



# **Canine Behaviour – What to do with Problem Dogs Mini Series**

## **Session Two: The Effect of Diet and Neutering on Behaviour and Its Management**

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## **Canine Behaviour - what to do with problem dogs**

### **Part 2: The effect of diet and neutering on behaviour and its management**

#### **Study notes**

#### **Diet**

Nutrition has a substantial effect on both physical and behavioural health. The composition of the food an animal eats and its ability to digest and synthesise it affects physiology. This in turn affects the dog's ability to perform everyday behaviours, and choices when doing so. The drives and activities involved in acquiring and consuming food will also impact on chosen behaviour in other situations. Whilst a CAB may advise on nutrition, they are required to do so in liaison with the animal's veterinary practice to ensure this does not conflict with advice given by them and maintains physical needs. The practice will also be offering dietary advice independent of the behaviourist. It is therefore useful for practice staff to be aware of the impact of diet and nutrition on canine behaviour.

#### **Natural feeding behaviour and drives**

The ancestor of the domestic dog, the grey wolf, is an opportunistic co-operative hunter. It is primarily carnivorous, although does eat some plant material including the contents of its prey's intestines. It is a glutton feeding, hunting and gorging every few days then resting until driven to hunt again.

Domestication of the dog occurred through selection for those wolves that were tamer and willing to eat a more varied diet. As such the eating habits and digestive physiology of the dog has changed from that of its ancestor. Although some breeds/individual dogs may still hunt, even co-operatively, most don't and have instead evolved to subsist on whatever humans don't want through scavenging. As a result it is now better able to digest starch based food items than its ancestor. The dog is largely still an opportunistic glutton feeder, which can lead to obesity in some cases given the free access to food and lack of effort required to obtain the dog now enjoys. The massively reduced time investment involved in seeking, acquiring, competing over and consuming food can also lead to boredom and frustration if the energy and reward associated with feeding drives isn't directed elsewhere.

#### *Coprophagy*

Although coprophagy can be due to poor nutrition or pathology it is more commonly a normal behaviour, rooted in the dog's scavenging past. Some also suggest it reflects the tendency for hunters to eat the excreta waiting to be passed in the gut of its prey. Its prevalence can be aggravated by observation of others, such as the dam, and boredom, competition or poor nutrition during development. If a dog eats his or her own faeces this can also be a sign of anxiety such as where a dog has been punished for defecating in the house.

## Pathology

If a dog isn't consuming, digesting or metabolising food normally due to pathology this can trigger problem behaviour. Equally a purely behavioural eating disorder can lead to physical disease. As such, when assessing the cause of changes in feeding or nutritional health possible behavioural influences should be considered alongside medical cause.

The key behavioural symptoms associated with an eating or nutritional disorders are as follows: -

- Anorexia
- Polyphagia
- Disrupted eating patterns e.g. not eating at certain times of day, for prolonged periods, in front of the owner
- Scavenging/avoiding specific foodstuffs
- Resource guarding
- Compulsions around food e.g. pica, eating rituals
- Increased irritability, anxiety or aggression due to hunger, malnutrition or fluctuations in blood sugar
- Changes in any behaviour that follow changes in diet

Each of these may be a sign of physical pathology that needs to be addressed before behaviour can be corrected. However they may also be purely behavioural. For example: -

- Anorexia can be caused by anxiety, neophobia, neophilia or learnt food aversions.
- Polyphagia can be caused by stress/anxiety, boredom, competition or frustration
- Changes in feeding patterns may be due to being punished for stealing or be attention seeking behaviour. It may just be the animal prefers certain food or is waiting for something better.
- Competition around food can be due to its value or learnt conflict around food as a puppy.
- Aggression, anxiety and compulsions can have multiple influences.

## Effects of ingredients

'We are what we eat' applies equally to behaviour as physical health. Therefore the composition of dog's diet needs to be considered when evaluation and treating unwanted behaviour.

