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# INDIVIDUAL DIFFERENCES IN RESPONSES TOWARD A MIRROR BY CAPTIVE TUFTED CAPUCHIN MONKEYS (*CEBUS APELLA*)

# DIFFERENZE INDIVIDUALI NELLE RISPOSTE ALLO SPECCHIO NEI CEBI DAI CORNETTI *(CEBUS APELLA)*

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ABSTRACT

The study examines the responses directed toward a mirror by capuchin monkeys tested both individually (Phases I-III) and in group (Phase IV). Subjects were four laboratory-born and tool-using *Cebus apella*. Manipulative responses decreased over phases for all subjects, whereas social responses decreased in the two adult monkeys and increased in the two juveniles. In addition. one subject preformed peculiar manipulations of the mirror, and the adult male showed reactions typical of psychological distress. No evidence of self-recognition was found.

Key words: mirror-image stimulation, self-recognition, *Cebus apella*, capuchin, mirror.

RIASSUNTO

Questo studio esamina i comportamenti diretti allo specchio di alcuni cebi dai cornetti testati sia individualmente (Fase I-III) sia in gruppo (Fase IV) allo scopo di investigare capacità di autoriconoscimento in questa specie. Sono stati osservati 4 soggetti appartenenti a ùifferenti classi di età. Le risposte allo specchio sono state di tipo sociale e manipolativo. Durante il corso delle osservazioni le risposte manipolative sono diminuite in tutti i soggetti presi in esame mentre quelle sociali sono aumentate nei giovani e diminuite negli adulti. Nel corso dell'esperimento i cebi non hanno mostrato capacità di autoriconoscimento.

Parole chiavi: Ccbo dai cornetti, autoriconoscimento, specchio.

## INTRODUCTION

Monkeys consider their image in the mirror as a conspecific, whereas great apes, with the possible exception of gorillas, show self-recognition (Gallup, 1970; Gallup et al.. 1971; Letbmate & Duker, 1973; Suarez & Gallup, 1981; Ledbetter & Basen, 1982; for an extensive review see Anderson, 1984 a, b). The difference between monkeys and apes has been interpreted as reflecting a difference in cognitive abilities related to self-awaress (Gallup, 1977).

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Some aspects of the behavior of tufted capuchin monkeys *(Cebus apella)*, such as the ability to use and modify tools (Westergaard & Fragaszy, 1987; Visalberghi & Trinca, 1989; for a review see, Visalberghi, 1990), or to represent serial order and conditional relations (D'Amaro & Colombo, 1988; D'Amato et al., 1985), suggest that these South-American monkeys are more similar to great apes than are others taxonomically closer to apes.

There are a few early anectodes referring to captive capuchins' mirror responses (Romanes, 1883; Garner, 1892). Also, two *Cebus apella* subjects were studied in a cross-species comparison by Lethmate & Ducker (1973). Most recently, Collinge (1989) investigated capuchins' mirror reactions in relation to their age and sex, and Anderson & Roeder (1989) investigated the responses of a group of tufted capuchins to five different types of mirrors. In addition, informal field observations have shown that wild capuchins react fearfully to a mirror presented on a platform (Izawa, 1990). The results of all these observations have shown that capuchins exposed to mirrors show high interest levels and a variety of social responses, but not self-recognition.

McGrew (1989) has argued that self-recognition is an intellectual indicator of differential tool-using capabilities among apes. The aim of the present experiment was to test capuchins which have previously shown tool use in a variety of different tasks (Visalberghi & Antinucci, 1986; Visalberghi & Trinca. 1989; for a review see Visalberghi, 1990) using mirrors which had characteristics likely to elicit optimal responses. The mirror we used was bigger than the animals, it was presented so that the monkeys had physical access to it (close proximity with the mirror enhances behaviors directed toward it, Anderson & Roeder, 1989), and was obiiquely positioned so that the human observer was able to see and videotape (for further fine grained behavior analysis) the monkey and its reflection at the same time. In addition, and in contrast with most of previous experiments, our subjects were tested both individually and with their familiar cagemates.

