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Stress in owned cats: behavioural changes and welfare implications

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Abstract

Domestic cats are exposed to a variety of stressful stimuli, which may have a negative effect on the cats' welfare and trigger a number of behavioural changes. Some of the stressors most commonly encountered by cats include changes in environment, inter-cat conflict, a poor human–cat relationship and the cat's inability to perform highly motivated behaviour patterns. Stress is very likely to reduce feed intake, and stress-related anorexia may contribute to the development of potentially serious medical conditions. Stress also increases the risk of cats showing urine marking and some forms of aggression, including redirected aggression. A number of compulsive disorders such as over-grooming may also develop as a consequence of stressful environments. Some of the main strategies to prevent or reduce stress-related behavioural problems in cats are environmental enrichment, appropriate management techniques to introduce unfamiliar cats to each other and the use of the synthetic analogue of the feline facial pheromone. As the stress response in cats depends, to a large extent, on the temperament of the animal, breeding and husbandry strategies that contribute to the cat developing a well-balanced temperament are also very useful.

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Introduction

The term 'stress' has been widely used in biology to describe a set of physiological and behavioural changes elicited by noxious or unpleasant stimuli,[1] with the hypothalamic–pituitary–adrenal (HPA) axis and the sympathoadrenomedullary system being generally considered the two main elements of the stress response.[2–4]

There is now sufficient evidence to show that it is not the physical nature of an aversive stimulus that has negative consequences on the animal but rather the degree to which the stimulus can be predicted and controlled.[5,6] As a result, it has been suggested that the term 'stress' should be restricted to conditions where an environmental demand exceeds the regulatory capacity of the organism, in particular when such conditions include unpredictability and uncontrollability. In domestic animals, stressors can be conveniently divided into physical stressors, social stressors resulting from the interactions with individuals of the same species and stressors related to handling by humans. According to its duration, stress is classified as acute or chronic.[1] Stressors have additive effects, which means that when several stressors impinge upon the animal at the same time, the resulting stress response will be much higher than if the animal was exposed to one stressor only.[7]

Stress in companion animals is important for several reasons. Firstly, when it is intense or long lasting enough to overtax the adaptation capacity of the animal, stress has a negative effect on the welfare of the individual.[8,9] Secondly, behavioural changes associated with stress can be especially annoying for owners and, as a consequence, stress-related problems are a very common cause of relinquishment and euthanasia of dogs and cats.[10–12] Additionally, it is obvious that in these cases the human–animal bond may be negatively affected. Finally, there is growing evidence to support the relationship between stress and disease, which will be discussed in this review.[6,13]

Several behavioural changes in cats, such as some elimination problems, aggressive behaviours or compulsive behaviours, are related to stress.[11] In this review we will address the behavioural changes related to stress

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that are the most commonly seen in veterinary practice. Additionally, we will discuss the effect of stress on the health of the cat, as well as the main treatment and preventive measures.

Temperament and stress

The stress response of a given cat will depend not only on the environment in which the cat lives, but also on the individual's temperament. Temperament has been defined as individual differences in behaviour that are stable across time and across situations, and which are mainly related to the animal's reaction to a challenge.[14,15]

A cat's temperament depends on its genetic make-up and its early experience. The effects of the cat genotype on its temperament have been revealed through studies looking at the effect of paternal temperament, breed and coat colour. It has been shown, for example, that kittens with friendly sires are friendlier towards humans (both familiar and unfamiliar) than kittens with unfriendly sires.[14,16,17]

As for the breed effect, some authors have concluded that Persian and Siamese cats are more interactive (more playful, curious and friendly) than non-pedigree cats,[18] while others have highlighted that Bengal cats score highest in aggression towards owners and Persians score lowest in activity level.[19] Furthermore in cats, associations between coat color and temperament have been found. Some studies have found that orange cats are more aggressive and darker cats more sociable than cats with other coat colours.[20] Other studies, however, have failed to obtain similar results.[21,22]

The effects of early experience on temperament have been described in several papers. For example, it has been reported that kittens reared by an experienced dam and weaned at a late age develop fewer behaviour problems (including lack of bite control and frustration-related aggression) than kittens weaned too early or reared by an inexperienced dam.[23] Furthermore, kittens born to undernourished dams that usually show poor maternal behaviour are likely to develop behavioural abnormalities.[24]

