
Age and gender differences in response to food enrichment in family groups of captive marmosets (*Callithrix-Callitrichidae*)

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ABSTRACT

The proximity of individual members of three family groups of marmosets was measured to two sources of food namely, on the introduction of their normal daily ration (baseline behaviour) as well as to a previously unfamiliar 'preferred' food. Significant group and age differences were found in the baseline condition in which the adults and the youngest recorded animals were most responsive to the food. A significant gender difference was also found in that females were significantly more responsive to their normal food during the period in which the additional food was given. Moreover, there was a significant change in behavioural responsiveness over the duration of the experiment in that females became more responsive to the additional food. There was no evidence of overt aggression or behavioural exclusion from the food.

INTRODUCTION

A common method of environmental enrichment for captive animals is to provide palatable food at specific times, in addition to the normal diet (UFAW, 1990).¹⁶ This may be accomplished easily both in terms of human effort and financial investment, and its success indicated by comparing behaviour when the additional food is present, with a previously recorded baseline of equivalent activities. An increase in naturalistically desirable behaviour, and a decrease in undesirable behaviour such as stereotypies, are common aims with animals housed individually (Scott, 1991)¹⁴ and as groups (Anderson and Chamove, 1984; Boccia, 1989).^{1,2}

Recent interest in this topic for the welfare of captive primates has produced a variety of techniques (Segal, 1989).⁹ Some of these involve the distribution of additional food over a relatively wide area with respect to cage size. The food may be also embedded, as in straw or grass to increase foraging effort and reduce competition (Chamove et al, 1982).⁴ In other cases, additional food is located at a particular site. Examples include many different kinds of device at which animals work for food (Nash, 1982).¹⁰

Further, food enrichment may be used as an environmental challenge to consider behavioural propensities among individuals of different age, gender and species per se (de Waal, 1984).¹⁷ There are also practical issues in terms of animal welfare, especially for animals living in groups. For instance, social influences upon access to food is of critical concern in animal management (Redshaw and Mallinson, 1991 ; Price and McGrew, 1990).^{12.13}

The present paper addresses both these aims. It is concerned with the relative responsiveness of marmosets of different age and gender to an additional 'preferred' food that is not part of the normal diet. It is also concerned with the extent to which responsiveness to normal food may change during the period when the additional food is given, as well as with changes in responsiveness to the additional food over time. Moreover, for various reasons we chose to present a preferred food with relatively restricted access. As we have already mentioned, this is a realistic condition in many situations in which animals work for food, and it concentrated activity.

We also selected a measure of physical proximity to both the usual and the additional sources of food as the critical variable of responsiveness. This is an important measure with reference to priority of access to food, and may indicate competitive exclusion from it. It is also the case that accurate measures of food consumption for animals in large groups are difficult to obtain, because individuals have different strategies of taking food and discarding it partly eaten (Tardif and Richter,1981).¹⁵

METHODS AND MATERIALS

The marmosets and their maintenance

We observed groups of marmosets that included a wide range of ages as well as, fortuitously, a generally even gender distribution. There were three families, two of common (*Callithrix jacchus*), groups 1 and 2, and one of penciled marmosets (*C. penicillata*), group 3. In each of these, a breeding pair lived with a number of their offspring. The gender distribution of the groups is given in Table 1 [not reproduced].

The oldest offspring (1) were around 23 months of age with younger groups reducing successively and equivalently by some 5 months in each case. The most recent sets of twins in all groups were not included in the observations because, although they were moving around independently, they were obviously not as mobile as the others.

Each family lived in a separate room in a wood and wire mesh cage that was 6' deep x 12' long and 8' high. There was a variety of branches, ropes, nets and logs, in addition to water bottles, three nest boxes and two wooden platforms on one of which the food was secured. The floor was covered with sawdust that was replaced twice a week. The temperature in the rooms was maintained at 72°F (± 2) with a humidity of 55-60%. Individuals were identified by means of neck collars.