## METHODS

**Subjects and Housing.** Subjects were four captive-born tufted capuchins (*Cebus apella*): 1 adult male (Cammello, Cm, 8 years old), 1 young adult female (Pippi, Pp, 5 years old), and two juvenile females (Brahms, Br, 4 years old and Carlotta, Cr, 2 years old). They were born from the same mother, hand-reared, and successfully reintroduced to their social group (for details of rearing procedure, see Visalberghi & Riviello, 1987). From 1984 they were housed together in an indoor-outdoor cage (1.7 x 1.9 x 2.6 m and 1.7 x 3.0 x 2.6 m, respectively).

**Apparatus.** The apparatus consisted of a plexiglass mirror (90 x 60 cm) that was secured to the floor in the middle of a familiar testing room (1.7 x 3.0 x 2.6 m).

**Procedure.** The experiment was conducted in four phases, each consisting of five sessions carried out over five consecutive days. Monkeys were exposed to the mirror as follows: Phases I and III, 10 min of exposure per session. Phases II and IV, two hours of exposure per session. In order to give the monkeys plenty of

Tab. 1 – Behavioral categories used for observation. To be scored these behaviors must be performed when the subject(s) is in front of the mirror. * Behaviors not included in Table 2

1) SOCIAL RESPONSES: behaviors directed toward the image reflected on the mirror.
a) LOOKING AT: visual fixation (more than 2 sec) of the reflected image(s).
b) FOREHEAD RAISING: the forehead is raised and maintained in this position for 1 *sec*, or more.
* c) MOUTH OPENING: the monkey opens the mouth. Teeth may be *exposed* or not.
* d) VOCALIZATION: scored only when the monkey looks its own image.
*e)* SELF-TOUCHING: the monkey touches its own body. Not scored when chest rubbing is observed.
f) LOOKING BEHIND THE MIRROR: after having looked at its own image the monkey looks behind the mirror as to search for a conspecific.
* g) CHEST RUBBING: the monkey rubs its chest.
h) CROUCHING: the monkey crouches in front of the mirror, looking at its own image with its back higher than its head.
i) HUDDLING: the monkey huddles itself up after looking, to avoid its **own** image.

2) MANIPULATIVE RESPONSES DIRECTED TO THE MIRROR: actions for which the mirror was used **as** an object regardless its unique reflection property.
a) MANIPULATION: the monkey contacts the mirror. This category includes climbing the mirror, and similar motor activities.
b) MOUTHING: the monkey bites or licks the mirror.
* c) MIRROR BEATING: the monkey repeatedly beats with strength the mirror with its hands.

3) PROXIMITY: scored whenever a monkey is in front of the mirror within 50 cm from it. Not scored when one of the above behaviors was also observed.

opportunity to develop self-recognition, between Phases II and III there was an interim period of 3 five-day sessions of two hours of exposure to the mirror. Therefore, when Phase IV was completed, each monkey had received a total of 20 sessions and about 52 hours of exposure over a seven week period.

In Phases I, II and III the monkeys were tested individually, whereas in Phase IV they were tested as a group. In order to separate one subject from its group the guillotine door, separating the testing room and the indoor-cage, was open until only the preselected subject was in the testing room. Two additional sessions, numbered 21 and 22, were run when Phase IV ended. In session 21, the mirror was covered with plywood as a control, whereas in session 22 the mirror was uncovered.

During ali phases data were collected from the start of each session for a 10-min period. Behavior was recorded on a checklist, using One-Zero sampling with 15 sec-intervals (Altmann, 1974) to score the three major behavioral categories: (1) social responses elicited by the mirror image, **(2)** manipulative and other responses directed toward the physical structure of the mirror and **(3)** proximity to the mirror (Table 1).

Tab. 2 – Number of 15-sec intervals in which behaviors were observed at least once (one-zero sampling), during Phases I, II, and III. Behaviors are defined in Table 1.

