28 (Figure 7 a, $p\leq 0.001$). Even for recently adopted cats or kittens, the application of this new pheromone solution on a scratching post appears to redirect the scratching behaviour to this specific area.

Of the 117 owners enrolled in this study due to their cat's current scratching issue, 83% declared that the solution with synthetic interdigital pheromone and catnip had been at least as effective as they expected for managing the unwanted scratching behaviour. Indeed, we observed that 89% of cats presenting this behaviour at the beginning of the study had decreased or stopped the unwanted scratching on vertical surfaces at the end of the treatment with the test solution containing feline interdigital pheromone. On the other hand, in the recently adopted cats, 91,4% of the owners had noticed a difference in effectiveness from Day 1 to Day 7 and the mean frequency of vertical inappropriate scratching in the home significantly decreased throughout the study period compared to adoption time.

DISCUSSION

The results of this study suggest that introduction of a scratching pole treated with a solution containing Feline Interdigital Semiochemical Analogue, blue dye and catnip was very effective at decreasing vertical and horizontal scratching of objects indoors. This finding has the potential to impact the welfare of cats.

In this field study, the frequency of unwanted scratching on vertical surfaces and the number of cats who scratched on surfaces other than their scratching post both significantly decreased after 7 days of treatment. After 28 days of treatment 67% of cats had completely stopped unwanted vertical scratching. We also demonstrated that the treatment efficacy lasted a minimum of 14 days after the last application in cats with no

additional treatment. The absence of difference in the proportion of cats who stopped scratching vertically between D28 and D42 suggests that once the unwanted behaviour is addressed, there is no further relapse, during a minimum of two weeks. Moreover, only 12% of the cats presented a rebound in scratching frequency on vertical surfaces between days 28 and 42.

Furthermore, this study also highlighted that for refractory cats who did not significantly improve during the first 14 days, the addition of Feliway® Classic spray treatment to the previous feline interdigital pheromone helped reduce the undesired scratching: the number of cats who completely stopped increased from 13% to 55% after 2 weeks of this additional treatment. The comforting message brought by the feline facial pheromone when applied as a spray on a spot marked by a cat's urine or claws has been described as having an inhibitory effect on this marking behaviour (15,16).

The AVMA recommends that declawing of domestic cats should be considered only after attempts have been made to prevent the cat from using its claws destructively (17). Furthermore, some studies have reported that preventing this natural behaviour can result in stress and behavioural change (6,18,19). To manage scratching on furniture, the majority of products available are either chemical deterrents or fear inducing stimuli systems (Ssscat® Spray Deterrent). However, there are risks associated with attempting to stop natural behaviours without providing other suitable outlets for the behaviour or encouraging alternative behaviours. Another alternative consists in placing plastic caps on the cat's nails to protect furniture, but this option is controversial too as it interferes with the natural behaviour of cats. Here we provide evidence that the application of a synthetic pheromone and catnip on a scratching post can be sufficient to redirect any scratching behaviour to the post and prevent damage to the furniture or home. This simple protocol may have an im-

portant benefit to cat welfare by preventing unnecessary declawing and/or punishment.

Providing scratching posts in the home to encourage the natural behaviour in a location that is acceptable to owners is considered the ideal solution for unwanted scratching but does not always completely solve the problem as cats may continue to scratch in other locations. Indeed, in the present study, 55% of the participants already had a scratching post at inclusion and were still facing unwanted scratching, although 85% of these cats were reported to actually use the post (with 57% of cats using it at least daily). Moreover, in another study 69 % of the owners with a scratching post reported inappropriate scratching in the same area of the scratching post(3). This may be due to some attractive effect of the interdigital secretions deposited by previous cat scratching that contributes to maintaining this established behaviour (13). Indeed, it has been previously demonstrated that the feline interdigital semiochemical (F.I.S.) itself increases the frequency and the duration of scratching on the places where it was applied, compared to a colored placebo11.