PROCEDURE

The families were fed their normal ad. lib. diet of monkey chow, fresh fruits, vegetables, animal protein and vitamin D3 supplement in a bowl that was 20.5cm in diameter and 7.5cm high, at a specific time between 10.00 and 11.00 a.m. Thereafter, the animals were observed immediately for 30 minutes on each of five consecutive days (baseline 1). In the two weeks that followed, five additional 30 minute baseline observations (Monday to Friday inclusive) were made in the normal feeding situation (baselines 2 and 3). In addition, on every afternoon of these days, a previously unfamiliar extra fruit, in the form of chopped pieces of fresh grapes, was presented for 30 minutes at a time, between 2 and 4pm, in a special perspex feeding box that was 16cm long, 6cm wide and 12cm high. Access to this food was restricted to a circular hole of 3.5cm in

diameter; a 2cm wide piece of black tape emphasised the opening. The box was secured to the wall of the cage by two cuphooks. It was laid flat on the feeding platform with the usual food bowl removed. We presented the additional food on the normal feeding platform to preclude responses to a new feeding location.

RECORDS OF BEHAVIOUR

Individuals were recorded as being in close proximity to each source of food if they were on the triangular food platform that was 60cm wide with sides that were 85cm long. The proximity range extended to the wire mesh of the cage 10cm above the platform. Incidences of aggressive encounters were also noted. Behaviour was recorded on data sheets by a time sample method that was cued electronically every 15 seconds into an ear piece of the observer. There were 120 data points per observation.

RESULTS

No incidences of aggressive encounter was observed.

Our first concern was to compare the proximity of the animals of the different groups, ages and gender, to their normal daily source of food in the three baseline conditions. With reference to baseline 1, that which was recorded before the addition of food, a three factor analysis of variance to test for significant group x gender x age effects showed both significant group [$F(2,19) = 6.75$ $p < 0.01$] and age [$F(4,19) = 7.46$ $p < 0.001$] differences. Hence, the smallest family unit, group 1, spent significantly less time in proximity to the food compared with the other two groups. More interestingly, however, a further analysis of the age effect showed a significant U shaped quadratic trend [$F(1,21) = 20.76$ $p < 0.002$] in which the adults were most responsive, followed by the youngest offspring; the other ages were clearly intermediate. Table 2 [not reproduced] gives the mean number of 15 second time samples that all the members of each age group were recorded as being in proximity to the food, together with these data for each gender. It is worth noting that although the differences were not significant at this stage, the means for the females were higher than those for the males.

Comparisons of the data in baselines 2 and 3 also showed a significant group effect in which group 1 was the least responsive by proximity. The values were [$F(2,19) = 3.90$ $p < 0.05$] in baseline 2, and [$F(2,19) = 4.00$ $p < 0.04$] in baseline 3.

As before there were significant age effects that were [$F(4,19) = 4.97$ $p < 0.01$] for baseline 2 and [$F(4,19) = 8.65$ $p < 0.0004$] in baseline 3. The significant quadratic trend was maintained for both analyses; these were [$F(1,21) = 17.37$ $p < 0.004$, and [$F(1,21) = 29.04$ $p < 0.001$] respectively. Hence, as in baseline 1, the adults spent most time in close proximity to the food. The means are given in Table 3 [not reproduced].

In contrast to the results of baseline 1, however, a significant gender effect was found. As before, the females had higher mean values for proximity to the food, but during baseline 2 the analysis was [$F(1,19) = 5.68$ $p < 0.03$] and for baseline 3 it was [$F(1,19) = 4.33$ $p < 0.05$]. The combined means are given in Table 3.

Analysis for the last five days of the study, however, did show that the females spent significantly more time in close proximity to the additional food [$F(1,21) = 11.22$ $p < 0.003$].

DISCUSSION

Feeding enrichment is a familiar topic in applied animal behaviour. There are many interesting examples that have immediate appeal because they are often simple to administer, and have no obvious deleterious effects on the health of animals, given that the food is nutritious and not presented in large quantities. There is, however, a number of cautions that should be considered. The most obvious of these concerns care to ensure that individuals continue to obtain a balanced diet from their normal feeding regimes without undue increase in competition. In general, the addition of any procedure into the daily routine of captive animals, especially for those that, as in laboratories, frequently have relatively little choice of activities with regard to food and feeding for example, should be investigated for its influences upon activities in the normal regime. As in field studies that utilize provisioning, wider influences of food enrichment should be considered and monitored. In the present experiment we selected an apparently simple situation in which a preferred food was added as a palatable 'extra' to increase the variety of food and to stimulate behaviour. We found no aggression, and no evidence of behavioural exclusion to either the additional or normal food. For example, in contrast with the baseline conditions, in which the adults were consistently the most responsive, followed by the youngest offspring observed, there was no longer differences in responsiveness to the additional food; all the marmosets increased their responsiveness. Our main interest however, had focused on two issues. First, we did find a significant change in responsiveness to the normal feeding regime during the period of food enrichment. In particular, although females generally were more responsive during the first baseline period before the additional food was given, they were not significantly so. The difference became significant however, during the second and third baseline periods with the addition of a preferred food. Hence, apart from behavioural implications that may accrue from such changes, there is also a methodological point, namely that baseline observations as a form of control to study the influences of an environmental enrichment, should be continued throughout the study.