| | CAMMELLO | | | PIPPI | | | BRAHMS | | | CARLOTTA | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PHASES | I | II | III | I | II | III | I | II | III | I | II | III |
| LOOKING AT | 62 | 11 | 4 | 111 | 112 | 73 | 95 | 95 | 93 | 105 | 113 | 91 |
| FOREHEAD RAISING | 9 | 1 | / | 54 | 59 | 36 | 10 | 17 | 17 | 11 | 32 | 2 |
| SELF-TOUCHING | 1 | 1 | / | 38 | 45 | 33 | 18 | 34 | 30 | 19 | 40 | 23 |
| LOOK BEHIND | 16 | i | i | 7 | 5 | 1 | 10 | 3 | / | 5 | 4 | / |
| CHEST RUBBING | 41 | 4 | 1 | 46 | 33 | 23 | 6 | 11 | 10 | 19 | 45 | 5 |
| HUDDLING | 22 | 6 | 4 | / | / | / | / | / | / | / | / | / |
| MOUTHING | 4 | / | / | 42 | 18 | 4 | 101 | 50 | 3 | 68 | 31 | ! |
| MANIPULATION | 27 | 2 | 2 | 85 | 56 | 32 | 147 | 83 | 37 | 116 | 89 | 37 |
| PROXIMITY | 63 | 12 | 12 | 147 | 126 | 106 | 165 | 121 | 84 | 143 | 144 | 111 |

Videotapes of Phases I, II and III, were analyzed to quantify the total amount of time each subject spent in front of the mirror and the mean duration of each visit. In Phase IV, the amount of time during which the adult male Cm was in a huddled posture and was groomed by the other monkeys was scored.

## RESULTS

### INDIVIDUAL TESTING

The subjects showed different levels of interest toward the mirror: overall, the juvenile females Br and Cr spent a similar amount of time in front of the mirror (12.1% and 13.1%, respectively). The adult female Pp was in front of the mirror for 25.6% of the total time, while the adult male Cm scored only 8.8% (Mann-Whitney U test, $U = 31$, $p < 0.001$). The mean durations of visits of juveniles were significantly shorter than those of adults: 18 sec (+/- 10.8) for Cm, 15 sec (+/-7.8) for Pp, 6 sec (+/- 2.7) for Br, and 7 sec (+/- 3.2) for Cr (Mann-Whitney U test, $U = 25$, $p < 0.001$).

Table 2 shows, for each phase, the number of intervals in which the subjects performed the behaviors listed in Table 1. The percentage of intervals in which manipulative responses to the structure were scored decreased across sessions 1-15 (Fig. 1). The decrease was statistically significant for all subjects except Pp (Kendall, $p < 0.001$).

Fig. 2 shows the percentage of intervals in which the subjects directed social responses toward their own image in the mirror during Phases I, II, and III. The only significant change in social responding concerned the adult male whose response decreased (Kendall, $p < 0.001$). Both juvenile females slightly increased social responding, while the older female's responding fluctuated more irregularly.

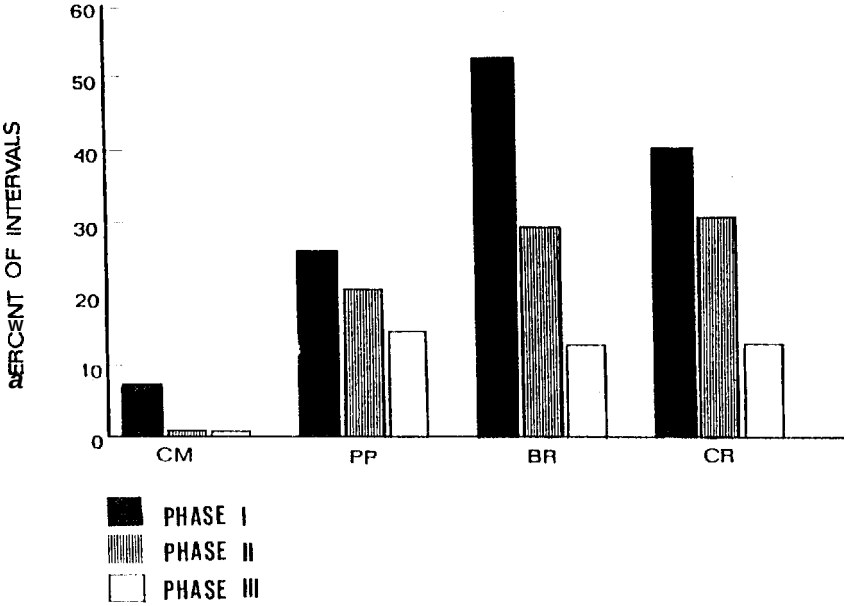


Fig. 1 - Percentage of intervals in which each subject showed manipulative responses to the mirror structure in Phases I, II, and III.

