

The influence of nutrition on canine behaviour

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The idea that the food that we eat can affect our emotional state, behaviour or even our medical health has been around for centuries. Most of us know of individuals who say that they experience adverse reactions to, for example, milk products, pork, citrus fruit, red wines, certain colouring agents and preservatives. The reactions people report include headaches, itching, diarrhoea, vomiting and amongst a few children some rather dramatic behavioural problems. This is a controversial area for clinical research in human medicine and psychiatry because of the highly individual nature of these food reactions. But Worsley and Crawford for instance, two Australian authors recently estimated that some 8 per cent of Australians were so affected. This was based on a random survey they did of 5,000 Australians, the question being 'do foods, and if so which foods, adversely affect your behaviour'. This 8 per cent of the human food-consuming population can be a powerful lobby even though they only represent a minority of consumers. Parents of children who react to one of the commonly-used food additives, tartrazine, have led the food industry to reformulate their convenience foods, like chocolate and ice cream to be yellow, but without tartrazine, using biologically-based, rather than synthetic dyes. There has been no such specific or systematic interest in diet and canine behaviour. If it is a tricky area to work with in human nutrition, it must be a great deal more difficult with dogs. Humans can report on their fitness, well-being or illness, but dogs are mute. We really should be considering what is inside the stomach when considering how a dog is behaving.

There is a tremendous amount of social interaction between the puppies and the dam in the first few days of life. A large proportion of the time the family unit is together is spent in consuming food and the main purpose of that food is simply to maintain metabolism and achieve growth. A number of psychologists and biologists have studied the effects of chronic and in some cases acute food deprivation upon the development of the mammalian brain and general behaviour. In the laboratory rat for instance, Rosenweig and Leiman in the '60s showed that chronic food deprivation did affect the development of the Central Nervous System and in particular, at critical periods such as the stage when the long nerve fibres were being myelinated. Acute food deprivations at such a time, say day 10 in the rat

development, could have dramatic effects upon adult behaviour and emotional stability. This challenges the general sparing ability of the mammalian body to cope with such food shortages. In Ethiopia it has been found that chronic starvation and sometimes acute food shortages amongst the refugee populations, are likely to adversely affect the adult's competence when they grow up. Aside from these general effects of food upon mammalian behaviour, the social effects of food and the importance of food within the relationship of child to dog is an important element in forming the bond of the newly arrived infant with the existing adult dog and is of a non-threatening kind. People pay a great deal of attention to the act of giving food to their dog. The participation of the dog in their meals and the formulation of the meals is of greater personal interest to the caring dog owner. I want to look at the direct effects of food upon canine behaviour and these cases are drawn from a sample of 1,000 cases seen over the period 1983–1984. These are all cases referred from a veterinary surgeon in practice. In fact I am principally going to discuss Golden Retrievers, a breed which has achieved great popularity since the war because it is generally a friendly dog, medium-sized and recommended by all of the authorities that know about dogs, including Blue Peter, a childrens' television

TABLE 1A. Behavioural problems in 40 Golden Retrievers, from a total of 1,000 cases

<i>Type of problem</i>	<i>n</i>	<i>%</i>
Aggression towards people	24	60
Aggression towards dogs	9	22
Other problems	7	18

TABLE 1B. Dog bites from 24 aggressive Golden Retrievers

<i>Number of bites to people</i>	<i>n</i>	<i>%</i>
None	1	
1–3 bites	3	
3 or more	20	

TABLE 1C. Classification of 23 dog-bite incidents by Golden Retrievers

<i>Seriousness</i>	<i>n</i>	<i>%</i>
Minor	2	9
Serious	8	35
Savage	13	56

programme. One particular dog actually removed the ear of the boyfriend of its mistress owner and on three other occasions it had been found to be dramatically aggressive. Seeing it in surgery one would not have guessed it could have done such things.

Table 1 shows 40 cases drawn from a sample of 1,000 that is 4 per cent of my total case load, pretty well the representation of the Golden Retriever in the dog population as a whole. A total of 24 of these 40 dogs which were aggressive to people will be discussed. They represent 60 per cent of the total. Golden Retrievers represent the whole gamut of behavioural problems, some were fighters, usually with other males, but others had other problems, phobias towards loud sounds and retorts, and destructive behaviour when left on their own. Of those showing aggression, 24 had bitten people, one had not actually bitten, but had threatened its owner, three had bitten 1-3 times and 20 had delivered many bites and of the 23 that had bitten, 13 of these cases were savage enough to result in the owner requiring hospital attention.

