Original Article

jfms Journal of Feline Medicine and Surgery

Journal of Feline Medicine and Surgery
15(10) 872–878

DOI: 10.1177/1098612X13479114
jfms.com
SAGE

Induction of scratching behaviour in cats: efficacy of synthetic feline interdigital semiochemical

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Abstract

The aim of the study was to evaluate the effects of synthetic feline interdigital semiochemical (FIS) on the induction of scratching behaviour in cats during a standardised behavioural test. The trial was a randomised blinded study on a single group of subjects, following a crossover design. The scratching behaviour of 19 cats was evaluated during a standardised test in which cats were introduced to an area with one scratching post. Each cat acted as its own control (receiving, at random, FIS then placebo or vice versa). The test lasted for 5 mins, after which the cat was left alone in the test area. Duration, frequency of scratching and latency of first scratching behaviour were noted. Two independent observers analysed the videos. Thirty-eight tests were recorded with a different scratching post each time (two tests per cat). The scratching post with the semiochemical was more scratched in duration and frequency by the cats involved in the study (intention to treat analysis). The same conclusion was found using per-protocol analysis, which included only cats that scratched during the test. Regarding latency, no significant difference was found between treatment and placebo. The results seem of interest in explaining the role of a FIS in inducing scratching behaviour on a scratching post. The semiochemical approach can modify the choice of areas selected spontaneously by cats, and could be used either as a preventive measure for a cat arriving at home or to control or change an inappropriate scratching behaviour.

Accepted: 19 January 2013

Introduction

Cats are very popular pets and epidemiological data show an increase in the number of house cats.[1–3] They are very often housed indoors, requiring them to adjust to the lifestyle of their owners.[4] Scratching behaviour in cats is an important means of chemical and visual communication.[5–8] In domestic cats, scratching seems to be related to different contexts and behavioural functions.[9] Scratching is suggested to be used to sharpen claws and to maintain the system that allows claw extension and withdrawal, which is used in typical hunting sequences or during climbing.[9,10] Some authors have identified both immediate and long-term social messages in scratching.[10,11] Scratching can be used for territorial marking, by depositing chemical signals released by the plantar pad glands,[6] and by leaving signs on the scratched surface.[9] Farm cats usually show scratching behaviour 1–6 times during the day,[12,13] preferably in the presence of conspecifics as compared to being alone,[10] but the frequency of the behaviour in indoor cats is not well documented. The use of scratches as a marking signal is normal in a wide territory, but when it is exhibited repeatedly inside the house, there is reason to suspect that the animal is not feeling safe in that specific environment.[9] Veterinary practices are increasingly being consulted about feline behaviour, and referral to behaviourists is no longer unusual.[7] Cat owners mainly report problems related to elimination (24%), destructiveness (24%) and inappropriate ingestion (20%),[14] while concerns related to scratching are reported in 15% of the cases.[4] Inappropriate scratching is rarely a

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behaviour that primarily leads owners to seek referral; it is more often mentioned as an additional problem during consultation. General population surveys suggest that scratching in an undesirable location occurs much more commonly than referral rates might suggest.[7] Inappropriate scratching has been reported to be the second most common complaint among cat owners.[4] Other colleagues have indicated that furniture scratching is reported in clinical practices as the second most common complaint.[15] The analogue of feline interdigital semiochemical (FIS)[8] is a synthetic mixture of fatty acids that represent components of a natural pheromone identified in sebaceous gland secretions from the plantar pad complex in cats. Although the mechanism of action of natural semiochemicals is not well understood, different authors have demonstrated the interest of using semiochemicals for different situations in dogs[16–22] and cats.[23–30] Some preliminary studies suggest using FIS in order to induce scratching behaviour in cats in a specific location.[31,32] Finding an ethical alternative to scratching furniture appears interesting, both for the welfare of the species and in order to preserve the relationship between pets and owners. The objective of this study was to evaluate the effect of FIS in inducing scratching behaviour on a standard scratching post against placebo.