Secondly, we also found a significant change in behavioural responsiveness to the preferred food over the duration of the experiment in that, although females were consistently in close proximity to the additional food, they were significantly so, in the second week. In other words, the gender difference became accentuated as the trials continued. Such results have potential implications for the management of callitrichids, but the relative responsiveness of the females in this study is of interest in other respects. In the first instance, however, it was obviously important to show that the result was specifically robust. Hence, we considered that the result may have been disproportionately influenced by the presence of a high individual mean of responsiveness for one female - as by the adult female. We found, however, (see Table 4 [not reproduced]) that no one individual contributed significantly more to the mean time in proximity to the food for females than any other.

Gender differences have rarely been reported for responsiveness to inanimate environmental challenges among callitrichids. However, there are some few reports that are generally relevant to our results, including occasional observations on wild common marmosets. For instance, Maier et al (1982)⁸ observed that a female dominated her pair mate when feeding on tree exudate; aggressive encounters over such food sources have also been noted by Lacher et al. (1981).⁷ Among laboratory studies, Petto and Devin (1988)¹¹ showed female dominance over supplemented food as recorded by feeding time, access to preferred foods and the variety of foods eaten. Further, Tardif and Richter (1981)¹⁵ found that adult females were the highest consumers of their family groups in both common marmosets and cotton-top tamarins (*Saguinus oedipus*) of a preferred food (fruit) that was given as an addition to the normal food. Both kinds of food were presented in a metal cup 12.5 cm in diameter to which the monkeys could gain access by reaching in through an

opening above it. The adult females ate more than others, mainly because they aggressively defended the food. The principal interest of that paper related to competition and food intake, and emphasised social influences and potential nutritional problems.

Female responsiveness in our study included all the females, without aggressive competitiveness. Perhaps our situation was not as inherently competitive. Our family groups were certainly substantially larger, with a more even gender distribution within each.

It is also generally relevant here that other work in our laboratory (Box et al) submitted³ found significant gender differences in response to preferred food given in a series of embedded food tasks for adult male, female pairs of three species of tamarins, the red-chested *Saguinus labiatus*, the saddle back *S. fuscicollis* and the cotton-top, maintained and tested under identical conditions. We found that females of all three species attempted the tasks more often, they attempted them for longer and extracted food more frequently.

By contrast, males and females within the same pairs of tamarins did not respond differentially in conditions where they were given access to an unfamiliar outside extension to their living areas. Perhaps feeding opportunities constitute a critical condition for the expression of behavioural differences. Moreover, it may be tempting initially to consider priority of access to food with direct reference to the energetic demands of the animals. Within families for example, adult breeding females have the highest nutritional requirements. Males and females are very similar in body size, but breeding females are generally both pregnant and lactating (Hearn, 1983);⁶ the energetic costs of lactation are high due to production of high protein milk (Deinhardt, 1970),⁵ and in both nature and captivity they regularly produce twins twice a year (Maier et al. 1982).⁸ Female assertiveness over food, especially over preferred food items in various social conditions would seem to be an advantageous behavioural propensity.

This argument is apparently relevant in competitive situations, but does not account for, specifically at least, our results here in which the breeding females were not overtly competitive and not significantly more responsive by proximity to the food. Further, the females of our tamarin pairs had not produced offspring. There are various other anomalies that require explanation. For instance, in contrast to our own work, a study by Molzen and French (1989)⁹ found no gender differences for any age group of Golden lion tamarins (*Leontopithecus rosalia*) when family groups were given an extractive foraging task as an enrichment device. There may well be significant differences among species in their strategies of responsiveness. There is certainly a paucity of substantive comparative information. Hence, we need to expand this work to include different environmental challenges for callitrichids of different species in different social contexts. The implications for research that directly concern animal welfare, are that these studies will constitute critical information for the selection and evaluation of environmental challenges, including food enrichment situations in captivity.

ACKNOWLEDGEMENTS

We thank Audrey Wright (Reading) and Christine Fillion (University of Georgia, USA who visited us) for their enthusiastic involvement in the collection of data. Graham Hart and Caroline Gleed maintain, and give much care to our colony of marmosets.

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