One such dog was an intensively obedience-trained individual which was very compliant indeed in the hands of the owner and her husband. They were a childless couple for whom the dog mattered a very great deal. It had a history of skin conditions, diarrhoea and vomiting at the time that there had been sudden outbreaks of aggression, principally directed towards the husband. The husband was usually away in foreign service in Brussels and it was on his return when incidents generally occurred.

Another dog which was very typically presented with food and object-guarding and most of the incidents had occurred in the context of food when food was being prepared in the family kitchen. Again serious bites had occurred. This dog was destroyed shortly after the consultation and no attempt was made to give it any treatment because children were involved in the family.

Table 2-24 cases. I have broken them down by the sex of the individuals. The

TABLE 2. Characteristics of 24 aggressive Golden Retrievers

<i>Sex</i>	<i>n</i>	<i>%</i>
Male	17	71
Male neutered	2	8
Female	4	17
Female neutered	1	4
<i>Age</i>		
Mean 2.9 yrs, range 0.7-8.0 yrs.		
<i>Typical Behaviours</i>		
Defends food/bones: n = 20 (83%)		
Defends objects: n = 19 (79%)		
<i>Medical</i>		
Susceptible for frequent diarrhoea: n = 15 (62%)		

majority, 71 per cent, were male that is about the same proportion of all the dog aggression cases we see. Between two-thirds and three-quarters of all the cases are entire males. Two of them had been neutered prior to the consultation on veterinary advice, that makes a total of 79 per cent that were male. The minority were female, but they represent an interesting and important minority because the severity of the symptoms presented by the bitches were much the same as the dogs. All ages were seen from young pre-puberty bitches to quite an old dog, which had been through quarantine, having been imported from the USA. 20 of them vigorously defended food and bones, they were object-possessive as well, 15 of the 24 had had a history of feeding problems, diarrhoea, vomiting and skin problems which had been in part or wholly resolved by changing the diet. One pair of owners had found they could partially resolve chronic spells of skin irritation which involved licking the forepaws and a clear rash on the abdomen, if they changed its diet. Interestingly this dog also suffered from halitosis and looked visibly unwell, depressed and aggressive at certain times. We looked at the diets that these dogs were offered and noted that 14 of the 24 (58 per cent) were fed premium canned dog food, plus a mixer. Now that is probably about the same proportion of the total dog population. Another two were fed a particular brand of a flaked, complete dry dog food, one was fed a semi-moist diet, one was fed either a complete dry or a canned food, but none of them was fed fresh or home-prepared foods. Unfortunately we do not have complete feeding data for three of the dogs.

So it is usual amongst dermatologists, when they have thrown everything else in the book at a difficult skin case to say 'well let's try the diet' because there just may be a dietary allergy at the basis of it. One of the common home-prepared diets which are used in skin cases is a rice and mutton diet, but usually with a higher proportion of meat to rice than I am suggesting here. On a dry weight basis we are suggesting one-third meat to two-thirds rice, which works out at about, on a wet weight basis, 20 per cent meat to 80 per cent boiled rice and we add appropriate vitamins, minerals from a commercial supplement and essential fatty acids. So we are aiming for a total protein intake on a calorie percentage basis of 15–18 per cent protein calories, which is about half or one-third that which would be provided by many commercial diets.

The 24 cases were divided into those cases where dietary advice of a very specific kind was given in the latter six months of the one year from these data and the 13 cases before we started giving dietary advice. They were not particularly scientifically matched, we just had to take the cases as they came our way. You can see that before we were giving dietary advice we had little success. Only one of the dogs improved over the time of monitoring which was three months in most cases, one of them worsened, six of the thirteen dogs that I saw were destroyed shortly after my visit, either on my advice or because the situation was by general consent too dangerous to continue. When we started giving dietary advice seven cases improved. Seven of those improvements were dramatic and immediate, and in most cases have been sustained, but not all cases have been sustained. One of them got worse, two of them we just lost contact with the clients, they did not call us back and

