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Role of Some Physical Characteristics in Species Recognition by Pigtail Monkeys

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ABSTRACT. Three adult pigtail monkeys pressed a lever to see pictures of pigtail and Japanese monkeys with a variety of physical features being removed. The features included head, tail, body, background, and color. The duration and the interval of exposure of these visual stimuli were dependent upon subjects' responding. Preferences for those pictures were evaluated by the ratio of lever-pressing duration to interval of lever-pressing. Two of the subjects showed a consistent preference to see pictures of pigtail monkeys over those of Japanese monkeys. Though this preference tended to maintain when these physical features were removed, it became relatively weak when head and head + tail were removed. These results suggest that pigtail macaques may discriminate species based not on a single characteristics but on some combination of features, and that head may be relatively important than the other features.

Key Words: Species recognition; Social perception; Social preference; Visual preference; Releaser; Sensory reinforcement; Pigtail monkeys.

INTRODUCTION

Previous studies suggested that macaque monkeys in general discriminate closely related species of the genus *Macaca* and that they prefer to see pictures of own species (DEMARIA & THIERRY, 1988; FUJITA, 1987, 1989a, b; SACKETT, 1970; SWARTZ, 1983; SWARTZ & ROSENBLUM, 1980). This ability may be a possible psychological barrier to prevent interbreeding among these species (FUJITA, 1987, 1989a, b, 1990; YOSHIKUBO, 1985, 1987), which often results in fertile hybrid offsprings (BERNSTEIN & GORDON, 1980; CHIARELLI, 1973).

FUJITA (1990, 1993) studied the effects of restricted social experience on this natural ability. Diachronic studies of monkeys who were hand-reared with conspecific or heterospecific individuals and monkeys reared by heterospecific mothers suggested that this social preference may be determined genetically in rhesus monkeys while it may be determined by experience in Japanese monkeys. The hard-wired preference for its own species may be regarded as adaptive for monkeys living with closely related species to have a chance to meet each other in the same habitat (see FOODEN, 1980).

An important aspect of this social preference lies in how the monkeys distinguish species. In the literature of instinctive behavior of animals, simple stimuli that reliably elicit fixed action patterns have been demonstrated (i.e. releasers) (e.g. TINBERGEN, 1951). In primates, HIGLEY et al. (1987) showed that adult female rhesus monkeys preferred reddish pink faces. They suggested that this characteristics might induce nursery behavior in adult rhesus females.

The repertoire of the behavior for which such releasing stimuli were demonstrated has been limited to a few important social behaviors such as mating, aggression, feeding, or filial recognition. It is interesting to investigate if simple visual preference for social pictures

may be also controlled by specific features. Recently, KYES and CANDLAND (1987) demonstrated that hamadryas baboons prefer to see pictures with eyes over those without eyes. In this study, I attempted to figure out which aspects of physical features determine the visual preference by pigtail monkeys for monkey pictures, using pictures several features of which were removed.

METHOD

SUBJECTS

Subjects were three pigtail monkeys (*Macaca nemestrina*), *Mn28* (male: 7 yrs old), *Mn3* (female: 17 yrs old), and *Mn19* (male: 14 yrs old). *Mn28* was reared by humans. The others were mother-reared. No restriction of food or liquid was imposed throughout the experiment.

APPARATUS

The experimental box was 122 cm high, 68 cm wide, and 136 cm long. The box had the experimental panel (65 cm high and 56 cm wide) installed with a window, two levers, a food cup, a houselight, and a water dipper. The window was made of a transparent acrylic board. It was located at the center of the panel and was sized 30 cm wide and 25 cm high. The levers were 4 cm wide and 3 cm long, located 10 cm below the window, and separated 25 cm from each other. Each lever could be illuminated from behind by a bulb. The food cup was at the bottom left corner of the panel. A universal feeder (Sanso S-100) could present pieces of food in the food cup. The houselight was at the top of the panel. Water was always available from the dipper at the left end of the panel.

There was a 14-inch color TV (Sony KX14-HD1) about 60 cm distant from the experimental panel. A video disk player (TEAC LV-200) could present still pictures on the TV. The whole equipment was controlled by a personal computer (NEC PC-9801U2).

