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Food preference in domestic pets

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Introduction

Domestic animals, whether on the farm or in the home, have only limited freedom to select their own diets and are to a substantial degree dependent on the judgement, prejudice or whim of their owners. Whereas the selection of a feedstuff for farm animals is strongly influenced by experience, or reports of weight gain and feed conversion, such yardsticks are not applicable to foods for household pets. The cost is still a factor, but more in the context of the standard of living of the family.

The other criteria which apply to the choice of food for dogs and cats are also more akin to those for human food than to those for farm animal feeds. The pet shares many of the foods which his owner enjoys, and the owner assumes that there is much in common between his own likes and dislikes and those of his dog. The food must therefore satisfy a critical organoleptic assessment from the owner as well as the dog. It is clear that the owner's assessment of these properties is more influential than the animal's—for how many owners would offer horse dung or rotten meat to their dogs, even though these commodities are often attractive to the canine palate? It is not, however, within the scope of this paper to discuss the organoleptic properties which man considers important in pet foods and we shall thus confine our attention to the responses of the dog and cat.

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Methodology

Some of the technical and interpretive problems of preference trials have been well described for cats by Hegsted, Gershoff & Lentini (1956), and for dogs by Waterhouse & Fritsch (1967). The methods that they used consisted essentially of providing the animal with a choice of two foods, each one of which was equivalent to 1 day's intake. After an interval, the foods were removed and the residues weighed. On the following day, the choice was offered again with the foods in the opposite positions. The mean intake of each food over 2 d was thus obtained for the group and the appropriate statistical tests applied to the percentage of food consumed by each animal.

In our hands, this method, though tedious, has proved satisfactory for cats, but there are several disadvantages in dogs. Since, in order to obtain a measurable residue, food is offered virtually *ad lib.*, many dogs over-eat and become obese. If smaller amounts are given, the food must be removed before the dog has finished eating in order to have a residue to weigh. The dog quickly learns that his meal will be removed, and thus tends to become a voracious and unselective feeder. As the test needs to be repeated on another day, 2 d are thus occupied in obtaining one result.

This method is, therefore, susceptible to improvement and, using an electronic recording technique developed by one of us (P.C.R.), we have over the last 2 years been able to carry out three tests in duplicate each day on forty dogs. On cats, two duplicate tests have been possible.

Like others (Hegsted *et al.* 1956; Waterhouse & Fritsch, 1967), we have encountered a number of variable factors in carrying out preference experiments.

Individual variation. As might be expected, individuals have been observed consistently to prefer a food or flavour which the majority reject, and this poses the question of how representative of the population is the test panel. However, inconsistent results due to individual variation may be reduced by using relatively large panels, and maintaining a regular turn-over of members of the panel (Kare, 1962).

Previous diet. The observations of Hegsted *et al.* (1956) and Waterhouse & Fritsch (1967) indicated that cats and dogs tend to prefer a new food to one which was familiar to them, thus, the results of a preference test could be biased by the previous diet. In routine preference testing, however, where animals receive several varieties of food each day, conditioning to any one food is less likely to occur. In our experience the results of duplicate preference tests, separated by an interval of several days during which a variety of foods were fed, usually showed good agreement.

Lateral bias. In a preference panel, some animals may show a preference for the left- or right-hand bowl regardless of its contents. While the effect of this bias is reduced by reversing the position of the foods in the second part of the test, sensitivity is markedly decreased by the presence of biased animals.

In a preference panel of 100 dogs, Waterhouse & Fritsch (1967) found that five animals showed a consistent bias to one side, whereas Hegsted *et al.* (1956) concluded that their preference tests on cats were not affected by animal bias to one side or the other.

Our own observations indicate that a substantial number of cats and some dogs

exhibit a lateral bias and that removal of these animals from the preference panel improves the sensitivity of testing.

Hunger and satiety. Another practical problem is to control the degrees of hunger with which the animals approach a test. It is common sense to suppose that the more hungry the animal, the less selective will be his performance in the test; whereas a dog which is satiated may ignore both test-foods.