Materials and methods

Animals

The cats enrolled in the study came from the cat housing facility at the Research Institute of Semiochemistry and Applied Ethology. The cats included in the trial were all at least 1 year old and of European breed. The cats were either male, female, or neutered male. In addition, only cats able to express all behavioural patterns of the species, with no indication of organic and/or behavioural disorders were included in this trial. Cats enrolled in the study had to be in good health; any signs of impaired physical condition or current medical treatment led to elimination from the study.

Experimental design

A randomised blinded trial was conducted on a single group of subjects following a crossover repetition design. Thus, each cat acted as its own control and received both treatments: FIS (verum) and placebo. Each cat was introduced to the test area, and served as the experimental and statistical unit of the trial. The treatment was attributed at random and stratified taking into account the rank in the treatment sequence.

Procedure

The verum treatment is a liquid with a natural purple colouring combined with the FIS (0.5%) (Feliscratch; Laboratoires BIOSEM) active ingredient. The product is kept in a plastic pipette whose shape allows the product to be applied to the scratching post in vertical lines. The placebo treatment is identical to the verum treatment, but does not contain the active ingredient. The placebo and verum treatments cannot be distinguished based on their visual or olfactive features. The blind procedure was maintained by assigning a code to all tests included in the trial (from 1 to 38). Each cat selected underwent a standardised protocol of habituation to the test area in order to avoid stress reactions related to the new environment. The verum and placebo treatments were applied during the trial on a scratching post in the test area 5 mins before the cat's entry. One cat was involved in each test. The test consisted of a simulation of a frequent situation in a home: a cat in a room faces a scratching post. After the beginning of the test, the cat was left in the test area for 5 mins. The scratching post was changed for each different test. The same type of scratching post was used for all 38 tests (KARLIE; Heimtierbedarf). The same 180 cm × 116 cm enclosed test area was used for all the cats involved in the trial. The behavioural tests were video recorded using a Sony DCR-SR57E camera (Sony) in order to obtain a complete recording of each test. At the end of the test, the test area was cleaned using a standardized protocol (10 mins) and a new scratching post was placed in the area for the following behavioural test.

Data and statistical analysis

The data were collected with the help of two independent observers who read the videos in continuous sampling. After the reading of the videos, the data was transferred to Excel for analysis. The parameters of the trial were the latency of the appearance of the first scratching behaviour on the scratching post, the total duration of the scratches in seconds on the scratching post and the frequency of the scratches on the scratching post. The data were transferred to a database in order to be analysed using Statistica v. 5.0 (Statsoft). Reliability between the two observers who carried out the reading of the videos was checked by calculating Spearman's rho.[33] The statistical analysis plan was as follows. In agreement with the specificity of a crossover design, interaction between treatment and order effect was tested first.[34] If the test was not significant, then treatment and order effects were considered independent from each other, and the statistical analysis of the two effects, respectively, were tested.[34] Normality of distributions was tested using a Shapiro–Wilk test. A non-parametric Wilcoxon test was used to compare observed means of differences for treatment effect and for order effect.

Results

During this study, 19 cats were included in the trial of the 19 cats enrolled initially. Therefore, all 19 cases were included in the intention to treat (ITT) analysis. Nine cats were excluded from the per protocol analysis (PP)

Table 1 Intention to treat analysis (n = 19). Non-parametric method; Wilcoxon test

(a) Total duration of scratches in seconds on the scratching post

Treatment × order interaction					Test statistic	*P*	Level of significance
					Z = 0.0432	0.9656	NS
Treatment	Mean ± SD FIS	Mean ± SD placebo	Median FIS	Median placebo	Test statistic	*P*	Level of significance
	44.24 ± 72.66	11.05 ± 17.02	6	0	Z = −2.6327	0.0085	**
Order	Mean ± SD first treatment	Mean ± SD second treatment	Median first treatment	Median second treatment	Test statistic	*P*	Level of significance
	20.26 ± 38.94	35.03 ± 67.22	0	0	Z = 1.0790	0.2806	NS