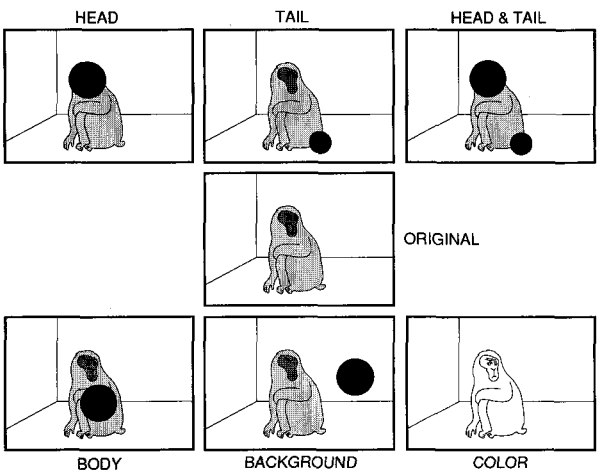

Fig. 1. A schematic representation of the stimuli used.

Stimuli

Stimuli were 300 pictures on the TV. They included pictures of pigtail monkeys, those of Japanese monkeys (*Macaca fuscata*), and control pictures. The pictures of monkeys were either original pictures of full body of the monkey or those that had some physical characteristics of the monkey removed (Fig. 1). The removed features were: head, tail, head + tail, body, background, or color. The number of monkey pictures was 20 for each species and for each type of modification of pictures, making up 280 (20 photos × 7 types of modification × 2 stimulus species). Five of the original monkey pictures had one male, five had one female, and the remaining ten had one male and one female. Orientation of the monkeys on the pictures were not controlled except pictures from the back and those of aggressive expressions were excluded. The control pictures were either plain white field or dark screen. Ten for each were used.

Another set of 100 pictures of animals and plants were used for preliminary training.

Procedure

All the subjects were shaped to press one of the levers to obtain a piece of food. They were then trained to press the illuminated lever. They were next trained to hold the illuminated lever for 2 sec.

After obtaining consistent lever pressing, the two levers were concurrently available. Food was dependent upon the cumulated duration of the responses on the left lever. A piece of monkey chow was delivered when the cumulative time reached 10 sec. This was to feed them automatically.

Pressing the right lever resulted in a picture on the TV (i.e. sensory reinforcement: Fowler, 1971; Kish, 1966; Matsuzawa, 1981; Matsuzawa & Fujita, 1981). The picture was on until the subject released the lever or until 10 sec passed (i.e. conjugate reinforcement: Rovee-Collier & Gekoski, 1979). When the subject pressed the lever again within 10 sec after the previous release of the lever, the same picture was presented on the screen. Lever pressing separated more than 10 sec resulted in a new picture. With this procedure, the subject had to see all the pictures at least once. However, once the subject saw the particular picture, he/she was free to see it as many times more as he/she liked. The change of the picture (after 10-sec pause) was signaled by 1-sec removal of the illumination of the picture lever.

A series of events from the first response to the new picture and the end of the 10-sec pause was called a trial. On every trial, the duration of each response and the interval between the responses were recorded. The last interval of each trial was recorded as 10 sec.

The test sessions were run after the subjects completed 300 trials with the preliminary set of pictures. The test lasted until the subjects completed 1500 trials. That is, each of the 300 pictures was tested five times. The length of the test session was 12 hrs.

RESULTS

The number of test sessions to complete 1500 trials was 9, 3, and 5 for monkey *Mn28*, *Mn3*, and *Mn9*, respectively.

For each of the 300 pictures, the average duration of lever pressing (D) and the average interval of lever pressing (I) were calculated. The ratio of D to I (D/I score) was chosen as an index of the visual preference for the pictures. This was to minimize the variability of

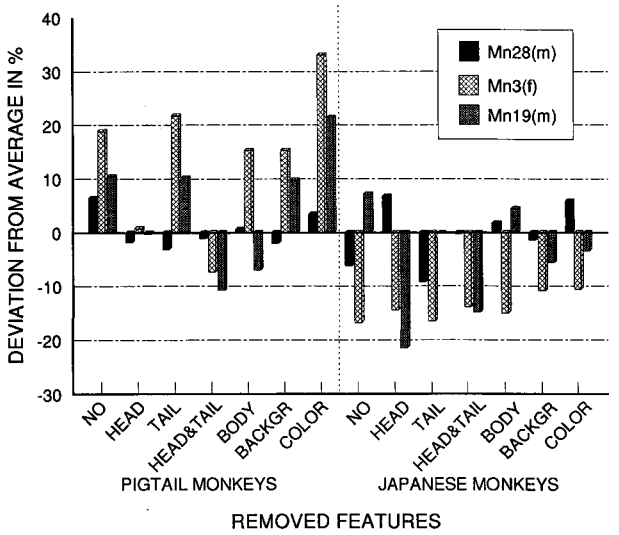

Fig. 2. Relative preferences for the pictures of monkeys. The horizontal axis shows removed features. The vertical axis shows the deviation in percents of the D/I scores averaged for each group of pictures from the grand average of D/I scores for monkey pictures. Upward bars mean preferences higher than the grand average, and downward bars mean preferences lower than it.