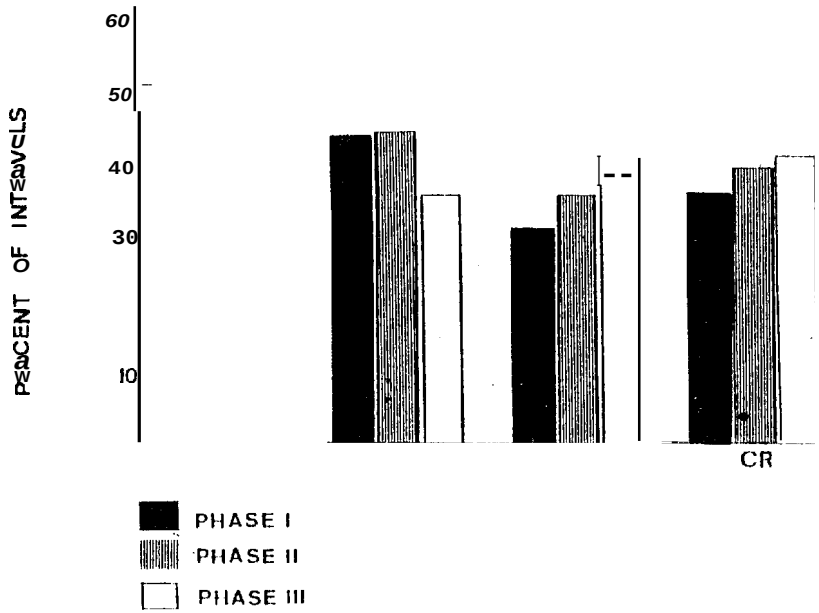


Fig. 2 - Percentage of intervals **in** which each subject showed social **responses** to the **mirror** in Phases I, II, and III.

**Qualitative description.** There was a striking difference between Cammello's social responses toward the mirror and those shown by the other monkeys. Overall, Cr, Br, and Pp exhibited sustained social behaviors toward the mirror, including those usually used by capuchins during courtship (Weigel, 1979; Visalberghi & Welker, 1986). In contrast, Cm showed very few of the social behaviors listed in Table 1.

Cm directed aggressive facial expressions and bared teeth screams toward the mirror, but across sessions he became increasingly fearful of his image. Typically, at the start of a session, he ran to the front of the mirror, looked at his image for 1-2 sec, displayed bared teeth screams, and then assumed a huddled posture in front of the mirror with active avoidance of visual contact. After a few minutes, he usually moved behind the mirror, or to a corner of the room still actively avoiding his reflection. Videotapes show that he walked faster when moving in areas from where he could see himself in the mirror than when he was in areas from which he could not see the mirror. Across sessions, and especially in Phase III, Cm became increasingly reluctant to enter the testing cage.

The juvenile female Br repeatedly performed several peculiar behaviors. Holding the distal part of her tail in one hand, she rubbed it on the mirror in a circle, then she rubbed it on the floor, and back on the mirror again: when doing so, she carefully looked back and forth from her hand to the mirror surface. Similarly, she beat her hand on the mirror, then on her foot which was contacting the mirror, and finally, after having placed the foot on the floor she would again beat it with her hand. Ail these behaviors were closely monitored by Br, as if she were investigating the effects of her own behavior on the mirror and the floor surfaces.

GROUP TESTING

In Phase IV, the adult male reacted to the mirror with fear as described before. The reaction of Cm immediately elicited intense affiliative behaviors especially in Br and Pp who contacted and groomed him extensively. The grooming behavior was so overwhelming that it swamped any other behavior directed toward the mirror.

Overall, in Phase IV Crn spent 89% of the time huddling or behind the mirror. During this time, Br, Pp and Cr performed grooming and contacted him for 67%, 19%, and 1% of the time, respectively. Furthermore, the values for proximity (not scored when contact occurs) ranged between 9% (Br) and 21% (Pp).

As can be seen from Fig. 3, across sessions, Cammello's huddling decreased. Br (73.2%) and, to a lesser extent, Pp (21.5%) generally groomed Cm when he huddled.