(b) Frequency of the scratches on the scratching post

Treatment × order interaction					Test statistic	*P*	Level of significance
					Z = 0.0000	1.0000	NS
Treatment	Mean ± SD FIS	Mean ± SD placebo	Median FIS	Median placebo	Test statistic	*P*	Level of significance
	2.13 ± 3.14	0.82 ± 1.22	1	0	Z = −2.8709	0.0041	**
Order	Mean ± SD first treatment	Mean ± SD second treatment	Median first treatment	Median second treatment	Test statistic	*P*	Level of significance
	1.42 ± 2.10	1.53 ± 2.80	0	0	Z = 0.1768	0.8597	NS

*Significant ($0.01 \leq P < 0.05$)
**Very significant ($0.001 \leq P < 0.01$)
***Very highly significant ($P < 0.001$)
NS = not significant ($P \geq 0.05$); FIS = feline interdigital semiochemical

analysis because they did not scratch at all during the test. Twelve females, five males and two neutered males ranging from 1 to 12 years of age were included in the trial. No missing data or outliers were observed.

Interobserver reliability

Reliability between the two observers who carried out the reading of the videos was calculated using a Spearman's rho. For the parameter 'latency of the appearance of the first scratching behaviour on the scratching post', Spearman's rho was equal to 1 with a *P*-value <0.0001 and a rho² equal to 1, corresponding to a 100% relationship and indicating a high correlation between the two observers. For the parameter 'total duration of the scratches in seconds on the scratching post', Spearman's rho was equal to 0.99951 with a *P*-value <0.0001 and a rho² equal to 0.99902, which corresponds to a 99.902% relationship. Again, there was a high correlation between the two observers. Finally, for the parameter 'frequency of the scratches on the scratching post', Spearman's rho was equal to 0.95853 with a *P*-value <0.0001 and a rho² equal to 0.91878, corresponding to a 91.878% relationship. Therefore, there was a high correlation between the two observers. The relationship was thus very reliable for all parameters.

ITT

Regarding the ITT analysis (ICH Harmonized Tripartite Guideline 'Statistical Principles for Clinical Trials' E9, 1998) of the crossover, the interactions between treatment and order were not significant for the duration and the frequency of the scratches on the scratching post parameters (Table 1). Therefore, the crossover is valid and we can conclude that the response to the second treatment was not influenced by the first treatment. The respective effects of treatment and their administration order were tested. For the total duration of the scratches in seconds on the scratching post, the effect of the treatment was highly significant ($Z = -2.6327$; $P = 0.0085$; Wilcoxon test), with a median duration of the scratches on the scratching post for the FIS treatment significantly higher than placebo. The order effect was not significant ($Z = -1.0790$; $P = 0.2806$; Wilcoxon test), with a median duration of 0 for the first treatment, which was not significantly different from that of the second treatment (0). For the frequency of the scratches on the scratching post, the effect of the treatment was highly significant ($Z = -2.8709$; $P = 0.0041$; Wilcoxon test), with a median frequency of the scratches on the scratching post for the FIS treatment significantly higher than placebo. The order effect was not significant ($Z = 0.1768$; $P = 0.8597$; Wilcoxon

Table 2 Per protocol analysis (n = 10). Non-parametric method; Wilcoxon test

(a) Latency of the appearance of the first scratch behaviour on the scratching post

Treatment × order interaction					Test statistic	*P*	Level of significance
					Z = −0.6267	0.5309	NS
Treatment	Mean ± SD FIS	Mean ± SD placebo	Median FIS	Median placebo	Test statistic	*P*	Level of significance
	51.70 ± 60.29	117.60 ± 134.48	25.75	33	Z = −1.2534	0.2101	NS
Order	Mean ± SD first treatment	Mean ± SD second treatment	Median first treatment	Median second treatment	Test statistic	*P*	Level of significance
	76.30 ± 120.35	93.00 ± 97.43	13	43.75	Z = −0.6267	0.5309	NS

(b) Total duration of scratches in seconds on the scratching post

Treatment × order interaction					Test statistic	*P*	Level of significance
					Z = 0.2089	0.8345	NS
Treatment	Mean ± SD FIS	Mean ± SD placebo	Median FIS	Median placebo	Test statistic	*P*	Level of significance
	84.05 ± 82.70	21 ± 18.64	57.25	25	Z = 2.5067	0.0122	*
Order	Mean ± SD first treatment	Mean ± SD second treatment	Median first treatment	Median second treatment	Test statistic	*P*	Level of significance
	38.5 ± 47.46	65.55 ± 81.89	28.25	45.5	Z = −1.2534	0.2101	NS

