Short-term evaluation of a foraging device for non-human primates

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Summary

In the USA, any institution involved in using non-human primates for research has had, for regulatory reasons, to address the psychological needs of these animals. Enriching the environment through the use of foraging devices has been one method and a study was designed to evaluate the short-term effect of a new foraging device on singly-housed cynomolgus monkeys. The study was divided into 3 one-week periods of observation: baseline, device filled with normal ration, and device filled with a novel food. Four behaviours were recorded: foraging, self-directed, hopper feeding, and other behaviours. During the observation periods the device was accepted in preference to the standard hopper style feeder and self-directed behaviours were significantly reduced compared with the baseline period. Changing to a novel food re-kindled interest in the device and reduced the extinguishing effect: i.e. decrease in interest or use of the device. Based on this study, the feeder has been included with several other devices in a rotation programme.

Keywords Foraging; primates; environmental enrichment; behaviour

New regulations pertaining to the psychological well-being of non-human primates used in research and concerns for animal welfare have prompted researchers to find means to fulfil the behavioural needs of these animals without compromising research results (Animal Welfare Act etc.). Among the many means of enriching the environment are devices that stimulate foraging activity {Anderson & Chamove 1984, Bayne st nJ. 1991, Chamove st at. 1982). Studies of primates in the wild or in large enclosures reveal that non-human primates spend a great deal of time seeking food (Oates 1986), whereas in captivity, food is generally provided in a ready to eat form and from an easily accessible feeder, thus foraging is no longer necessary.

Foraging devices attempt to provide the primate with a challenge to obtain food {Anderson & Chamove 1984, Bayne st al. 1991, Chamove et nJ. 1982, Lam ct af. 1991, Murchinson 1991, Rosenblum & Smiley 1984) and can involve a degree of physical manipulation o1 the device and, at least initially, a stimulus for exploration. By engaging in these activities the animals may not develop abnormal behaviour patterns e.g. stereotypies, self-trauma, hair plucking, etc., associated with captivity. To assess comprehensively whether such devices minimize captive behaviours would take a considerable period of time and involve a significant number of animals, but research facilities need to have some indication of benefit from foraging devices much more rapidly, so that decisions concerning acceptability can be made. Short-term acceptability (= usage] is particularly valuable if a number of devices and/or food combinations can be used to minimize abnormal behaviours but they must be used i.e. retain novelty for the animals (Bloomsmith et aJ. 1990, O'Neil 1988). Thus, a programme which includes

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a variety of such devices used in rotation could be put in place and eventually the value of the programme itself evaluated over the long term.

In this study, a newly devised foraging device was provided to a relatively uniform group of cynomolgus monkeys and tested for acceptability. Behaviour patterns were evaluated with and without the device filled with normal ration to assess whether the device was used and to give an indication of the changes in types of behaviour exhibited with and without the device. Acceptability was also evaluated with the device filled with a novel food. The results give an indication of acceptability and add to the background information concerning the use of this device which is now used on a weekly rotating basis as part of the facility's enrichment programme.

Materials and methods

AnIrnals

Eight adult male cynomolgus monkeys *(Macaca fas:icu1az1s* were randomly selected from a group of 11 originally obtained from Charles River Research Primate Corporation and Hazelton Research Primates. All had been housed individually for at least 3 years and maintained in the same room for one year prior to study initiation. Relative cage positions were fixed 2 months prior to study initiation and for the duration of the study. All manipulations of the animals used in this study had prior approval from the Institutional Animal Care and Use Committee.

Husbandry

The animals were housed in stainless steel primate cages measuring 115.6 x 73.7 x 82.6 cm and were equipped with a resting shell, automatic watering device and an externally mounted feed hopper. The room was maintained at 23.2°C + 1° and 38.1 + 5^0a humidity, with 12/12 h light/dark cycle and 12.39 air changes per hour. Room environment was monitored 24 h per day by a computer based system (Environmental Watchdog°, Edstrom Industries, Waterford, Wisconsin). Access was restricted to minimize disruptions.

