# Multimodal environmental modification (MEMO) for prevention and treatment of disease in cats: part 1

**Cat's lives have changed over the last few decades as they have moved from outdoors into our homes. Cats respond to their surroundings based on their individual history, the context they live in, and their expectations about what will happen next. Stress from threats in their environment can result in a variety of illnesses, including feline idiopathic cystitis, gastrointestinal disease and behavioural abnormalities. These problems often can be resolved by using multimodal environmental modification (MEMO) to create a safe, stimulating environment that cats can thrive in.**

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Understanding the origin of cats and why they respond to experiences the way they do helps us to handle cats in both the home and veterinary environment.

## Wild animal to indoor pet

The world changes and animals adapt — to the extent of their capacity. When I was growing up on an Angus cattle ranch in rural central California during the decade of the 1950s, domestic cats were outdoor-only animals that rarely received veterinary care. Today, as a veterinarian practising in Columbus, Ohio, a metropolitan area of nearly 2.4 million, essentially all the cats we see are confined to the inside of their owners' homes.

This dramatic change in environment, from free-living to essentially 'zoo animals' because of their confinement, may be testing the adaptive capacity of some cats. Cats developed as a species as solitary predators of small prey, in 'home ranges' of some two hectares (20,000 $m^2$) (Figure 1). Hunting primarily small prey, which often contain only 20–30 kcal of energy, required cats to be 'opportunistic' feeders, competing with other cats to take prey whenever it became

In this, the first of two articles, Dr Buffington explains how the early experiences of cats can shape their responses to experiences as adults. In part 2, published in next month's *Feline Focus*, he will provide specific guidelines for MEMO and describe how to coach clients through the change process so that their cats can thrive in their care.

**Figure 1:** Cats evolved to roam large territories

available. Domestic cats also developed as prey as well as predator species, hunted by larger carnivores and primates. Additionally, cats are the most '3-dimensional' of the common mammalian species, climbing both to search for prey and to avoid predators. Cats also need to scratch, both to ensure the health of these appendages that are so necessary for their survival, and to mark their territory.

## Key point

Modern cats may be confined to a small 'territory' indoors but they evolved to live in large home ranges and this change may result in behavioural problems.

## Origins of behaviour

Like all animals, cats' heritage determines their interactions with their environment. Each time an animal acts, the environment responds in some way. The animal perceives the response it receives from the environment through its senses (sight, sound, smell, touch and taste). The animal's brain learns about its surroundings from this information based upon its own personal history, the place where the interaction occurred (the context), and what the animal expects to happen next (its expectation, based on its history and the context). The animal then makes a decision based the personal meaning of the environmental response to its actions, which often is to approach or withdraw. This action-response-learning-action cycle begins very early in life and ends with death, and is fast, as fast as 50 times per second! This means that the animal is consciously aware of how it feels only 'after the fact', because the response is faster than the nervous system can get it into conscious awareness. Anyone who has had the experience of seeing an animal suddenly react to something done to it knows how fast it can be, especially if the action is to bite or scratch you!

The history of many cats seen in our practice also includes some kind of adverse early life event; a feral mother without enough food to eat living in threatening surroundings, orphaned, adopted from a shelter, for example. Recent research into the developmental origins of health and disease have found that such events can have long-term influences on these animals, and even their offspring. Transmitting information about the environment through the mother to the fetus appears to be an evolutionarily conserved mechanism to help adapt the animal to the environment it will be born into. This 'predictive adaptive response' is mediated through changes in gene expression by modifying the signals that determine which genes are read and which are silenced, a process known as epigenetic modulation of gene expression. When offspring

are born into the predicted environment, the changes can confer a survival advantage. When born into an environment different from the one encountered during gestation however, the changes may limit the animal's capacity to adapt to it.

## Key point

Even before birth a cat's experiences in utero can affect future behaviour via 'predictive adaptive responses'.

Responses to both nutrient-limiting and threatening environments have been studied. When animals exposed to nutrient-limiting environments during gestation are born into environments with unlimited access to food, obesity and related disorders are more common, because the animal was adapted to conserve as many nutrients as possible. In the case of threatening environments, animals are born more keenly aware of their surroundings, which can make them hypervigilant to threat, and more likely to activate their stress response system to seemingly non-threatening environmental events (Figure 2). Environmental modification of gene expression occurs throughout life, although it has its greatest impact early in life when body systems are at their most 'plastic' and responsive to environmental sculpting.