### *Protein levels*

An adult dog has a requirement for a minimum of 18% protein in its diet for growth, repair and normal function (depending on breed). Any excess is excreted in urine, used as energy or (controversially) laid down as fat. Protein levels in excess of need have been implicated in heightened arousal and aggression. This may be due to an associated increase in production of catecholamines such as adrenaline or noradrenaline. Excess protein is also converted into energy, potentially giving the dog more than it needs for everyday activity. This can then result in increased arousal, irritability, frustration or just plain mischief.

Higher protein diets are now more common due to the increased popularity of raw feeding, homemade or 'prey model' diets. However the evolution of the dog must be considered when choosing a suitable diet.

### *Protein/carbohydrate balance*

There is also evidence to suggest that the balance between protein and carbohydrate can affect behaviour. Tryptophan hydroxylase (THP) is an amino acid involved in the anabolism of serotonin (5-HT), a monoamine neurotransmitter responsible for gut regulation, cardiovascular function, growth and central nervous system (CNS) regulation of mood, appetite, sleep, memory and learning. 5-HT is produced in the gut and the raphe nuclei in the brainstem. However, 5-HT produced in the gut or taken orally cannot cross the blood brain barrier (BBB). It is therefore essential that sufficient THP is able to enter the CNS to enable brain stem metabolism of 5-HT. THP uses the same transporter mechanism as some other amino acids to cross the blood brain barrier, so they are in competition. As such increased levels of these competing amino acids will decrease the quantity of THP crossing the blood brain barrier and so levels of serotonin in the brain. This is more likely to occur in a low carbohydrate diet, so the ratio of THP to other amino acids can be increased by feeding carbohydrate.

### *Filler/fibre*

It is sometimes suggested that 'filler' ingredients, such as those that have a poor biological value or are poorly digestible, are detrimental to health. However when considering the digestibility of food it must be kept in mind that the fibre - i.e. indigestible - portion of a diet serves a function. Behaviourally dogs fed on higher fibre diets show reduce scavenging, activity, vocalisation and anxiety/compulsive behaviour. This is thought to be due to satiety.

### *Potential effects of additives*

Research has leant scientific support to claims that certain food colours can impact on the behaviour of some children. The additives implicated are summarised at box 1. Some dog foods contain the implicated additives. To date there is no evidence to support or refute the potential effects of these additives on canine behaviour. Anecdotal reports suggest beneficial changes in behaviour following a change to a diet free of these additives. However any changes seen following a change of diet may arise due to many factors, including other concurrent behaviour modification steps taken and the tendency for diets high in additives to have poorer nutritional value and/or be higher in sugar.

E102	Tartrazine (yellow)
E104	Quinoline yellow
E110	Sunset yellow
E122	Carmoisine (red)
E124	Ponceau (red)
E129	Allura red
E211	Sodium benzoate

Box 1: Artificial additives implicated in hyperactivity in children

### *Docosahexaenoic acid (DHA)*

Docosahexaenoic acid (DHA) is an omega 3 fatty acid found in fish, eggs and some meat. It plays a significant role in brain and retina development. A lack of DHA has been linked to dementia. Some puppy diets contain supplementation with DHA as it is suggested to make puppies easier to train. However studies performed so far have been based on comparing elevated and deficient dietary DHA. To be of value studies are needed comparing elevated to recommended daily allowances of DHA.

### *Antioxidants*

Oxidation is the process by which a molecule loses one of a pair of electrons, creating a 'free radical'. Free radicals are useful in killing bacteria and supporting some cell signalling function. However in higher concentrations they can cause cell damage and trigger DNA mutation. Aging cells are particularly susceptible to this. Antioxidants reduce free radical levels by 'lending' an electron. Again this effect is reduced in ageing cells. Supplementation of free radicals in elderly dogs has shown a beneficial effect on cognitive function.