DOScziption of foTaging device

The foraging device was a pvc pipe 5.1 cm in diameter and 26.0 cm long with three vertical holes 2.54 cm in diameter placed 5.1 cm apart |Fig. 1). Dome-shaped inserts

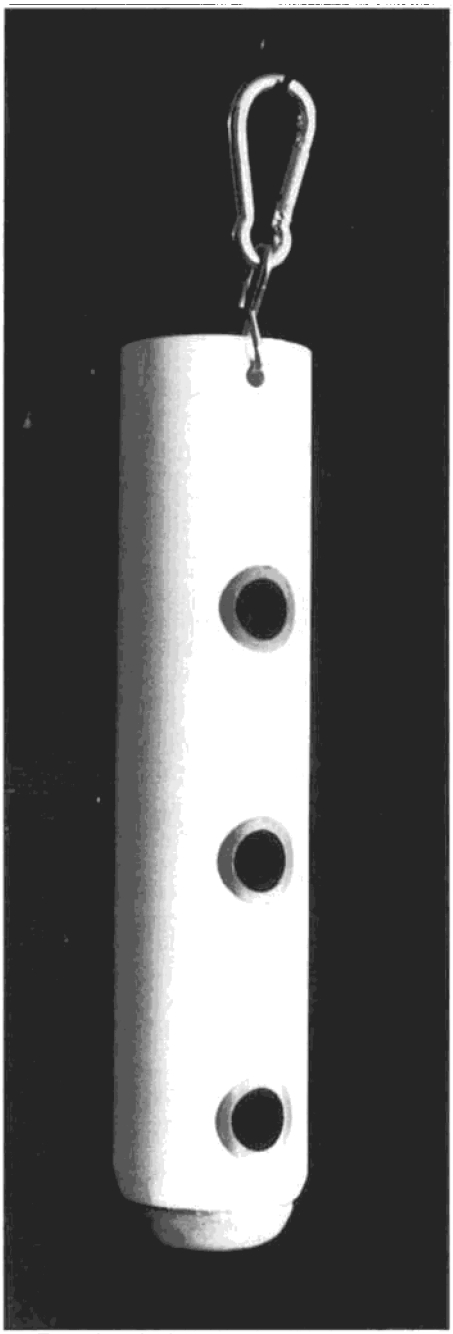

Fig 1 Foraging device

made of 1.3 em pvc pipe were cemented in each hole to prevent food from spilling. A 5.1 cm diameter flat, pvc plug with a 0.317 cm hole for drainage was cemented to the bottom. The foraging device was attached to the cage with a stainless steel hook and snap. The device was washed every 2 weeks in a mechanical cage washer with an 82.2°C final rinse.

Acclimation to experimented diet

A nutritionally balanced, granular diet {Prima Foraging Bites°, Bio-serv) that could be accessed from both standard hopper feeders and the foraging device was selected. The animals were acclimated to **the new diet by gradually replacing the** normal feed (Purina High Protein Monkey Chow°, 5045 Puriria Mills Inc., St Louis, MO) with the granular diet during the 14 days prior to study initiation.

Lxyeñmezita1 design and data compilation

Based on preliminary observations the investigators categorized the behaviours as follows:

1) Foraging—feeding from the experimental device or from anywhere in the cage other than the hopper.
2) Self-directed — a set of activities in which the subject became interested in its own body; e.g., sell-grooming, scratching, pulling or plucking hair.
3) Hopper feeding — consuming food directly from the standard feed hopper in the cage.
4) Other behaviours — any behaviour not included above.

The experiment was divided into 4 one-week phases. The first phase (Week 0) was a training period that served 2 purposes: (1) the development of concordance between investigators in scoring behaviours into the 4 categories; (2) acclimation of the subjects to the new diet and to the presence of investigators in the room. Week 1 was for collecting baseline data. Weeks 2 and 3 were for collecting data with the device using 2 different feeds.

During Week 0, 4 of the 8 animals were video recorded to train the observers and to establish inter-rater agreement on categorizing the behaviours. The video tape became a permanent record of reference behaviours.