(c) Frequency of the scratches on the scratching post

Treatment × order interaction					Test statistic	*P*	Level of significance
					Z = 0.5238	0.6004	NS
Treatment	Mean ± SD FIS	Mean ± SD placebo	Median FIS	Median placebo	Test statistic	*P*	Level of significance
	4.05 ± 3.33	1.55 ± 1.30	2.75	1.5	Z = 2.5143	0.0119	*
Order	Mean ± SD first treatment	Mean ± SD second treatment	Median first treatment	Median second treatment	Test statistic	*P*	Level of significance
	2.7 ± 2.23	2.9 ± 3.36	2.75	2	Z = 0.3153	0.7526	NS

*Significant ($0.01 \leq P < 0.05$)
**Very significant ($0.001 \leq P < 0.01$)
***Very highly significant ($P < 0.001$)
NS = not significant ($P \geq 0.05$); FIS = feline interdigital semiochemical

test) with a median frequency of 0 for the first treatment, which was not significantly different from that of the second treatment (0).

PP

Regarding the PP analysis (ICH Harmonized Tripartite Guideline 'Statistical Principles for Clinical Trials' E9, 1998) of the crossover, the interactions between treatment and order were not significant for the parameters of latency, duration or frequency of the scratches on the scratching post (Table 2). Therefore, the crossover is valid and we can conclude that the response to the second treatment was not influenced by the first treatment. The respective effects of treatment and their order of administration were tested. For the latency of the appearance of the first scratching behaviour on the scratching post, the effect of the treatment was not significant ($Z = -1.2534$; $P = 0.2101$ Wilcoxon test); the

median latency of the appearance of the first scratching behaviour on the scratching post for the placebo treatment was not significantly higher than for the FIS treatment. The order effect was not significant ($Z = -0.6267$; $P = 0.5309$; Wilcoxon test); the median latency of 13 for the FIS treatment was not significantly different from that of the placebo treatment (43.75). For the total duration of the scratches, in seconds, on the scratching post, the effect of the treatment was significant ($Z = 2.5067$; $P = 0.0122$; Wilcoxon test), with a median duration of the scratches on the scratching post for the FIS treatment significantly higher than the placebo treatment. Again, the order effect was not significant ($Z = -1.2534$; $P = 0.2101$), with a median duration of 28.25 s for the first treatment, which did not differ significantly from that of the second treatment (45.5 s). For the frequency of the scratches on the scratching post, the effect of the treatment was significant ($Z = 2.5143$; $P = 0.0119$; Wilcoxon test), with a median frequency of the scratches on the scratching post for the FIS treatment significantly higher than placebo. The order effect was not significant ($Z = 0.3153$; $P = 0.7526$; Wilcoxon test), with a median frequency of 2.75 for the first treatment, which was not significantly different from that of the second treatment (2).

Discussion

Results of the study reported here showed that the presence of FIS on the scratching post modified the emission of scratching behaviour in cats involved in the trial. Nevertheless, sensitivity to FIS varied among the evaluated parameters of the induced scratching behaviour. Duration and frequency of scratching behaviour were influenced positively by exposure to the semiochemical. In many mammalian species, a relationship has been established between semiochemicals and the behaviour observed.[35] Results of the present study revealed evidence of an interaction between FIS and the feline behaviour of scratching in cats. For the feline behavioural responses of the sample of cats used in this study, the scratching behaviour was significantly affected by exposure to verum treatment: cats exposed to FIS increased the duration and frequency of scratches; non-significant differences were found for the latency of the first scratching behaviour. ITT and PP analyses outlined in the ICH Harmonized Tripartite Guideline 'Statistical Principles for Clinical Trials' E9 (1998) showed the same results for all parameters, supporting the coherency of the dataset.