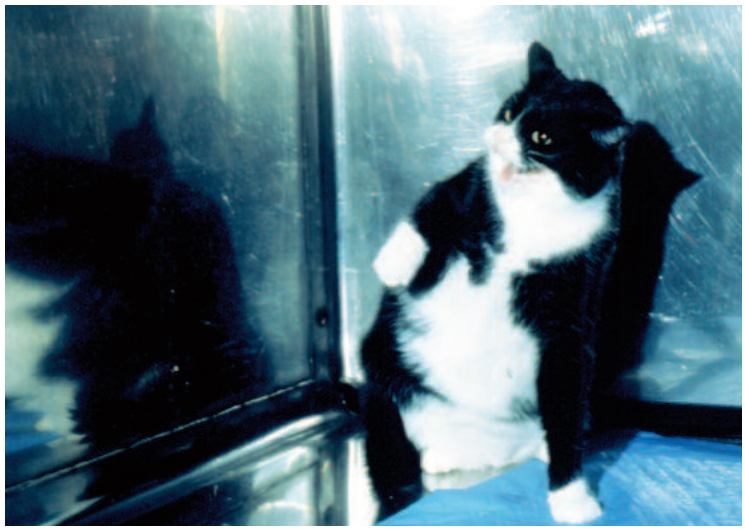

**Figure 2**: Cats born into threatening environments may remain hypervigilant for life and respond disproportionately to perceived threats

## Context and expectation

Understanding cats' evolutionary and individual histories helps explain the importance of their surroundings to their health and welfare. Cats' health and welfare depend on their ability to cope with their environment, which can be thought of as the ratio of their perception of control to their perception of threat. As long as this ration remains greater than one, they can cope; when it declines to less than one, they are at risk for health problems. There are two aspects of the environment to consider, context and expectation. Cats' context, their immediate surroundings, contains the environmental features they have to cope with and the resources available to permit them to cope with their situation. Expectation is what the cat thinks will happen next. For example, a cat with normal genetics may have a bad experience early in life (like being orphaned), which causes a different set of genes to be read that makes it more sensitive to threats in its surroundings. In an enriched environment, this sensitivity may never be expressed; if the context is a barren, unstable, or chaotic environment that is more than the cat can cope with however, sickness can result.

Expectation is all about predictability. If the cat learns to expect a good outcome, everything will be fine. Expecting a bad outcome, or even more importantly not knowing what to expect, can be very threatening. This is especially important for kept cats because, compared with their historical origins, they are confined in very small spaces, often with competitors (other cats) and predators (dogs, humans), with little control of their surroundings and prohibited from engaging in their normal, necessary behaviours (eg, scratching and climbing). It is not surprising that some cats struggle to cope with this kind of captivity. Of course, the answer is not always to return cats to the outdoors, where there may be even more competitors, predators, and potential for exposure to injury and infectious diseases.

## Cat and human 'culture clash'

Confined animals are completely dependent on their owners for every aspect of their existence: where, when and how they eat, drink, eliminate and rest; who they interact with, and what opportunities they have to express their species-typical behaviours. They also are likely to experience the 'culture clash' between their history and that of their owners. In contrast to the more independent social structure of cats, humans and most other species of domestic interest have a more group-oriented social structure. For predators (dogs and humans), this facilitates hunting for larger prey, while for prey species (eg, cattle, horses, etc) it facilitates 'safety in numbers'.

Unfortunately for cats, this difference has led to the perception by some that cats are 'aloof' or 'untrainable', when in actuality it means only that cats respond to positive punishment (adding a stimulus, like yelling or hitting, to reduce the occurrence of a behaviour, like scratching) as a mortal threat rather than as the subordination signal that more group-living species perceive it to be. This does not mean, however, that cats are untrainable — cannot learn what to use and what to leave alone — only that they learn in a different way.

### Tip

Cats are trainable but learn in a different way to other species. Punishment should be avoided and alternatives to the undesirable behaviour offered.