The socialisation period in cats begins at the age of 2 weeks, when cats are able to interact with their environment, and finishes at around 7 weeks of age. The kittens' experiences during this period will have long-lasting effects on their development and behaviour.[24–27] For example, kittens handled during this period are friendlier towards humans than non-handled kittens. Both the amount of handling and the number of handlers have an effect on the degree of friendliness towards humans.[14,27,28] One aspect that is related to the socialisation process and that may influence the cat's temperament is its origin. In fact, studies performed in dogs and cats suggest that animals from pet shops have a higher probability of developing behavioural problems than animals from other sources. Although the reasons for this difference are not clearly understood, it has been suggested that kittens reared in pet shops may not be exposed to many stimuli during the sensitive period.[29,30]

Causes of stress

Some of the main causes of stress in cats include environmental changes, a barren environment, a poor human–cat relationship, inter-cat conflict, and lack of control and predictability.

Novelty may be stressful in itself and therefore changes in the physical environment of the cat, as well as the arrival of a new household member or a change in the daily routine, may all lead to stress.[31,32]

A barren environment that provides few opportunities to express normal behaviour may also lead to stress,[33] and promoting the cat's natural behaviour using enrichment strategies has been shown to reduce it.[8,34–37] There are some species-specific behaviours that seem to be particularly relevant from an animal welfare standpoint,[38] and enrichment strategies should mainly target such behaviours. For instance, outdoor cats spend a high proportion of their active time hunting and exploring their territory, and the inability to engage in such behaviours when cats are kept indoors (particularly in a barren environment) may result in stress-related problems.[39] Scratching is also a feline behaviour. It serves several functions as it has an important role in territorial communication and helps to maintain claw health.[40]

A poor human–cat relationship is another important cause of stress. In most cases, a poor human–cat relationship is a consequence of either inappropriate socialisation or inadequate handling, such as using punishment. Owners with a lack of knowledge about cat behaviour may contribute to these problems.[41,42]

Inter-cat conflict may appear as a result of several causes, including the introduction of a new cat or the reintroduction of a cat that was previously separated owing to a medical problem or other circumstances.[43–45] In both cases, a territorial conflict or a defensive aggression (probably owing to the different odour of the cat) could occur.[46,47] Competition for resources, such as resting places or feed bowls, may also lead to inter-cat conflict, and territorial cats tend to block access to valuable resources. In fact, on some occasions, elimination problems are a consequence of a territorial conflict as the territorial cat does not allow the other cat to access the litter box.[48]

One of the main psychological factors that increase the aversive dimension of a given stimulus is a perceived sense of unpredictability and lack of control.[34,49–52] In the domestic environment, both changes in the husbandry routine and inconsistency in the owners' reaction to the cat behaviour may cause chronic stress.

Table 1 Main behavioural changes caused by stress (adapted from Rochlitz[70] and Amat et al[27])

Behaviour	Changes caused by stress
Feed intake	Usually decreases but may increase in some circumstances
Grooming	Usually increases but may decrease in some circumstances
General activity	Decreases
Play	Decreases
Exploratory behaviour	Decreases
Facial marking	Decreases
Positive interactions with other cats and with humans	Decrease
Vocalisation	Increases
Vigilance	Increases
Hiding	Increases
Urine spraying	Increases
Aggressive behaviour	Increases, particularly redirected aggression and some forms of affective aggression
Compulsive behaviours	Increase (compulsive behaviours will not develop in healthy cats in an optimal environment)

Stress and disease

One of the consequences of the stress response is suppression of the immune system function and the development of a new infection or the reactivation of a previous one.[53] For instance, it seems that stress has an important role in the reactivation of feline herpesvirus: this is a common cause of respiratory disease in cats and a frequent problem in, for example, cat colonies.[54–56] According to Tanaka et al,[56] cats with high levels of stress are almost five times more prone to develop upper respiratory tract infection than cats with lower levels of stress.

Stress has been associated with several gastrointestinal problems such as diarrhoea or vomiting.[57,58] It seems that stress can alter the integrity of the intestinal barrier,[59] which will, in turn, cause an increase in its permeability and a local inflammatory reaction.