One limitation of the study is the addition of catnip to the solution containing the semiochemical, making it impossible to distinguish which component was most effective at attracting the cat to the post. The product does contain a minimal amount of catnip, but catnip does not reliably attract all cats since about 33% of cats do not respond to nepetalactone, the terpenoid compound responsible for catnip's feline attracting abilities (20). Catnip is often recommended for attracting cats to scratching posts (2,21) but unwanted scratching of furniture and unreliable use of scratching posts remains a problem so it is highly unlikely that catnip alone would be responsible for attracting this high of a percentage of cats to the post and maintaining their interest in scratching the post. Moreover, in a previous study(12), the placebo contained catnip as well, highlighting the specific effect of the F.I.S. component within the product tested. Here, after

only 7 days of pheromone solution application, 79% of the "scratching cats" and 87% of the "recently adopted cats" had used their new scratching post where treatment was applied. In comparison, although data are not available, cat owners frequently report buying new scratching posts (from the most simple models to very sophisticated ones) that their cats never use, even once.

The lack of a placebo control does limit the value of these findings to some degree. However, we clearly observed a decrease in unwanted scratching with the use of the product and this decrease was similar for cats with a scratching post prior to the study and those who did not have a scratching post (Figure 6). This decrease cannot solely be attributed to the introduction of the scratching post since 55% of cats included in the study already had a post available before inclusion, and 85% of them were using it at least once a week, while still scratching in other places in the home. At the end of the 28-day treatment period, 93% of cats which already had access to at least one post in the house before the study had decreased their scratching outside the scratching post treated with the pheromone, while 67% completely stopped (Figure 6). This provides further evidence that the effects of the scratching post alone may not be as important as the product application in the population of cats that already had a scratching post. This demonstrates the capacity of the tested solution to reduce or stop unwanted scratching for owners with a scratching post who still face scratching problems.

Besides the limitation of the study it appears that the protocol treatment consisting of introducing a scratching post and applying the product decreased the unwanted scratching on vertical surfaces compared to the initial stable baseline.

In addition, we also observed an unexpected significant decrease in the scratching of horizontal surfaces (such as carpets, chairs, etc), although cats were only recruited based on existing scratching of vertical unwanted locations (such as doors,

table legs, sofa, etc). It has been suggested that territorial scratch marking is preferably performed on a vertical surface (22). To our knowledge, no data are available in the literature regarding the possible differential motivations for cats to preferably scratch vertical or horizontal surfaces. But these study results support the benefit of the application of the F.I.S analogue solution on a vertical scratching post, in decreasing any scratching displayed inappropriately in the home, either on vertical or horizontal locations.

CONCLUSIONS

In this study, we demonstrated that an innovative behavioural therapy consisting of the application of a colored solution containing a synthetic feline interdigital semiochemical and catnip on a rope covered scratching post is effective at redirecting and managing unwanted feline scratching behaviour. In some cases, this treatment can be combined with the use of another feline pheromone (the F3 fraction) for further benefit. This clinical study performed on a large sample demonstrates for the first time the effectiveness of a treatment for redirecting unwanted scratching behaviour in cats. Moreover, this treatment presents a natural and humane alternative to other current options that is respectful towards the cat's ethology.

ACKNOWLEDGEMENTS

We would like to thank the cats' owners for their contribution to this research.

Funding

This study was funded by CEVA Sante Animale.

Open Access

This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

Contributions

A.B. and V.T. contributed to study design, data interpretation, literature search, figure, writing and editing. X.D.J. contributed to data interpretation, literature search, figure, writing and editing. J-F.C. contributed to data interpretation, data analysis, figure, writing and editing.

Conflict of interest

This trial was initiated by Ceva Santé Animale and the four authors of the paper are working for Ceva Santé Animale.