These results suggest that the presence of FIS can not only influence and prime[35] the location of this important feline behaviour that is associated with territorial marking (and the exercise of a mechanical–functional activity), but also gives specific social, long-lasting information to other individuals.[36] Frequency and duration, which are the measures most commonly used for describing behaviour, provide different and complementary pictures. Values for the two measures for the same behaviour are not always highly correlated, so it is wise to record both;[33] the two measures for scratching behaviour were taken into account in the present study. The importance of analysing the frequency and duration of this behaviour appears to be relevant from a clinical standpoint: if a cat scratches a scratching post, the owner will probably be satisfied, particularly if the cat scratches for a long period of time, always returning to the same place and not scratching other surfaces. Using a scratching post with a chemical message to help manage scratching behaviour at home could be particularly interesting in preserving the relationship between owners and cats. Only 1% of owners decide to relinquish their pet solely owing to inappropriate scratching, but it is also reported to be one of the most common complaints among owners;[7,15] the semiochemical approach could be useful in managing this situation. As suggested by Hart,[37] for the owners, scratching is difficult to understand, and they usually tend to give a univocal and oversimplified interpretation of the phenomenon. A dramatic increase in the manifestation of scratching behaviour in indoor cats could also be related to pathologies such as anxiety,[38] rapidly transformed in attention-seeking behaviour,[7] or used as a displacement activity.[11,39] In multi-cat households with the problem of intraspecific aggression, scratching and urine marking are exhibited concurrently.[11] For some authors,[40] the presence of scent signals increases the cat's confidence in its territory, at which time urine spraying could be used for outdoor communication with other cats, and indoors as a method of self-reassurance when other messages (facial marks and scratching) are not enough. Possible corrective interventions for cat scratching have thus far only involved limitation or restraint (through the application of special caps or through deep flexor tendon tenectomy), or prevention (through declawing) of the true expression of the behaviour,[41] a controversial practice[11] that is forbidden in some countries (European Union). Further investigations into cat communication and the complex pattern of scratching behaviour, along with the use of chemosignal analogues, would offer owners more realistic solutions to understand, manage and accept scratching behaviour. Semiochemical signals are currently the object of different scientific studies,[42] and, in the case of FIS, they could help owners to redirect scratching to convenient posts without having to resort to other disabling, potentially painful solutions. Scratching is an inborn behaviour that can be performed by 5 weeks of age,[5] and the results of this study show the potential interest of using the synthetic analogue of FIS in a preventive manner during the introduction of a kitten to a new house. Scratching behaviour is an important marking behaviour for cats, but can also represent a potentially

undesirable and problematic behaviour for owners. The semiochemical approach may help owners to consider scratching behaviour in cats as a tool for communication, and not simply a problem to be restricted and eliminated. Moreover, results of the present study suggest that the use of FIS could be useful when this behaviour is inappropriate (normal marking, but in an inappropriate place, or anxiety related), and would offer an ethical and ethological alternative to owners.

Conclusions

Our results suggest the possible use of FIS in a preventive manner for a cat arriving in a new environment (to prime a scratching post) and/or to control inappropriate scratching behaviour with the aim of moving scratching behaviour to an appropriate target (scratching post), previously designated by the owner. Environmental enrichment is implemented to improve the animal's physical fitness and well-being,[43] and FIS appears to be a tool for enriching the house environment for a cat. Further clinical studies are needed to obtain more information about scratching behaviour in cats and the semiochemical approach.

Funding The research received no specific grant from any funding agency in the public, commercial, or non-profit sectors.

Conflict of interest The authors do not have any potential conflicts of interest to declare.