The common sense view is not, however, supported by Jacobs & Sharma (1969). They compared dogs receiving food *ad lib.* with those receiving a meal once daily, which they called the deprived dogs. They found that the deprived dogs totally rejected a bitter-tasting food after 24 h starvation, whereas the dogs fed *ad lib.* did not reject it. They use this evidence in support of their contention that when a dog is in energy balance or surfeit '... the metabolic properties of the ingested food are critical and when it is deprived the sensory properties receive priority in regulating intake.'

Our own experience lends some support to these observations. In our preference-tests there was a significantly greater rejection of quinine in food by both cats and dogs after a 24-hour fast than during a regimen of four meals/d.

It is of more practical interest to know whether discrimination between two acceptable foods is affected by hunger. Jacobs & Sharma (1969) found that the deprived dogs increased their food intake when saccharin was added, whereas dogs fed *ad lib.* did not, and suggested that this behaviour agreed with their hypothesis that taste is more important to the hungry than the satiated animal. An equally tenable interpretation is that increased intake of sweet-tasting food by hungry animals is part of an eating response to calorie deficit (Wade & Zucker, 1969). However, a more serious criticism of their findings is that electrophysiological data indicate that saccharin appears to elicit a bitter taste in the dog, (Andersson, Landgren, Olsson & Zotterman, 1950) and that in behavioural tests most dogs reject it though some prefer it (Kare & Ficken, 1963). Since Jacobs & Sharma used only three dogs in each group there is a possibility that the dogs fed *ad lib.* did not increase their intake of saccharin-flavoured food because to them it was not sweet.

To sum up, there is evidence that hungry dogs reject a bitter taste more strongly than less hungry dogs, but no clear indication of a difference in response to an acceptable flavour.

Taste

Sweet. Preference for sugar solutions is commonly observed in the domestic animals, but the cat fails to show this, being unable to distinguish a 1.0 M solution of sugar from water (Carpenter, 1956). Thus, when water and sugar solution were available, consumption of sugar solution resulted in severe gastro-intestinal disturbance and after the death of one cat the experiment was ended. This insensitivity to sugar agreed with earlier electrophysiological findings of Zotterman (1935), in which, although potentials were obtained in the cat's chorda tympani nerve when the tongue was irrigated with salt, bitter or acid solutions, sucrose produced no

response. Later, however, the presence of a few sweetness receptors was shown (Pfaffman, 1941; Liljestrang & Zotterman, 1954) and it was found by Frings (1951) that when cats were previously starved, they could detect sucrose added to diluted milk. The cat appears to have rather non-specific taste units, few being exclusively reactive to one kind of taste stimulus (Pfaffman, 1965).

Salt. Sensitivity to salt is probably universal in mammals (Denton, 1967) although Carpenter (1956) has shown marked species differences.

NaCl produced a significant preference response in the cat at a lower concentration (0.1 M) than did KCl (0.5 M). On the other hand, electrophysiological studies by Beidler, Fishman & Hardiman (1955) indicated that, in both dogs and cats, KCl was a more effective stimulus to chorda tympani nerve discharge than NaCl. In rodents the reverse was true. Incidentally, these authors pointed out that the Na:K ratio in the red cells was also different in carnivores compared to rodents, being high in carnivores (16.1) and low in rodents (0.12).

Bitter. Sensitivity to quinine is high in cats (Carpenter, 1956). They discriminated against a quinine hydrochloride solution in comparison to water at a concentration of 0.005 mM, whereas rabbits and hamsters required a concentration as high as 2.0 mM before significant rejection occurred.

The effect of quinine is greatly reduced when included in food and, in our preference tests on cats, clear-cut rejection occurred at 1.3 mM, i.e. about 250 times more concentrated than when an aqueous solution of quinine was tested against water. Cats were more sensitive than dogs, which did not reject quinine under these conditions until the concentration was increased to 10.3 mM.

Acid. End organs responding to acid solutions (Zotterman, 1935) are widely distributed on the tongue of both the dog and cat (Andersson *et al.* 1950) (Zotterman, 1935). In practical terms it is difficult to assess the effect of pH *per se* on the acceptance of food, since the marked changes of odour which accompany pH changes are a contributory, if not a predominant, influence.