### **Behavioural considerations when advising on diet**

Diet will always need to balance physical and behavioural needs. Key behavioural considerations when advising on diet include: -

- Ensuring it is appropriate for the dog age, activity levels and the needs of the specific dog or breed. In particular keep in mind protein and overall energy levels needed/used.
- Better quality foods typically contain less colours/preservatives, fast burn sugars and ingredients. Being able to monitor the composition of the food enables the owner to ensure it is suited to their dog's overall needs.
- Activity feeding, such as via food based toys, activities and training increases the time the dog spends eating and so reduces potentially unwanted activity elsewhere. It can also be used to direct strong feeding drives e.g. scent hounds can be fed by scattering kibble on the lawn on a dry day
- Competition can be prevented by managing feeding where there are multiple dogs. Some dogs will always need to be separated when being fed or given high value snacks or treats.
- Blood sugar fluctuations can be managed by feeding at least twice daily and ensuring the diet contains slow burn carbohydrate sources.
- Homemade/raw diets can increase the time spent in feeding activity. However they are more prone to imbalances that may affect behaviour. The value of the food can also trigger competitive behaviour.
- Prey model diets rarely truly reflect that of the wild counterpart e.g. don't include hair, hide, gut contents etc. The differences in the lifestyle of the ancestor and the dog being fed the diet also need to be considered.

Changes in diet should be made gradually over a 5-7 day period. These need to be maintained for four weeks in most cases (1 week for additives) before the impact of the change can be evaluated. Owners are recommended to keep a feeding and behavioural diary to facilitate this.

## Neutering

Neutering of animals may be performed prophylactically or for the treatment of various medical conditions. It is also often recommended for behavioural management. However its effects may not be as predictable or far reaching as was historically suggested.

### Development of gender specific behaviour

At conception the zygote is genetically either male or female. However the physiological and behavioural differences between the sexes, referred to as sexual dimorphism, arise due to a combination of genetic gender and the influence of hormones during development.

If the embryo is genetically male a gene code found only on the Y chromosome will trigger testosterone production at various intervals through gestation and just prior to parturition. This will have a masculinising effect on the pituitary gland, which will in turn trigger heightened sensitivity to testosterone and male patterns of behaviour after birth. The lack of this influence in female embryos results in heightened sensitivity to oestrogen and female behaviour patterns. These effects are unaffected by neutering.

As the dog reaches puberty there will be further surges in testosterone and oestrogen, which will have further influence over brain organisation. This is again unchanged by subsequent neutering.

Because gender specific physiology and behaviour relies on a combination of genetics and hormonal influences, variation in the demonstration of this will occur. How marked this is will depend on the precise nature of the testosterone surges of the individual or neighbouring fetuses (see below).

### Male dogs

#### *The effects of testosterone*

Testosterone regulates the reproductive drive in the male. It also: -

- Increases focus on a specific stimulus
- Increases confidence and risk taking
- Triggers noradrenaline production which leads to increased arousal and reactivity
- Increased arginine vasopressin (AVP) production, which increases approach, and the speed, intensity and duration of an aggressive response
- It is also thought to be linked to the sensations of reward

Although testosterone is linked to heightened aggressive responses it only tends to drive aggression due to sexual competition. That said it may affect the chosen response in other forms of aggression e.g. fearful, possessive or territorial, due to its effects on confidence and the nature of the aggressive response.

Testosterone levels start to rise at about 4 months of age and continue to increase as the dog enters and passes through puberty. They then settle as they reach maturity. Production may also be sporadic during puberty leading to seemingly erratic behaviour.