REFERENCES

1. Heath SE. Behaviour Problems And Welfare. In: *Animal Welfare*. 2007, pp. 91–118.
2. Landsberg GM. Feline Scratching and Destruction and the Effects of Declawing. *Vet Clin North Am Small Anim Pract* 1991; 21: 265–279.
3. Wilson C, Bain M, DePorter T, et al. Owner observations regarding cat scratching behaviour: an internet-based survey. *J Feline Med Surg*. 2016; 10:791-7.
4. Landsberg GM, Hunthausen WL, Ackerman LJ. Behaviour Problems of the Dog and Cat3: Behaviour Problems of the Dog and Cat. *Elsevier Health Sciences*, 2012.
5. Patronek GJ, Glickman LT, Beck AM, et al. Risk factors for relinquishment of cats to an animal shelter. *J Am Vet Med Assoc* 1996; 209:582–588.
6. Morgan M, Melanie M, Houpt KA. Feline Behaviour Problems: The Influence of Declawing. *Anthrozoos: A Multidisciplinary Journal of The Interactions of People & Animals* 1989; 3: 50–53.
7. Patronek GJ, Beck AM, Glickman LT. Dynamics of dog and cat populations in a community. *J Am Vet Med Assoc* 1997; 210: 637–642.
8. Lockhart LE, Motsinger-Reif AA, Simpson WM, et al. Prevalence of onychectomy in cats presented for veterinary care near Raleigh, NC and educational attitudes toward the procedure. *Vet Anaesth Analg* 2014; 41: 48–53.
9. Fritscher SJ, James H. Declawing has no effect on biting behaviour but does affect adoption outcomes for domestic cats in an animal shelter. *Appl Anim Behav Sci* 2016; 180: 107–113.
10. Feldman HN. Methods of scent marking in the domestic cat. *Can J Zool* 1994; 72: 1093–1099.
11. Cozzi A, Lecuelle CL, Monneret P, et al. Induction of scratching behaviour in cats: efficacy of synthetic feline interdigital semiochemical. *J Feline Med Surg* 2013; 15: 872–878.
12. McGlone JJ, Plummer RR. Evidence for a cat pheromone that modulates kitten scratching. Laboratory of Animal Behaviour, Physiology and Welfare, Texas Tech University, Lubbock, TX <http://m.jmtg.org/abs/t/63342> (2015, accessed 27 April 2016).
13. Mengoli M, Mariti C, Cozzi A, et al. Scratching

- behaviour and its features: a questionnaire-based study in an Italian sample of domestic cats. *J Feline Med Surg* 2013; 15: 886–892.
14. AVMA Animal Welfare Division. Welfare Implications of Declawing of Domestic Cats. *J Am Vet Med Assoc* https://www.avma.org/KB/Resources/LiteratureReviews/Documents/declawing_bgnd.pdf (2016, accessed 25 March 2016).
 15. Yeon SC, Flanders JA, Scarlett JM, et al. Attitudes of owners regarding tendonectomy and onychectomy in cats. *J Am Vet Med Assoc* 2001; 218: 43–47.
 16. Atwood-Harvey D. Death or Declaw: Dealing with Moral Ambiguity in a Veterinary Hospital. *Soc Anim* 2005; 13: 315–342.
 17. Grognet J. Catnip: Its uses and effects, past and present. *Can Vet J* 1990; 31: 455–456.
 18. Beaver BV. Feline Communicative Behaviour. In: *Feline Behaviour*. 2003, pp. 100–126.
 19. Pageat P, Gaultier E. Current research in canine and feline pheromones. *Vet Clin North Am Small Anim Pract* 2003; 33: 187–211.
 20. Pageat P, Patrick P, Emmanuel G. Current research in canine and feline pheromones. *Vet Clin North Am Small Anim Pract* 2003; 33: 187–211.
 21. Hart BL, Hart LA, Bain M. *Canine and Feline Behaviour Therapy*. Wiley, 2006.

Supplementary 1: Bayesian network representation of the relations between daily quantifications reported during the first week and the weekly evaluation at D7. Each node represents a variable (daily quantifications). The size of the node represents the importance of the variable. The arcs represent the strength of the conditional probability link between the variables. The more distant and thin an arc is between two variables, the less the relationship strength is. The color shows the result of a hierarchical classification based on the distance between the variables. Hence, this graph shows that the daily quantifications are strongly related to the weekly quantification and this variable summarizes on its own the information of the daily assessment. This analysis allows to validate the quality of the questionnaire and to select the more relevant variable. It has been conducted with Bayesialab software.



Supplementary 2: Bayesian Network representation of the conditional probability link between weekly assessments of scratching on vertical and horizontal surfaces and demographic data of the owners and their cats. Each node represents a variable. The size of the node represents the importance of the variable. The arcs represent the strength of the conditional probability link between the variables. The more distant and thin an arc is between two variables, the less the relationship strength is. The color show the result of a hierarchical classification based on the distance between the variables. This graph show that:

- The demographic data do not globally bring information.
- The demographic data and the scratching assessment are not probabilistically connected.
- The scratching on horizontal surfaces belongs to a separate class than the scratching on vertical surfaces showing that there are probably two different phenomenon.
- The probabilistic relation between scratching on vertical and horizontal surfaces is very thin.
- The probabilistic relation of a weekly scratching assessment is directly connected to the week before and the week after but indirectly with other assessments.
- The final change in behaviour at D42 is only connected to the vertical scratching assessment at D42 and not connected to the scratching on horizontal surface.