Water sense

Receptors sensitive to water have been reported for both the dog and the cat (Liljestrang & Zotterman, 1954). The significance of these receptors is not clear, but could be regarded as an auxiliary sense complementary to the salt receptors, providing a positive signal for hypotonic solutions. The only other species in which water receptors have been found is the pig (Liljestrang & Zotterman, 1954): they are not present in the rat (Zotterman, 1956) or in the goat, sheep or calf (Bell & Kitchell, 1966).

Olfaction

This is undoubtedly the predominant component in the total experience of flavour in the human. It seems likely that in the dog and the cat the importance of olfaction in the selection of food is at least as great. It is, therefore, unfortunate that the technical difficulties of fully-controlled experiments on the olfactory sense

in the conscious animal have resulted in much conflict of evidence, particularly on the acuity of dogs. Neuhaus (1953), for example, concluded that the dog can detect fatty acids at levels from 1000 to 1000×10^6 times lower than the lowest level detected by man, whereas the data of Niccolini (1954) indicated that canine and human olfactory thresholds were similar.

Whether the olfactory sense of dogs is better than that of less co-operative animals—such as the cat—seems not to have been examined. Moulton, Ashton & Eayrs (1960), using two dogs, found an olfactory sensitivity for butyric acid up to 100 times greater than the best reported for man. They point out that this may not necessarily indicate greater sensitivity of the individual receptors for, since the area of the nasal mucous sheet is much larger in the dog than in man, the ability to adsorb the odorous molecules is probably greater also. The remarkable olfactory feats of dogs may, therefore, come more from a superior ability to discriminate between olfactory patterns than from absolute sensitivity of the receptors. A large number of trials were done on the two dogs to measure their ability to detect the n-aliphatic acid series ranging from formic to caprylic. Generally, acuity increased with chain length, formic being detectable at a molar concentration of around 10^{-7} and caprylic at 10^{-12} or 10^{-13} ; there were, however, important differences in the pattern of response between the two dogs.

Olfactory sensitivity is of primary importance to the wild dog in locating its prey and hence in maintaining its nutritional status. The part played by olfaction in the nutrition of the domestic dog is less easy to assess though the hedonic aspects of eating are not to be underrated in terms of food utilization. Thus, Behrman & Kare (1968) collected the pancreatic secretion of conscious dogs during sham feeding with a basal diet to which had been added either water or a solution of sugar, citric acid or quinine. The protein content of the pancreatic juice was increased when sugar solution was added to the food compared to the protein content when water was added to the food. By contrast, the unacceptable tastes, citric acid and quinine, were associated with decreased protein-content of the pancreatic juice.

In conclusion, the hedonic experiences which can be provided in food for dogs and cats are to some extent restricted by the sensory predilections and prejudices of their owners. While man and his dog or cat clearly share many of the pleasures of sensation, our limited knowledge suggests that one dog's meat may well be another dog's, cat's or man's poison.

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Do laboratory animals like eating?

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Hunger and thirst are active, innate drives leading an animal to want to eat and drink. Satiety is said to be reached when the animal stops eating and drinking, even though more food and drink are still available. But, as Katz (1958) has pointed out, an animal that appears to have reached satiety may nevertheless resume eating if the same food is presented anew, or a different food is offered, or other animals are introduced, or for other reasons. This suggests that the innate hunger drive is modified by the nature of the food, its method of presentation and the social circumstances accompanying feeding.

There are obvious parallels in the field of human gluttony, from the Lord Mayor's banquet to the private dinner party, which encourage ritual overeating. But, although these parallels are apparent, it cannot be therefore inferred that animals have food preferences. What evidence exists is far from conclusive and the greater part of it is observational or anecdotal.

Limitation of choice

Laboratory animals are dependent for all their dietary needs on what is offered to them in the cage. They have to eat this or starve. Since in most instances the food offered is in the form of a compressed compound pellet, there is no scope for exercising a food preference. It has been pointed out that a compound pellet designated by a name or number to identify it with a formula of ingredients may give no more than the appearance of constancy (Porter, Lane-Petter & Horne, 1963). Moreover, even the best of the compound diets in use may be less than nutritionally optimal in all circumstances. Most of such diets are unpalatable by human standards; neither the taste nor the mealy consistency is pleasant. And the habit of many mice and some rats, as well as guinea-pigs, rabbits and many other laboratory species, of wasting their food suggests that they too often find it unpalatable. However, they