Stress has an important role in the development of feline interstitial cystitis (FIC), which is the most common diagnosis in cats with feline lower urinary tract disease.[60,61] Although the precise mechanism by which stress contributes to FIC is not clearly understood, it seems that the glycosaminoglycan layer of the urine bladder wall is thinner in cats with FIC than in healthy cats, and there is an increased activation of the sympathetic nervous system that causes altered bladder permeability.[62] Cats with this recurrent disease may show dysuria and haematuria, and very often urinate outside the litter box.[61,63]

Furthermore, there is a clear connection between skin and nervous system.[64] Some dermatological diseases, such as atopic dermatitis or acral lick dermatitis, can be affected by stress, which is likely to trigger or perpetuate pruritus.[65–67] For instance, a negative correlation has been found in atopic patients between stress-coping skills and levels of immunoglobulin E (IgE); high levels of IgE may contribute to allergic diseases.[68,69]

Behavioural changes caused by stress

Stress may cause a wide range of behavioural changes in cats (Table 1). In some cases, stress inhibits normal behaviour,[32] and cats will hide for long periods of time, play less, reduce their exploratory behaviour and show fewer affiliative behaviours such as allorubbing or allogrooming.[70] In these cases, owners may not be aware of the discomfort being experienced by their cat.

One of the most serious stress-related behavioural changes in cats is anorexia, which may lead to potentially fatal as hepatic lipidosis. Hepatic lipidosis seems to be particularly common in overweight cats that stop eating because of a stress response.[71] Stress-induced anorexia is mediated mainly by the release of corticotropin releasing hormone (CRH) from the hypothalamus. CRH influences the hypothalamic circuitry controlling appetite and food intake, and modulates the oculomotor pathways involved in the recognition and acquisition of food.[72]

Additionally, stress seems to increase food neophobia,[73] and therefore stress-induced anorexia is likely to be more pronounced when cats are given a new food in a stressful environment.

In some cases, however, stress may cause polyphagia.[74–76] Indeed, the effect of stress on feed intake results from the complex interplay between a vast array of hormones and neurotransmitters, including glucocorticoids, leptin, insulin, CRH, urocortins, neuropeptide Y and melanocortin, among many others.[74,77–79] The precise effect of the stress on food intake will depend on several factors, including the intensity of the stressor.[75]

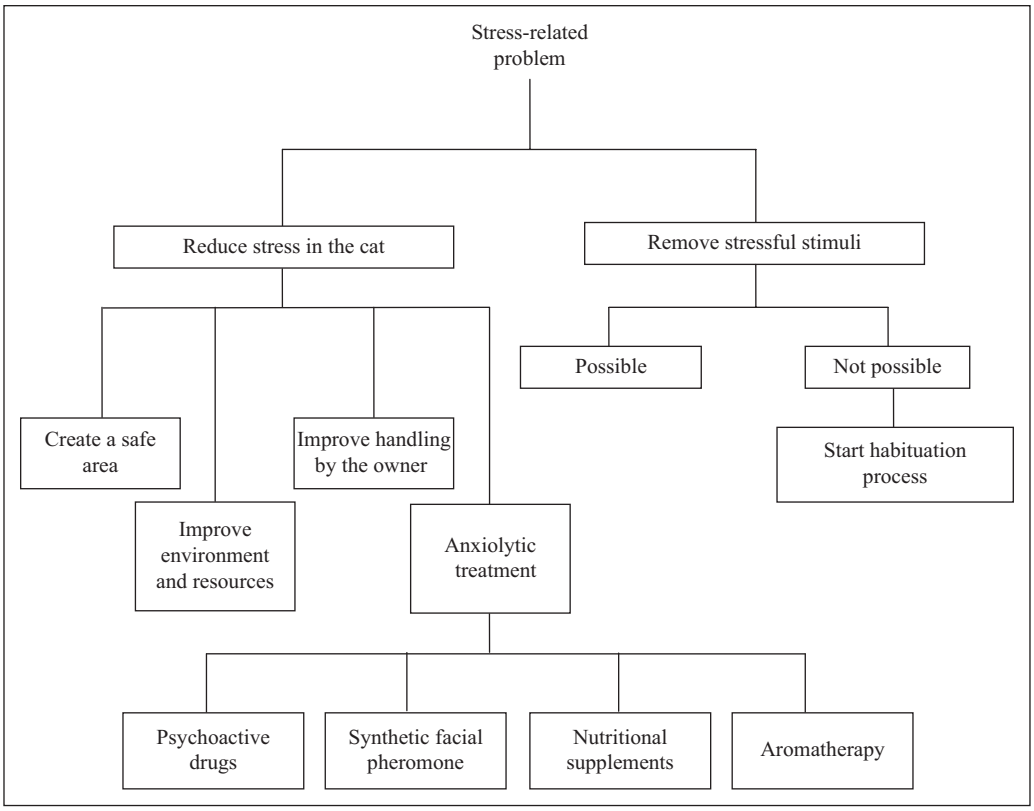

Figure 1 Strategies to prevent and reduce stress in cats

As a consequence of stress, cats may also exhibit compulsive behaviours.[66,80,81] Compulsive behaviours are repetitive behaviours that may arise as a consequence of a disease or when the animal is not able to adapt to the environment.[82] Compulsive behaviours may serve as a coping mechanism when animals are exposed to stressful events. Indeed, several studies have shown a decrease in plasma glucocorticoid concentration in sows, calves and pigs with compulsive behaviours.[83–85] As several medical conditions can cause these disorders, the first step in the diagnosis is to rule out such conditions by carrying out a physical and neurological examination, a complete blood cell count, biochemistry profile and urinalysis.[81]