### *Cryptorchid*

Unilateral or bilateral cryptorchidism may affect testosterone levels. The retained testicle(s) will not produce normal sperm but will continue to produce testosterone, albeit at a lower level. If the animal is bilaterally cryptorchid he may show behaviours associated with reduced testosterone circulation. In humans retained testicles produce increased levels of testosterone during puberty. Retained testicles are also more likely to become neoplastic, potentially resulting in increased testosterone levels

### *The effects of castration*

Castration removes the testicles and so the principal site for production of testosterone and, to a lesser extent, oestrogen. Castration therefore reduces, but doesn't totally eliminate, testosterone from the circulation. The effects of castration on behaviour are as follows: -

- Reduces reproductive behaviours such as mounting, roaming and scenting, where these are solely due to circulating testosterone and haven't become learnt
- Reduces sexual competition
- Potentially reduces speed, intensity and duration of aggression in other situations.
- Reduces risk taking and so potential choice to sue aggression
- Reduces confidence, which may be beneficial or detrimental depending on the cause of the unwanted behaviour
- May affect relationships with companion dogs. The direction of this will vary.

It is unlikely to affect behaviours due to general over-confidence, age, excitability or lack of training.

Testosterone levels drop rapidly following castration, although pituitary hormones may take longer to pass or even rise initially. Reproductive behaviour may persist for some time post castration.

Given the wide variation in the potential effect of castration its usefulness as a method of changing problem behaviour needs to be assessed on a case by case basis, once the cause for the problem behaviour has been determined and the dog's overall behaviour understood.

### *Chemical castration*

Chemical 'castration' with progestins can reduce reproductive and aggressive behaviour. However, as progestins have a calming effect, this is not predictive of surgical castration.

Chemical castration with deslorin reduces testosterone by inhibiting pituitary hormones that trigger production. Early research suggests it is more predicative of the behavioural effects of surgical castration.

## **The female dog**

### *The effects of female reproductive hormones*

Female reproductive hormones are more complex. Those of known direct relevance to behaviour are as follows: -

- Oestrogen starts to rise a few weeks before external signs of the season are seen. It increases irritability and lowers aggression thresholds. This facilitates competition with other bitches and keep the male at bay
- Progesterone takes over at ovulation, increasing aggression thresholds and sociality, so the bitch is ready to mate.
- Prolactin rises at parturition or during pseudo pregnancy. This triggers nesting behaviour and protective aggression over neonates or surrogates respectively.

### *Effects of ovariectomy*

Where unwanted behaviour occurs in cycles linked to reproductive hormones and completely regresses once the cycle has passed neutering is likely to resolve the problem. For example aggressive behaviour clearly linked to the period of prolactin production, even where no other overt clinical signs of false pregnancy are seen, should not recur post neutering. Equally bitches that only fight as one or both of their seasons approaches should also fall back into the status quo once hormones are removed from the scenario.

If the behaviour does not follow the pattern of reproductive hormones then neutering is unlikely to be beneficial. There is some evidence to suggest bitches already showing aggression may deteriorate if neutered before puberty. This is thought to be due to interruption of the feminisation of the brain that would normally occur during the first season.

Spaying when progesterone is high is thought to potentially trigger a pseudo pregnancy. Spaying during a false pregnancy can cause this, and so the associated behaviour such as heightened aggressive responses, to persist.

### *Androgenisation*

Where a female foetus is situated between two males in the uterus she may be affected by the testosterone wash produced immediately prior to parturition. She may then be more sensitive to the normal female levels of circulating testosterone, leading to increased demonstration of male typical behaviours e.g. leg cocking.

## **Paediatric neutering**

Research into early neutering (before 5.5 months) showed increased noise phobia and reduced separation distress but no changes in aggressive behaviour. No research has yet been conducted into neutering under 3 months of age.



The main considerations when doing so are the effect of the handling and procedure during the puppy's sensitive developmental period, and that it isn't possible to have yet determined the character of the dog and so whether neutering is appropriate for them.

### **Neutering peri-puberty**

Brain development in humans continues throughout puberty and early neutering of humans can interfere with full brain maturation. A similar effect was seen in laboratory dogs but has not yet been explored in pet dogs who are subjected to considerably more complex developmental influences.