the data. In a previous study (FUJITA & MATSUZAWA, 1986), we found a positive correlation between D and I. Where there is such a correlation, taking the ratio of the two variables is expected to reduce variability of the data.

Figure 2 shows the relative preferences for the pictures of monkeys. The horizontal axis shows removed features. The vertical axis is the deviation in percents of the D/I scores averaged for the particular group of pictures from the grand average of D/I scores for monkey pictures. Upward bars mean preferences higher than the grand average, and downward bars mean preferences lower than it. This score is referred to as relative preference scores (RPS) below.

Two monkeys (*Mn3* and *Mn19*) in general showed stronger preferences for pictures of pigtail monkeys than those of Japanese monkeys. However, one of the monkeys (*Mn28*) showed very little differentiation of the D/I scores; less than plus-minus 10%. The data for this monkey are excluded from the analyses that follow.

The D/I scores for the two successful subjects were analyzed by a three-factor ANOVA of subject ($N=2$) × removed features ($N=7$) × stimulus species ($N=2$). The main effect of subject was significant [$F(1, 6)=46.29$, $p<0.001$]. The main effect of removed features approached a significance [$F(6, 6)=3.42$, $p=0.08$]. The main effect of stimulus species was significant [$F(1, 6)=30.63$, $p<0.001$]. The last point means that the two monkeys discriminated pictures of pigtail monkeys and those of Japanese monkeys.

Figure 3 shows change of RPS for the same pictures resulting from removal of a variety of physical features. Upper graph shows pictures of pigtail monkeys and lower graph shows those of Japanese monkeys. Removed features are shown on the horizontal axis and increase or decrease in RPS is shown on the vertical axis. For pictures of pigtail monkeys, the preference of both subjects most greatly decreased when head + tail was removed, followed by when head was removed. Removing tail, body, and background had little effect

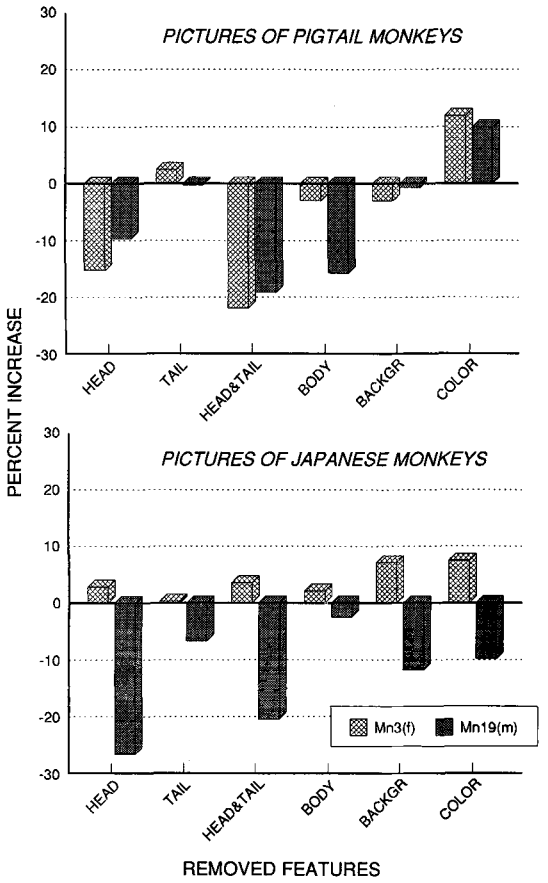

Fig. 3. Increase/decrease of relative preference scores (RPS, see text) for monkey pictures resulting from removal of physical features. Upper graph shows RPS for pictures of pigtail monkeys and lower graph shows that for Japanese monkeys. Removed features are shown on the horizontal axis. The vertical axis shows increase/decrease of RPS from the original pictures.

on preference. Interestingly, removing color of the pictures increased their preference.