Baseline behavioural data were collected during the Week I of the experiment. The following standard procedure was used in making observations:

1) The granular diet was placed in the food hopper prior to each recording session.
2) No observations were recorded during the first 5 min of each session to allow for acclimatization to observers.
3) Over a 20-min period each subject was systematically viewed 38 times for 4 sec to categorize its instantaneous behaviour and the behaviour was classified into one o1 the 4 categories.
4) Observations were repeated 3 times daily (7:30, 11:00, and 14:30) for 5 days.

During Week 2, the foraging device was introduced. The procedures for observations were followed except both the foraging device and feed hopper were filled with approximately equal amounts of the granular diet prior to each observation session.

During Week 3, a novel food was used in the foraging device. The procedure was modified by placing equal amounts of the experimental treat mix consisting of Fruit Loops, granola, raisins, and peanuts in the device and, the granular diet in the food hopper. The foraging device was emptied following each observation period.

Statistical methods

The measurements analysed for this study were the fraction of total behaviour devoted to foraging |foraging fraction or episodes of foraging) and the fraction of total behaviour which was self-directed {self-directed fraction or episodes of self-directed behaviour). These fractions were defined as the proportion of observed time engaged in the behaviour. The observed behaviours were foraging, self-directed, hopper feeding and other behaviours. An arcsine transformation was performed in these proportions |Snedecor & Cochran 1980) to better approximate

homogenous variation and a normal distribution.

The primary method of statistical analysis was analysis of variance (hereafter, ANOVA) on the transformed percentages with the main effects of subject {monkey, a blocking factor), treatment, and time within day; appropriate interactions of the main effects were also added to the model. In the event that interactions of the main effects were statistically significant at P —— 0.05 level, the model would be reduced and re-analysed by each level of one of the main effects contributing to the significant interaction until no lower level interactions were statistically significant, or were no longer present in the model¡ then the treatment effect was re-evaluated at P —· 0.05 (Montgomery 1978, Snedecor & Cochran 1980) .

Results

Seven out of 8 animals accepted the feeding device and were actively using it within one day. Most animals would steady the device by grasping it with one hand and use a finger of the other hand to extract feed. The one animal that did not use the device refused to use it even when it contained a novel food.

Foraging during the first day of test week 2 **was not** significantly **different** from **that** of week 1 {Fig. 2). Examining the analysis of data indicated that foraging episodes on day 1 were affected by time of day and were not significant at each data collection time point. The frequency of foraging was very high at the first observation point but declined to a level similar to that of week 1 by the last observation of the day.

Episodes of foraging increased during days 2-4 of week 2. The increase in proportions was statistically significant (P< 0.05) when compared to week 1 (Fig. 2) and amounted to 240-500%. Even though the same type of feed was available in the easy to access hopper feeder, the foraging device was readily used. The difference in frequency of foraging on day 5 of week 2 was not significant compared to the frequency for the same day of week 1.

The effect of the foraging device on self-directed behaviour is depicted in Fig. 3. Self-directed behaviour decreased as much as 23% during week 2 when the device was in place. The decrease was significant *(P* < 0.05) when compared to week 1.

The frequency of foraging with the novel food increased over the level achieved during week 2 *{P* < 0.05). A 300-1200°A increase in foraging episodes occurred when the food was changed from standard died to a novel treat. The freque Managing

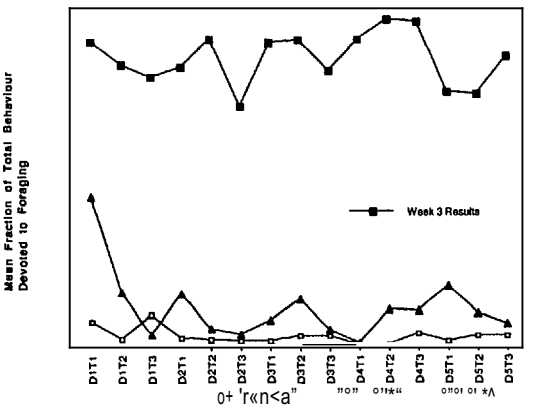

Fig 2 The mean fraction of total behaviour devoted **to foraging** behaviour with time (weeks 1-3). The time period consists of the observation hour within a day, e.g. D1T2 is the second time period measurement (11.00) on the first day of a study phase (Monday)