Cats can learn how to live in their surroundings by being deterred from undesirable behaviour and a clear alternative made readily available. For example, when an owner does not want a cat to scratch or climb on a piece of furniture, they can make the furniture aversive by applying something like foil, sticky tape, or a scent to it as well as providing an alternative scratching or climbing resource nearby and making it as attractive as possible to the cat by applying something the cat finds irresistibly appealing like a favourite treat such as food or catnip, and praising the cat for using the preferred object. In this way, one changes the context to one that permits the cat to learn what to do as well as what not to do, and creates the expectation that the owner is a source of praise and positivity rather than a predatory threat.

## Sickness behaviours

While many cats tolerate confinement, indoor housing has been associated with increased risk for a variety of common health problems in cats, including behavioural disorders, obesity, upper and lower gastrointestinal disease, lower urinary tract diseases, and type 2 diabetes mellitus. We also have found that environmental stressors can result in an increase in sickness behaviours, both in healthy cats and in cats with feline interstitial cystitis (FIC), the most common lower urinary tract disease in the United States. Sickness behaviours are non-specific clinical and behavioural signs that include fever, lethargy, vomiting, diarrhoea, and decreases in food and water intake, general activity, body-care activities (grooming), and social interactions. They are thought to promote recovery by inhibiting activity. Sickness behaviours are well-documented responses to infection and inflammation that have recently been found to occur in response to threatening environments.

### Key point

Sickness behaviours are biological responses to threatening environments as well as to infection and inflammation.

The most common sickness behaviours we found, both in healthy cats and cats with FIC were expulsion of hair, food or bile from the mouth, decreased food intake and eliminations, and eliminations outside the litter container (Figure 3). This suggests that, in addition to the many medical causes of these signs, they also can occur in response to threatening environments. Importantly from a nursing care point of view, we also found that sickness behaviours resolved when the threat was removed.

**Figure 3:** Inappropriate urination is a sickness behaviour that can result from environmental stress

Cats with FIC also commonly have variable combinations of co-morbid disorders, such as those listed above. It is possible that these other problems resulted from the severity of the urinary tract disease, but if this were the case one would expect the other problems to develop after the urinary signs. In fact, the co-morbid diseases often begin before lower urinary tract signs appear, and in no consistent order, suggesting that they may be manifestations of a common underlying problem like a sensitised stress response system.

## Multimodal environmental modification

This idea is strengthened by the demonstration that all signs are mitigated by effective multimodal environmental modification (MEMO). We have documented the

**Figure 4:** Veterinary professionals have an opportunity to educate clients about their cats and so improve their relationship

effectiveness of MEMO in both clinical trials and laboratory studies, providing strong evidence both for the effects of confinement on the health and well-being of confined cats, and of the ability of effective environmental enrichment to improve their health and welfare. These results also suggest that improving cats' context and expectation eventually changes their history, likely by subsequent changes in gene expression.

Recent research in a variety of species has shown that providing meaningful cognitive, sensory, social, and activity enrichment enhances neural plasticity in the brain. Neural plasticity is the ability of some neurons to undergo experience-dependent changes in their structure and function, which forms the basis of learning. These alterations occur in response to changes in gene expression, as well as in growth factor production and neurotransmitter profiles, which help animals learn to cope with their surroundings throughout their lives.

When I was growing up, animal husbandry was an important part of ranching because it was known then that productivity was directly related to the quality of care of animals. Now as then, owners accept the responsibility for the health and welfare of animals they keep in confinement. What has changed in the intervening years is that fewer people have extensive experience with the animals they own, and so may not appreciate the needs of confined animals, correctly interpret their animals' behaviours, or understand how to establish and maintain an appropriately enriched environment. This situation has created an unparalleled opportunity to educate these clients about their pet's needs, to improve the bond between them, and consequently the quality of both their lives (Figure 4).

In part two of this article to be published in next month's *Feline Focus*, I will provide specific guidelines for MEMO for confined cats, and describe how to coach clients through the change process so that their cats can thrive in their care.

## Key point

Multimodal environmental modification can improve a cat's health and welfare, and providing meaningful environmental enrichment may even alter their gene expression to help them cope with their surroundings.

Article published in *Feline Focus*, The International Society of Feline Medicine's nurse and technician journal. To access more *Feline Focus* articles, and other member benefits such as webinars, sign up for free at www.icatcare.org/nurses.