Three of the most common compulsive disorders in cats are the condition known as feline hyperesthesia syndrome (FHS), psychogenic alopecia and pica. Cats with FHS show brief bursts of unusual behaviour such as a rolling skin, intense grooming, scratching and running. Others signs are salivation, vocalisation and uncontrolled urination.[86] FHS is more common in mature cats. Although its causes are not clearly understood, it has been suggested that both epileptic seizures and myopathies may be involved.[87,88] Nevertheless, FHS could be the consequence of any situation related to stress, conflict or frustration, and has also been linked to barren environments.[86]

Overgrooming disorders such as psychogenic alopecia seem to be more common in Siamese and Abyssinian cats.[89,90] Usually, alopecic areas are located in the caudal part of the body, mainly on the ventral abdomen.[80,86] Sometimes this behaviour is related to FIC, as the affected animals lick their abdomen in order to alleviate pain.[80]

According to the literature, pica (eg, eating of non-food items) can be considered either a compulsive disorder or a feeding disorder.[91–93] Pica in cats may involve various materials such as wool, cotton, fabric, rubber or plastic.[66,94] Some authors have suggested that pica could be a coping mechanism,[95,96] and it may also have a genetic component, as Oriental breeds show this disorder more frequently.[94] Additionally, it is believed that stressful events play an important role in the development of pica.[94]

Stress can also affect urine marking behaviour: this is a normal behaviour seen most frequently in intact males and in females in oestrus.[97,98] Oftentimes, but not always, cats mark by spraying urine on vertical surfaces. Stress increases the frequency of urine marking and, in particular, cat density and the likelihood of inter-cat conflict seem to have a major effect on the frequency of this behaviour, which has an incidence of 25% in single-cat households and up to 100% in households with 10 or more cats.[99]

The relationship between stress and aggression is bidirectional: offensive and defensive aggressions cause

a stress,[100,101] and the activation of the HPA axis facilitates aggressive behaviour.[102] Redirected aggression is a fairly common type of aggression in cats and consists of the animal attacking a stimulus other than the one that elicited the aggressive motivation.[102,103] Redirected aggression may serve as a coping mechanism when cats are exposed to stressful events, and some studies have observed that plasma glucocorticoid concentrations decreased after redirected attacks.[104–106] Additionally, most instances of redirected aggression in cats involve a defensive posture,[102] which adds further support to the possible link between fear (and more generally stress) and this form of aggression.[107,108]

Strategies to prevent and reduce stress in cats

Whenever possible, the stressful stimulus should be removed. However, this is not always possible; for example, when the stressful stimulus is the other cat that lives in the same household. In these cases, exposing the cat to the stressful stimulus in a pleasant context and in a gradual manner may be very useful to progressively reduce the cat's response (see Figure 1).[109,110]

In cases of inter-cat conflict, for example, a reintroduction protocol could be used.[111,112] The protocol is divided into three phases: olfactory habituation, visual habituation and direct contact habituation. The duration of each part is variable, depending on the severity of the conflict, the cats' response and the owner disposition. In the olfactory habituation phase, each cat is confined to a different part of the household and all important resources (including food, water, litter box and scratching post) are provided in both areas. Each cat is then moved to the other area so that both animals are exposed to the other cat's odour. Additionally, using a piece of cloth, the secretion of the facial gland of each cat can be applied to the cheeks of the other cat. The visual habituation phase can start when both cats are relaxed during territory exchanges. In the visual habituation phase, visual contact between cats through a mesh door, for instance, is provided when cats are engaged in a pleasant activity. Cats are otherwise kept separated and the duration of the visual contact sessions is gradually increased. Finally, in the last phase of the reintroduction protocol (direct contact habituation), the wire mesh is removed.