they did not answer our correspondence and one of the dogs was destroyed because it deteriorated. So we have moved from poor percentage for treatment of these cases, to a potentially encouraging prospect of treatment. Since then we have started using dietary therapy in a more comprehensive manner. But why do these dogs suddenly show these dramatic symptoms of aggression, out of character with the individual? They occur not when challenged, or in a normal dominant confrontational context. They look ill on the day of the attacks and the owner feels that there is tension, that the animal is depressed and anticipates an attack to some degree. No particular movement or activity of theirs is likely to provoke it, although the presence of food and objects is one trigger factor. Is it that the dog is suffering some allergy to a constituent such as, say, pork, a colouring agent, or a gelling agent in the diet? Or is the diet deficient in some way? This is highly unlikely because the range of diets which were offered to these dogs varied considerably, going through all the price range of the British canned dog foods and dry foods. I had a conversation with Professor Meyer, of the Hanover Veterinary School and he said he had some evidence that a digestive or micro-biological hypothesis should be considered, namely that the presence of bacteria in the large bowel could ferment the undigested non-absorbent protein and amino-acid fractions and produce raw ammonia which would be rapidly resorbed into the blood stream and cause central effects. We have been unable to confirm that hypothesis with the limited number of cases which have been available for post mortem examination.

Of more interest has been the suggestion that there is some liver condition explaining the dog's behaviour. Hepatitis can occur for many reasons in dogs, in humans and in other animals. A common cause is that the blood supply is diverted or is abnormally constructed so that a proper blood supply to the liver is not provided and these shunts are probably more common than was previously considered; more common because they are not diagnosed by radiographic methods which have only recently been developed. These can be acquired, or more usually we believe, they are congenital and they can fluctuate in their degree of severity with time. Equally a dog as a result of infection or exposure to say, toxic heavy metals may suffer a cirrhosis of the liver or perhaps through fatty invasion of the liver by the animal being obese or by hepatitis from infection with short term or long term consequences. If the liver is badly infected then we would expect to find some evidence of disrupted ammonia-protein metabolism in the dog because the liver is the 'scrap yard', of the body. So, in collaboration with Dr Serena Brownlie of the Royal Veterinary College and other veterinarians, we have been looking for evidence of liver abnormalities in these dogs. The record is not particularly good. Of five dogs that have been examined by Dr Brownlie, only two show definite evidence of marked liver impairment and this was on the basis of a BSP clearance test and the presence of abnormal elevated blood ammonia levels. The other three which she was able to examine were normal. However, on the post mortem examination of two dogs, two Golden Retrievers, there were signs of histological damage to the liver. Clearly there is not a single explanation for all the behavioural changes we have observed in these dogs and it

may be that the liver of these dogs can cope with an adequate to below average dietary intake of protein or protein of a good quality, but not when challenged with a high intake of low quality or biologically degraded protein levels. The competence of the liver may fluctuate with time across days and Dr Brownlie's test may have been on a good day for that particular dog. The effects of heat on protein, if it is protein that is that main variable that is producing these changes, are fairly considerable and dramatic. At a physical level they cause the coagulation of the protein. Continued degradation of individual amino-acids and the non-protein fraction of the diet will be increased and result in the production of ammonia.

Another reason for producing changes in the body which places additional stress on the liver, is an amino-acid imbalanced diet. A number of studies show that you get marked short-term increases in blood ammonia when challenged by a sulphur amino-acid deficient diet. The sorts of products which have heat-degraded protein can be identified by the burnt smell from a succession of long term Maillard reactions occurring within the product during preparation or storage. So the diet that we have been recommending that clients use has been mildly heat-treated, lightly cooked for two or three minutes and no more, we remove all connective tissues which are notably a poor protein source. We usually use breast of lamb or some other white meat like fish or chicken as the principal meat source, but it is not just with Golden Retrievers that this approach has been helpful. A standard poodle had markedly improved as a result of simple protein restriction after being very aggressive towards children. Because it did not totally resolve the problem, the dog was subsequently destroyed. It was found to have an exceptionally small liver which was histologically degenerate. This was a two-year old dog which had suddenly deteriorated in its behaviour.

An eight-year old Jack Russell Terrier, an admitted child substitute, totally indulged and much loved by its obese mistress, had suddenly undergone behavioural changes to the extent that she had been quite badly bitten on the nose. That may be quite common with this breed, but for this individual for its eight years previously it had been a charming little fellow. We put the dog on a dramatic, rapid slimming course and the low protein diet and there was rapid resolution of the problem. For the sake of avoiding immediate risks we also counselled that the mistress did not have the dog on her lap. We now recommend that people with dogs who have behavioural problems change their normal maintenance diet, usually towards a low protein, home prepared diet, but sometimes towards one of the commercially available diets, which we believe might be more suitable.

