Short communication

Note on effects of a daylong feeding enrichment program for Chimpanzees (*Pan troglodytes*)

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Abstract

For captive chimpanzees, daylong feeding enrichment, offering longer feeding times as comparable to those of their wild counterparts, is expected to alleviate undesirable behavior. This study is designed to determine whether longer feeding opportunities over the course of a day would directly engender longer feeding times. A liquid dispenser was presented for 8 h/day to five chimpanzees. The daily feeding duration was increased to a maximum of 16.1% of the 8-h experimental time. Expanding food availability increased the number of feeding bouts. Attractive-tasting beverages elicited longer feeding bout durations. Results suggested that chimpanzees’ preferences regarding food characteristics as well as food availability were influential factors favoring the prolongation of feeding time.

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1. Introduction

Limited feeding conditions have been indicated as a major cause for captive chimpanzees engaging in undesirable behavior (Nash et al., 1999). In contrast, wild chimpanzees spend 27.5% of the day feeding (Pruetz and McGrew, 2001). Feeding time is divisible by the number and duration of feeding bouts. Morimura and Ueno (1999) showed daytime feeding time can be increased from 6.8 to 23.6% by increasing the number of feeding bouts. Providing foods that require processing prior to consumption lengthens the feeding bout duration (Bloomsmith et al., 1988). Thus, combining both methods to increase the number and duration of feeding bouts was...
expected to elicit longer feeding times. To date, prolongation of the feeding time has received little attention.

Therefore, this study was conducted to determine how the duration of food availability affects feeding times. Feeding opportunities were controlled by using a liquid-dispensing feeding device (Morimura, 2003). Moreover, to examine the effects of qualitative and quantitative aspects of food on its consumption, the beverage taste and dripping rate were controlled.

2. Methods

2.1. Subjects

The subjects were five young chimpanzees at the Great Ape Research Institute of Hayashibara Biomedical Laboratories, Inc. (GARI). Two were males and the others were females. The five subjects lived together in the facility with one 7400 m² outdoor enclosure that included a 13-m high artificial structure, a secondary forest of about 2700 m², and a pond of about 900 m². The care and use of the chimpanzees conformed to the Guide for the Care and Use of GARI.

2.2. Procedure

A single beverage-serving device was set up in the outdoor enclosure (Fig. 1). The experiment includes four conditions. The normal condition was set up to investigate the effect of increasing feeding opportunities. This condition consisted of baseline, 0-, 1-, 2-, 4-, and 8-h drip periods. For the baseline period, a device without a beverage-serving capability was presented. For the 0-h drip period, the full amount of beverage was served at one time. For other drip periods, beverage was allowed to drip during the

![Fig. 1. (a) The apparatus, made of polyvinyl chloride, was 95 cm long and 10 cm wide. (b) The device held one 1.5-l bottle inside for beverage stock. (c) The beverage-dripping rate was controlled using a nozzle and a screw, which was 15 mm long with 2.1 mm in diameter.](image-url)
Table 1
Comparisons of the total feeding duration and the number and duration of feeding bouts among beverage-dripping periods for four conditions

| Conditions          | Beverage-dripping period | Friedman ANOVA |  
|---------------------|--------------------------|----------------|---
|                     |                         | \( \chi^2 \)  | d.f. | p    |
| Feeding duration (%)| Normal: 0.8 ± 0.4        | 16.4 ± 5       | 0.01 |
|                     | Thickened tastes: 2.3 ± 2.1 | 18.1 ± 4       | 0.001|
|                     | Different tastes: 2.8 ± 1.6 | 16.2 ± 4       | 0.003|
|                     | Double-rate: 3.5 ± 2.1   | 9.2 ± 3        | 0.03 |
|                     | 2 d.f.                   |                |      |
| Bout number (n)     | Normal: 3.6 ± 0.4        | 24.0 ± 5       | <0.001|
|                     | Thickened tastes: 8.0 ± 3.1 | 18.4 ± 4       | 0.001|
|                     | Different tastes: 5.2 ± 1.9 | 17.1 ± 4       | 0.002|
|                     | Double-rate: 8.2 ± 2.8   | 12.1 ± 3       | 0.01 |
|                     | 4 d.f.                   |                |      |
| Bout length (s)     | Normal: 10.6 ± 4.2       | 12.9 ± 5       | 0.02 |
|                     | Thickened tastes: 37.0 ± 39.5 | 5.0 ± 4        | 0.29 |
|                     | Different tastes: 69.6 ± 59.5 | 7.8 ± 4       | 0.10 |
|                     | Double-rate: 54.5 ± 53.9 | 5.9 ± 3        | 0.12 |