Environmental enrichment is a technique used to reduce stress and improve welfare by increasing the physical, social and temporal complexity of the environment.[33] It is not a static change, so should change over time. Nevertheless, it is important to remember that sudden changes can cause additional stress and therefore all changes should be made in a very progressive way. The main features of an environmental enrichment programme for cats include the following:

- Provision of a safe area where the cat feels comfortable and has all the important resources.[113] Potential stressors such as other cats or dogs should be prevented from entering the safe area.
- As cats spend a high percentage of time foraging, providing puzzle feeders and hiding food in several places may be very useful.[113,114] Mainly in indoor cats, toys should be used and changed at regular intervals to keep the cat's interest.[115] Toys that simulate small, moving catchable prey are particularly useful.[116,117]
- Providing a vertical or a three-dimensional space (eg, shelves, cat trees or platforms) should be encouraged, as cats use vertical space as a vantage point and as a hiding area.[29,113,118,119] In fact, some studies have suggested that providing hiding places reduces stress.[34,120,121]
- The litter tray, the resting area and the feed bowl should be kept separate.[33]
- There is some evidence to suggest that cats are strongly motivated to scratch; therefore, providing a suitable substrate for scratching is an important enrichment strategy.[122]

In multi-cat households, an adequate distribution of resources to avoid conflict is essential, and this should include the feed and water bowls, resting areas and litter trays.[123] This is even more important when one cat tries to prevent the other cats from accessing a particular resource.[113,122] The number of litter boxes will depend on the number of cats, and there should be at least the same number of litter boxes as cats that live in the house, and they should be located in different locations and be easily accessible (particularly when there are geriatric cats).[113,124]

Although restricted feeding could sometimes be recommended (particularly in obese cats), it may cause stress; therefore, ad libitum feeding is probably better on welfare grounds associated with other practices to reduce obesity (eg, measures to increase activity, such as periods of play).[125] Particularly when FIC is suspected, it is also very important to encourage cats to drink enough water in order to dilute the urine.[126–128] Both water fountains and water bowls that are big enough so that the cat's vibrissae do not touch the sides of the bowl are potentially useful.[122]

As we have highlighted that stress and temperament are related, it is very important that during the sensitive period kittens have contact with all the stimuli they are likely to encounter later on in life; otherwise, they are likely to react with either a negative emotional state such as fear or an inappropriate behaviour such as aggression.[43,129] These interactions between the cat and the stimuli should be positive; otherwise, the negative response of the cat towards them will increase.

Punishment by owners should be completely avoided.[130,131] Daily routines (eg, play time, feed

schedule, owner schedule) and interactions with the owners should be predictable, thus reducing the chronic stress associated with unpredictability.[113] Further, cats should always have control of their surroundings, which is particularly important in cats experiencing stress. This can be achieved by providing them with safe areas as previously described.[113,130,132–135]

A discussion of the pharmacological strategies that can be used to treat stress-related problems is beyond the scope of this review. However, it is important to note that administering a drug may be an additional source of stress. Therefore, one important aspect to be considered is the frequency of drug administration. For example, in cases of stress-induced anorexia, benzodiazepines have been widely recommended as appetite stimulants in cats.[136] However, some of them, particularly diazepam, can cause hepatic necrosis, even after a short treatment.[137–139] A safer option is mirtazapine, a tetracyclic antidepressant with noradrenergic and serotonergic activity, which has been used in cats with chronic kidney disease owing to its antiemetic and appetite stimulant properties.[140,141] One of the advantages of this drug is its fast onset of action and its dosage, as it has to be administered every 3 days.[141]

A potentially very useful treatment and prevention strategy for stress-related problems is the synthetic analogue of the feline facial pheromone (Feliway; Ceva Animal Health). This pheromone has been shown to facilitate cats' habituation to new environments and is therefore useful in hospitalised cats, and when cats are transported or moved to a new home. The pheromone also reduces non-sexual urine spraying and compulsive disorders.[142–146] Depending on the situation, Feliway can be used as a spray or as a diffuser, and can be combined with other anxiolytic products.

Recently, both nutritional supplements and aromatherapy have gained popularity in treating or preventing stress-related problems. Although more research is clearly needed in this area, there is some evidence to show that alpha-casozepine, which is a gamma-aminobutyric acid agonist, reduces anxiety in number of species, including the domestic cat.[147–149] As for aromatherapy, it seems that lavender essential oil has calming effects in cats.[150]

Conclusions

Stress-related problems such as behavioural changes and some diseases have a strong negative impact on cat welfare. The main causes of stress include a barren or unpredictable environment, as well as conflicts with other cats. Strategies to reduce or prevent stress should aim at improving the environment of the cat or reduce inter-cat conflict.

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