Diarrhoea and the electrolyte loss that diarrhoea represents is also a behavioural challenge to the dog by affecting its total physiology and the sorts of diets that dogs are fed does affect other aspects of their behaviour, for instance coprophagia. A common problem particularly amongst certain breeds of dogs. Is it a problem or is it normal behaviour? At certain stages in rapid growth and calorie deficit it is a normal behaviour but nevertheless unacceptable to many owners. It is particularly unacceptable once the dog becomes an adult and continues to be coprophagic

despite apparently suitable feeding regimes. Dietary manipulation is used in treatment of this type of problem and one such manipulation is very obvious — give the dog a high fibre diet. Wood or tissue paper has been traditionally used as a source of fibre but one would also use alphalpa meal if it is readily available, as well as indigestible lignin sources derived from wood. The bizarre recommendation that people mix in 6, 12 or more white tissues into their dog's diet is given. This bulks out the stools, and is totally non-nutritive and gives a sense of gut-fill.

When we are treating the coprophagic dog, we review the hunger satiety hypothesis. Is the dog only eating in order to supplement its main diet, usually only for energy and has the adult dog acquired a liking or tolerance to the presence of faecal material in its mouth are the questions to be asked. When we are treating these dogs we try so far as possible to give them an *ad libitum* or generous diet, bearing in mind that the dog is principally eating for both volume, taste and calories and that would mean a very high fibre diet which can be a complete food either dry or canned but certainly bulked out or supplemented with wood pulp or paper. We would shift it to as many meals per day as possible so that the stomach always has food in it, say three meals per day as a reasonable minimum. The owner is instructed to train the dog to defaecate on command, a surprisingly easy objective for the owner to fulfil if they are told how. Exercise should be both greater in duration, frequency and in variety. It is ensured that the dog is allowed off its lead because so many dogs will defaecate more readily away from their owner than in their close presence. If that is ineffective we might use a dietary taste repellent which I have not found particularly useful, or a simple iron supplement. Lastly one could resort to using a lithium chloride conditioned aversion therapy that we developed several years ago where the dog is actually made to feel ill after consuming faeces.

So in this particular instance the effects of dietary fibre were to provide a sense of satiety for the dog and increase the gut transit time, ie, the food passes through the total gastro-intestinal tract more rapidly. This is effected by an increased frequency of meals. This will increase the number of stools and the stool volume but will change their palatability to the coprophagic dog. There may be increased sleep after a very bulky meal, as well as decreased activity and reduced food searching following satiety. Food searching and a motivation to obtain food from the owner, to jump the fence to obtain by scrounging in the neighbourhood by dogs is an important motivator of a number of behavioural problems that people observe. We might predict that as a result of feeding high fibre diets on a frequent meal basis we will get a calmer, better behaved, if less continent dog. Because of the increased number of stools being passed, the dog may not be able to go the overnight period without defaecating.

For the dog which only defaecates in the night-time period when the household is asleep, clearly exercise at the time is out of the question as a means of treatment. We counsel them to increase the frequency of exercise and possibly do it on a predictable two hourly basis throughout the daylight hours. We counsel them to have the dog defaecate in their presence for a food reward and also to feed the dog early in the

morning as soon as they wake up. A low fibre diet that is readily digestible and which leaves a minimal faecal residue is advised.

Urination and defaecation may or may not be associated in time but frequently the dog that defaecates does also urinate in the overnight period so we also put the dog on a degree of water restriction. We tell the owner to take the dog's water up at night. Note that it is a long period of restriction. Most water is drunk at the same time as feeding and there need no longer be violent exercise. The heat of the day should be over so there is no need for water for thermo-regulation during this overnight period. We would expect a rapid resolution of most overnight toileting problems unless there is some separation anxiety component to it. Increased exercise outside the home and garden is an important part of the treatment of these cases because social stimulation by the presence of other dogs and their faeces stimulates the desire for urination and defaecation marking. If it is a day-time toileting problem, possibly because the owners go to work in the morning and in the afternoon, we would do the best we can. This is more difficult to tackle by dietary management, but we recommend that they be walked as often as possible, prior to leaving for work and return at mid-day to again walk the dog and also in the evening. Owners are asked to feed the dog at the end of the day, say 6 o'clock, on their return from work after the first exercise so that the dog has the overnight period in which to digest the food, and again water restriction at the beginning of the vulnerable period. If it is a young dog, and sometimes even with an old dog, the environmental restriction of the puppy's movement in a toilet training crate may also be a useful adjunct.

For routine puppy toilet training this is a sensible procedure, not only for house training, but also to protect the dog from being trodden on by other dogs and also to get them used to some solitude and separation from human and canine company.