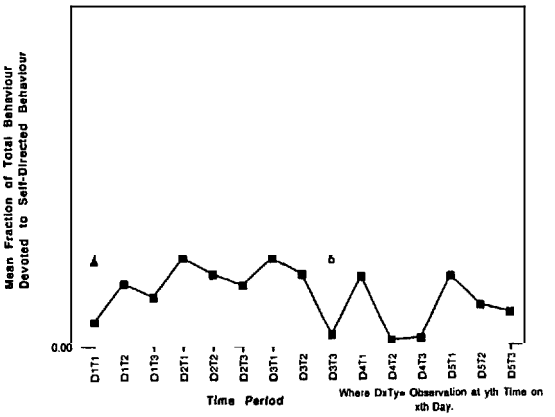

Fig 3 The mean fraction of total behaviour devoted to self-directed behaviour plotted against time (weeks 1–3). The time period consists of the observation hour within a day, e.g. D1T2 is the second time period measurement (11.00) on the first day of a study phase (Monday)

remained high throughout the week that novel food was provided in the device.

Adding a novel food to the device during the third week was associated with a 58-84% decrease in self-directed behaviour (Fig. 3). The decrease in proportions was significant when compared to week 2 $P < 0.05$}. Self-directed behaviour remained at a low level throughout the week.

Discussion

The device was readily accepted and used by all but one animal. Those animals that adapted to the feeder began manipulating it and developed techniques to obtain food very soon after it was placed on their cages. The capacity for manipulation displayed by these monkeys and rapidity with which they adapted to using the device is consistent with the findings of Torigoe {1987).

Observed foraging during Week 2 of the study indicated the device was used even when it contained the same food as the readily accessible hopper. Evans et *aI.* (1989) reported that manipulation of a puzzle feeder was as important as hunger or taste in motivating puzzle use. Lack of significant use of the device on the last day of the week could be interpreted as an indication of the extinguishing effect reported as occurring with use of some toys (Bloomsmith st *at.* 1990, Line et aJ. 1991). The extinguishing effect of some toys has been a limitation to their usefulness {Bloomsmith ct nI. 1990, O'Neil 1988).

Extinguishing was not observed during Week 3. The addition of a novel food was sufficient to motivate the animals to use the device throughout the test week. Food preference based on palatability or other factors is consistent with observations of free-ranging non-human primates that eat a wide variety of food items but do select certain foods {Garber 1987, Malik & Southwick 1988, Marriott 1988). Varying the type of food may mimic the options available in the *kee*-ranging state and based on these observations increase the usefulness of the device.

Self-directed behaviour was significantly reduced when the foraging device was provided. The level of reduction was greater when a novel food was used. Because some captivity related behaviours appear to be excessive forms of behaviours included with the self-directed group of behaviours, e.g. sell-grooming vs hair plucking, one is tempted to relate a decrease in self-directed behaviours to a potential decrease in captivity behaviours. However, the measure of such an effect would require more extensive comparison of a device exposed group and a non-exposed group over a time period sufficient for the development of captive behaviours.

The one animal that never used the device is interesting and points to the fact that cynomolgus monkeys are individuals (Suomi 1991). In developing programmes to meet the psychological well-being of groups of animals a variety of methods should be employed to better assure that the needs of each animal are met.

Based on these studies the device was included in the enrichment rotation programme. It is filled with either granular ration or a novel food and is used a maximum of 2 weeks at a time. The quantity and type of novel foods are selected to meet nutritional requirements. Use of this device in concert with other devices in rotation, appears to minimize the extinguishing effect of any one device and, in that way, provides more benefit to the animals. On an empirical basis, our veterinary clinical staff report fewer cases of psychological disturbance, e.g. self-traumatization, stereotypy, than before the rotation programme was in place. The device withstood handling by the animals on this study and sanitization at 82.2°C. Moreover it has been actively used by additional cynomolgus monkeys, capuchins, and rhesus monkeys with minimal damage.

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