‘na’ represents ‘not available’.
corresponding time. Dripping rates were: 18.0 g/min for the 1-h period, 9.0 g/min for the 2-h period, 4.7 g/min for the 4-h period, and 2.1 g/min for the 8-h drip period, with ±0.1 g/min error. The normal condition had 60 sessions (5 sessions × 6 dripping periods × 2 repetitions). Each session lasted 8 h (09:00–17:00 h) during which 1.5 l of commercial isotonic drink (Aquarius; Coca-Cola Japan Co., Ltd.) was served. This solution was obtained by mixing 0.5 l of the beverage concentrate with 1.0 l of water.

The thickened taste condition was set up to investigate the effect using a more concentrated beverage. The same beverage of concentrate (1.5 l) was supplied undiluted. The double-rate condition was set up to investigate the effect of increasing feeding efficiency via flow rate. The normal diluted beverage was supplied, but 3.0 l was available each day. The different-taste condition was set up to investigate the effect using a different-tasting beverage. Grape-flavored beverage consisting of 0.5 l of a concentrate diluted with 1.0 l of water, as in the normal condition, was supplied. These three experiments were done as a block consisting of one session for each of the six dripping periods, and repeated five times.

The observation was done on each of the five subjects. The chimpanzees could freely access the device during the 8-h experimental time in all the conditions. The behavioral data were collected by an instantaneous sampling method at 3-s interval through the experiments. The frequency of visiting the device, defined as the subject being within 50 cm of the dispenser, was counted as an index of feeding. The total feeding duration was calculated based on the frequency of visiting the device over the 9600 sampling points occurring during daytime (1200 points/h × 8 h). The number and the length for each feeding bout were also calculated. A Freedman analysis was used for statistical analyses using $p < 0.05$ to denote significance. Scheffe’s multiple comparison was done as a post hoc test.

![Fig. 2. Scatter-plot comparison of the length and number of feeding bouts. The average feeding bout duration was determined by the qualitative characteristic of the beverage, regardless of the beverage-dripping periods. Each dot’s size corresponds to the beverage-dripping duration. Only under the normal condition, the smallest blank dot indicates the baseline period. Numbers beside each dot represent the total feeding duration of experimental time.](image-url)
3. Results

The total feeding duration and the number of feeding bouts increased monotonically with the extension of the beverage-dripping period (Table 1). Feeding bout durations were not statistically significant, except for the normal condition.

Moreover, the total feeding duration of five subjects was, on average, a maximum of 8.0 ± 3.0% in the different-taste condition and a minimum of 4.6 ± 1.4% in the normal condition (Freidman ANOVA: $\chi^2 = 8.8$, d.f. = 3, $p = 0.03$). The numbers of feeding bouts were not significantly different among the four conditions (Fig. 2, Freidman ANOVA: $\chi^2 = 6.4$, d.f. = 3, $p = 0.10$). Conversely, the feeding bout duration differed among the four conditions (Freidman ANOVA: $\chi^2 = 9.7$, d.f. = 3, $p = 0.02$). The duration in the different-taste condition was longer than those in the normal condition (post hoc test: $S = 8.6$, $p = 0.03$).

4. Discussion

A series of the experiments succeeded to illustrate the two different factors of food affect independently the total feeding duration of captive chimpanzees. Increasing the food availability increased the number of feeding bouts for each condition. The comparison among the four conditions revealed that attractive food, specifically grape-flavored beverage in the different-taste condition, elicited longer feeding bout durations. These results suggest that chimpanzees’ preferences regarding food characteristics as well as food availability, rather than food quantity, were influential factors in the prolongation of feeding time. Therefore, a pivotal issue in the search for appropriate daylong feeding enrichment involves asking what kind of, and how much, variation in stimuli chimpanzees prefer during food exploration, processing, and eating (Fernandes, 1996). Application of a bout analysis to the feeding enrichment program offers some workable plans for further studies to clarify the relationships between a daylong feeding enrichment and prolongation of overall daily feeding duration.

5. Conclusion

Not only (1) food availability, but also (2) chimpanzees’ preferences regarding food characteristics influenced feeding time of captive chimpanzees. The performance of a daylong feeding enrichment program could be affected by, at least, those two different factors of food provisioning condition independently.

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References