With toileting problems it is important to rule out that there is not some clinical, medical, veterinary basis to the problem, for instance inappropriate diet, or some neuro-muscular change which is causing loss of sphincter control. It may be necessary to investigate the developmental history of the dog, to discover if inappropriate use of punishment or bad management of the environment and general feeding regime of the dog has produced a problem or if there is an acquired problem through some recent change in the structure of the household or the attitudes of the household towards the dog. In treatment we try to tailor feeding patterns so that they follow the period of greatest risk. Always feed the dog after there is no longer a likelihood of defaecation in the house. We tailor exercise patterns to stimulate defaecation and urination outdoors. We use a low residue diet so far as possible and remove water. We train dogs to urinate and defaecate on command and we use rewarding rather than punishing techniques. Usually the best repellent is to feed the dog where it defaecates. There are however dogs which just continue to eat. It is not unusual for some labradors to eat 12-15 per cent of their body weight in a meal if permitted. Indeed the wolf after it has been starved for a few days can quite well eat 20 per cent of its total body weight from a single kill. So the

canid has a fantastic ability to gorge, but this is not necessarily an advantage to the domestic dog.

The principal initiator of palatability and eating speed of the dog is the water content of the food. With a range of foods from very dry to very wet the rate at which they are consumed is always a straight-line relationship with increasing moisture content. It is the more wet foods which are eaten in the more greedy way.

We see in so many cases that the initiating factor for fights between an established pair of dogs in the home is the presence of highly palatable food, so we routinely recommend in these cases that clients feed less palatable food. Food is also a point of confrontation and competition between the owner and the dog. Again that confrontation is much less marked if a less palatable food is being offered, and the site of feeding is moved from indoors to outdoors. So where we have food competition with a member of the family, we recommend that they feed low palatable food outside the house, vary the bowl because the bowl becomes as much an object for competition as its contents. We try to use a rewarding technique for repossession. We use some means of physical control at a distance. We tell the owner the technique is to remain calm and not to raise the confrontation and emotional temperature and always avoid punishment.

There are a number of other areas in which we use diet as a main manipulator of behaviour; with overfed obese dogs, diet is an obvious place to start. For the obese dog we feed a very high fibre diet, diets of low nutritive density are much more sensible than some of the others which are around. With the inappetent dog we try to increase the palatability and the nutrient density of the diet because stomach fill is one of the signals for satiety.

With destructive cases we believe you get a more settled, calm dog by providing a high fibre diet and we use feeding prior to separation as a means of increasing sleep and restfulness. We like to leave dogs with chews; in this case a non-nutritive polyurethane flavoured chew which will keep the dog occupied. This traditional, old-fashioned concept is entirely right, though we are dubious about encouraging clients to leave the dog alone with a real bone.

We are developing a technique called response substitution training. Instead of challenging and punishing the unwanted behaviour, we are providing a substitute behaviour which the dog can present, for example the problem behaviour of a Bull Terrier which was treated was one of photo fixation. It stared at a point on the wall and became fixated upon that point that had been illuminated for anything up to eight hours. If confronted and punished the dog, a dominant individual, bit and would attack the owner. A succession of punishing attempts had led to a succession of bite incidents. The dog had had a comprehensive neurological examination and no abnormalities were found so the method used was one of response substitution training where the dog is put back on an extending lead on the signal of an ultrasonic bleeper and by doing so it then received a squirt of a very highly palatable canned food which it remained highly motivated to receive in this reward, play environment. We defused the situation entirely by play and food reward. Looking at

the general situation of how we feed our pets and in particular how we feed our dogs, they do not really have to do very much to obtain the food we give them. We present it to them and perhaps it is consumed within a very small percentage of their total day-time activity. Whilst in the wild, a free roaming carnivore such as a wolf, with all the social skills that they possess will make very many attempts at hunting a large species such as the elk, which are unsuccessful. In fact one out of four attempted hunts of a large prey species such as an elk or caribou is going to be successful and so they will go several days without feeding in harsh winter conditions and they will have to spend anything up to 30–50 per cent of their total active time hunting in harsh winter conditions.

So what do our domestic dogs do with all the time that we provide them with? They do have the opportunity to engage in playful and other social interactions with us, but perhaps we should be thinking about providing the dog with more active substitute behaviour for this 'search, identification, catch, handle, eat' phase of the wild carnivore and any predator to forage and then to eat, which our pet animals do not have to do.

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