References

1 Houpt KA. **Transforming an outdoor cat in an indoor cat**. *Vet Med* 2000; 95: 830.
2 Rochlitz I. **A review of the housing requirements of domestic cats (*Felis silvestris catus*) kept in the home**. *Appl Anim Behav Sci* 2005; 93: 97–109.
3 Amat M, Ruiz de la Torre JL, Fatjò J, et al. **Potential risk factors associated with feline behaviour problems**. *Appl Anim Behav Sci* 2009; 121: 134–139.
4 Heidemberger E. **Housing conditions and behavioral problems of indoor cats as assessed by their owners**. *Appl Anim Behav Sci* 1997; 52: 345–364.
5 Beaver BV. **Feline behavior: a guide for veterinarians**. 2nd ed. St Louis, MO: Elsevier Science, 2003, pp 114–121.
6 Pageat P and Gaultier E. **Current research in canine and feline pheromones**. *Vet Clin North Am Small Anim Pract* 2003; 33: 187–211.
7 Casey R. **Management problem in cats**. In: Horwitz DF and DS Mills (eds). BSAVA manual of canine and feline behavioural medicine. 2nd ed. Gloucester: BSAVA, 2009, pp 98–110.
8 Pageat P, Bougrat L, Monneret P, et al. **The effect of feline interdigital semiochemicals with primers in relation to scratching marking**. *J Vet Behav* 2010; 5: 37.
9 Heath S. **Behaviour problems and welfare**. In: Rochlitz I (ed). The welfare of cats. Dordrecht: Springer, 2007, pp 91–118.
10 Bradshaw JWS. **The behaviour in the domestic cat**. Wallingford: CAB International, 1992.
11 Frank D. **Management problem in cats**. In: Horwitz DF and Mills Heath S (eds). BSAVA manual of canine and feline behavioural medicine. Dorset: UTET, 2004, pp 99–110.
12 Panaman R. **Behavior and ecology of free-ranging female farm cats (*Felis catus* L)**. *Z Tierpsychol* 1981; 56: 59–73.
13 Houpt KA. **Companion animal behavior: a review of dog and cat behavior in the field, the laboratory and the clinic**. *Cornell Vet* 1985; 75: 248–261.
14 Voith VL. **The human-companion animal bond**. *Vet Clin Small Anim* 1987; 3: 289–295.
15 Fatjó J, Ruiz-de-la-Torre JL and Manteca X. **The epidemiology of behavioural problems in dogs and cats: a survey of veterinary practitioners**. *Anim Welf* 2006; 15: 179–185.
16 Tod E, Brander D and Waran N. **Efficacy of dog appeasing pheromone in reducing stress and fear related behavior in shelter dogs**. *Appl Anim Behav Sci* 2005; 93: 295–308.
17 Mills DS, Ramos D, Estelles MG, et al. **A triple blind placebo-controlled investigation into the assessment of the effect of dog appeasing pheromone (DAP) on anxiety related behavior of problem dogs in the veterinary clinic**. *Appl Anim Behav Sci* 2006; 98: 114–126.
18 Taylor K and Mills DS. **A placebo-controlled study to investigate the effect of dog appeasing pheromone and other environmental and management factors on the reports of disturbance and house soiling during the night in recently adopted puppies (*Canis familiaris*)**. *Appl Anim Behav Sci* 2007; 105: 359–368.
19 Gaultier E, Bonnafous L, Legué DV, et al. **Efficacy of dog-appeasing pheromone in reducing stress associated with social isolation in newly adopted puppies**. *Vet Rec* 2008; 163: 73–80.
20 Gaultier E, Bonnafous L, Legué VD, et al. **Efficacy of dog-appeasing pheromone in reducing behaviors associated with fear of unfamiliar people and new surroundings in newly adopted puppies**. *Vet Rec* 2009; 164: 708–714.
21 Denenberg S and Landsberg GM. **Effects of dog-appeasing pheromones on anxiety and fear in puppies during training and a long-term socialization**. *J Am Vet Med Assoc* 2009; 233: 1874–1882.
22 Siracusa C, Manteca X, Cuenca R, et al. **Effect of a synthetic appeasing pheromone on behavioral, neuroendocrine, immune, and acute-phase perioperative stress responses in dogs**. *J Am Vet Med Assoc* 2010; 237: 673–681.
23 Pageat P. **Experimental evaluation of the efficacy of a synthetic analogue of cats' facial pheromones (Feliway) in inhibiting urine marking of sexual origin in adult tomcats**. *J Vet Pharmacol Ther* 1997; 20:169.
24 White JC and Mills DS. **Efficacy of synthetic facial pheromone (F3) analogue (Feliway) for the treatment of chronic non-sexual urine spraying by the domestic cat**. In: Mills DS, Heath SE and Harrington LJ (eds). Proceedings of the First International Conference on Veterinary Behavioral Medicine, 1–2 April 1997, Birmingham. Universities Federation for Animal Welfare, Potters Bar: p 242.
25 Griffith CA, Steigerwald ES and Buffington CA. **Effects of a synthetic facial pheromone (Feliway) on behavior of cats**. *J Am Vet Med Assoc* 2000; 217; 1154–1156.
26 Mills DS and White JC. **Long-term effect follow-up of the effect of a pheromone therapy (Feliway) on feline spraying behavior**. *Vet Rec* 2000; 147; 746–747.