For pictures of Japanese monkeys, one monkey (*Mn19*) showed a tendency somewhat similar to that for pictures of pigtail monkeys, but the other one (*Mn3*) did not show much change in preference. This might be because of a floor effect; she did not prefer to see pictures of Japanese monkeys after all (see Fig. 2).

Two separate two-factor ANOVAs of subject ($N=2$) × removed features ($N=7$) were conducted for pictures of each species. The data were D/I scores. For pictures of both species, the main effect of subject was significant [$F(1, 6)=34.24$, $p<0.001$, and $F(1, 6)=39.18$, $p<0.001$, for pictures of pigtail monkeys and Japanese monkeys, respectively]. However, the main effect of removed features was significant only for pictures of pigtail monkeys [$F(6, 6)=12.47$, $p<0.01$ for pigtail monkeys, and $F(6, 6)=0.79$, ns, for Japanese monkeys]. This means that removing features had differential effect only for pictures of pigtail monkeys.

Figure 4 shows the difference in RPS between for pictures of pigtail monkeys and for those of Japanese monkeys. Horizontal axis shows removed features. Vertical axis shows

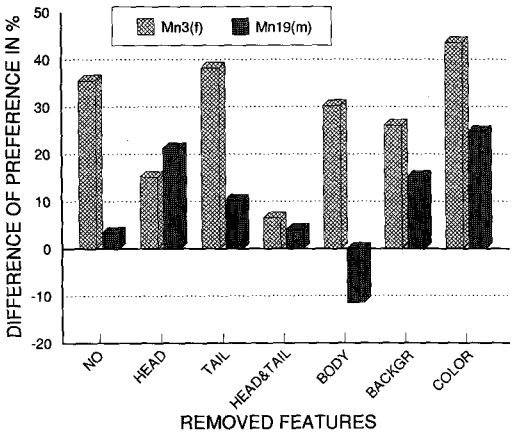

Fig. 4. Discrimination of pigtail and Japanese monkeys in terms of the difference in RPS between for pictures of pigtail monkeys and for those of Japanese monkeys. Horizontal axis shows removed features. Vertical axis shows RPS for pictures of pigtail monkeys minus RPS for pictures of Japanese monkeys.

RPS for pictures of pigtail monkey minus RPS for pictures of Japanese monkeys. Generally speaking, the two subjects tended to maintain a positive difference in D/I scores between pictures of pigtail monkeys and those of Japanese monkeys, whatever features were removed. However, the discrimination was the weakest when head + tail was removed. The strongest discrimination was shown for black-and-white pictures.

DISCUSSION

As is shown in Figure 2, two of the three subjects tended to see pictures of pigtail monkeys more than those of Japanese monkeys. This was consistent with previous data (FUJITA, 1987). The reason why one of the subjects did not show much differentiated preference might be the quality of pictures on the TV, which was clearly poorer than the photographic slides used in the previous study. Another possible reason is that this subject was reared by humans. Previous studies show that preferences for species may be determined by social experience; Japanese monkeys having restricted social experience did not show a preference for pictures of their own species, while normally reared Japanese monkeys clearly did (FUJITA, 1987, 1989a, b, 1990, 1993).

Analyses of the D/I scores of the two successful subjects showed that removal of physical characteristics changed the preference for pictures of pigtail monkeys (Fig. 3). In particular, removal of head and head + tail greatly reduced the preference by both of the subjects. Similar effect occurred for pictures of Japanese monkeys in one of the subjects. This suggests that the head may be the most important determinant of this preference for visual images of monkeys in general. The other monkey's failure of showing such an effect might have been a floor effect that the preference scores for intact pictures of Japanese monkeys were very low.

Interestingly, removal of color increased the preference for pictures of pigtail monkeys. One possible explanation for this might be that removal of color had the effect of

temporary extinction of operant lever pressing, similar to bad tuning of TV. In this case, frequency of responses (like turning the tuner switch) is expected to increase. This was actually the case for one of the monkeys (*Mn19*). However, for the other monkey (*Mn3*), the same increase in preference scores were resulted from long response durations instead. It is difficult to identify the reason.

Finally, the tendency to prefer pictures of pigtail monkeys over those of Japanese monkeys was maintained when any single feature was removed (Fig. 4). Critical features for species discrimination was not found from the present experiment. This may suggest that the pigtail monkeys discriminate pictures of different species based on combination of physical features instead of single critical features. Actually, their discrimination was the weakest when two features, head and tail, were removed at one time. However, this is not conclusive yet because covered areas were the largest for pictures that had the two physical features removed at a time.

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