27 Ogata N and Takeuchi Y. **Clinical trial of a feline pheromone analogue (Feliway) for feline urine marking**. *Vet Med Sci* 2001; 63: 157–161.
28 Gunn–Moore DA and Cameron ME. **A pilot study using synthetic feline facial pheromone (Feliway) for the management of feline idiopathic cystitis**. *J Feline Med Surg* 2004; 6: 133–138.
29 Kronen PW, Ludders JW, Erb HN, et al. **A synthetic fraction of feline facial pheromones calms but does not reduce struggling in cats before venous catheterization**. *Vet Anaesth Analg* 2006; 33: 258–265.
30 Cozzi A, Monneret P, Lafont-Lecuelle C, et al. **The maternal cat appeasing pheromone: exploratory study of the effects on aggressive and affiliative interactions in cats**. In: Proceedings ACVB/AVSAB Veterinary Behavior Symposium, 30 July 2010, Atlanta, GA, USA.
31 Pageat P, Bougrat L, Monneret P, et al. F**eline interdigital semiochemicals with primers effect for scratching marking**. In: Proceedings 7th International Veterinary Behaviour Meeting – IVBM, 29–31 October 2009, Edinburgh, UK. ESVCE Editor, Lovendegem: pp 111–112.
32 Cozzi A, Lafont Lecuelle C, Bougrat L, et al. **The interest of the use of feline interdigital semiochemical (Scratchylicious) to induce scratching behaviour in cat**. In: Proceedings ACVB/AVSAB scientific meeting, 15 July 2011, St Louis, MO, USA, pp 4–5.
33 Martin P and Bateson P. **Measuring behaviour**. 3rd ed. Cambridge: Cambridge University Press, 2007, pp 25–41
34 Laplanche A, Com-Nougué C and Flamant R. **Statistical methods in clinical investigation**. Paris: Médicine-Sciences, 1987, pp 46–57.
35 Wyatt TD. **Perception and action of pheromones: from receptor molecules to brains and behavior**. In: Wyatt TD (ed). Pheromones and animal behavior. Cambridge: Cambridge University Press, 2003, pp 164–205.
36 Overall K. **Normal feline behavior**. **Clinical behavioural medicine for small animals**. St Louis, MO: Mosby-Year Book, 1997, pp 45–76.
37 Hart BL. **Behavioral aspects of scratching in cats**. *Feline Pract*. 1972; 2: 6–8.
38 Dehasse J and De Buyser C. **Social ecology of cats**. *Prat Méd Chirde Anim* 1993; 28: 469–478.
39 Gagnon AC, Chaurand JP and Larue JF. **Behaviour and behavioural problems of cats**. Maisons-Alfort: Editions du Point Vétérinaire, 1993.
40 Hart BL and Hart LA. Canine and feline behavioral therapy. Philadelphia: Lea & Febiger, 1985
41 Swidersky J. **Oniychectomy and its alternative in feline patient**. *Clin Tech Small Anim Pract* 2002; 17: 158–161.
42 Wyatt TD. **Pheromones and signature mixtures: defining species-wide signals and variable cues for identity in both invertebrates and vertebrates**. *J Comp Physiol A Neuroethol Sens Neural Behav Physiol* 2010; 196: 685–700.
43 Hosey G, Melfi V and Pankhurst S. **Zoo animals behaviour, management, and welfare**. 1st ed. New York: Oxford University Press, 2009, pp 259–288.