During the control session 21 the monkeys did not show social responses to the plywood covered mirror; Cm did not huddle up *to* the mirror, and his cagemates did not direct affiliative behaviors toward him (Fig. 3). In contrast, all the behaviors typical of Phase IV were resumed in Session 22.

During the videotape analysis behaviors suggesting self-recognition were never observed (see Gallup, 1975 for descriptions of behaviors related to self-recognition).

## DISCUSSION

The capuchin monkeys reacted to their image in a mirror with social behaviors and with manipulative behaviors directed towards the structure of the mirror. There was no evidence of self-recognition.

Marked interindividual differences in reaction were noted. The two juvenile individuals made shorter visits to the mirror and showed more manipulative behaviors than the older individuals. Manipulation by the juveniles decreased across sessions, whereas social responses to the mirror image tended to increase. In contrast, the two older individuals made longer visits to the mirror, and showed more social than manipulative behaviors; however, the patterns of response of the male and the female were strikingly different. The adult female showed positive social interactions with her image whereas the adult male was initially aggressive and later submissive and distressed in front of his reflected image.

Therefore, the results of the present experiment confirm and extend recent findings on capuchins obtained by other investigators (Anderson and Roeder, 1989: Collinge, 1989). In addition, the present observations add new intriguing

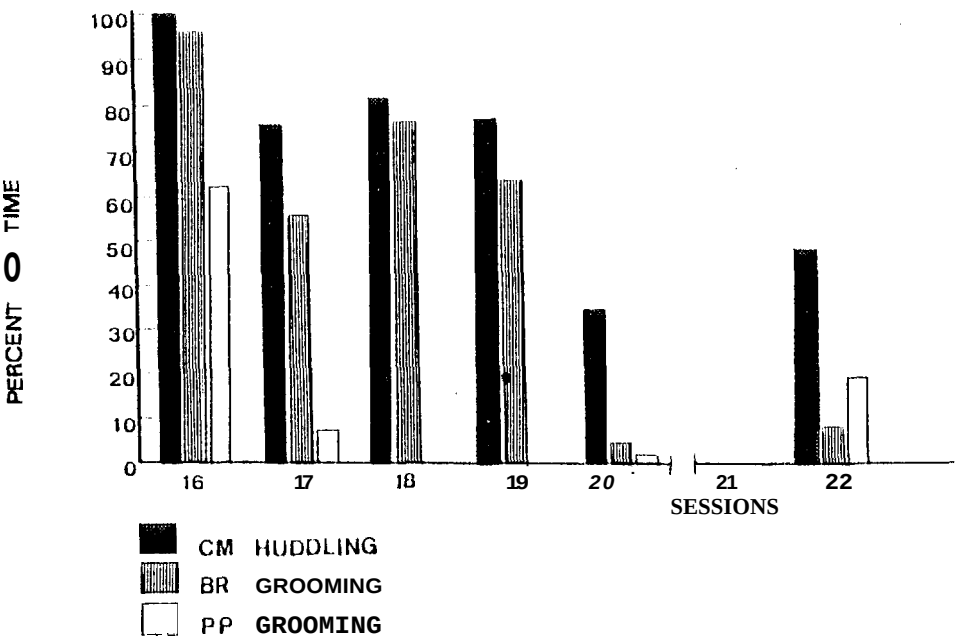


Fig. 3 – Percentage of 10-min sessions **spent** by Cm huddling in front of the mirror in Phase IV (trials 16-20), and in **trials** 21 and 22, **and** percentages of **time spent by** Pp and Br grooming Cm.

information about (a) exploratory behaviors and (b) the avoidance and distress induced by a mirror.

One female showed particular ways of exploring the mirror. She appeared to systematically "compare" the effects of her behaviors (pounding, rubbing, **and** pushing) when performed on the mirror and on the floor. Eglash and Snowdon (1983) report analogous behaviors in pygmy marmosets *(Cebuella pygmaea)*. Half of their subjects performed "reality testing" behaviors such as following their own movements in the mirror. Reality testing behaviors are of particular interest because they bring to mind those performed by human infants before they recognize themselves in a mirror (Dixon, 1957; Lewis and Brooks-Gunn, 1979).

Despite sustained interest and reality testing behaviors none of our capuchins ever showed any sign of self-recognition, even after the formal experiment ended and the mirror was left in monkeys' outdoor cage for two weeks.

The response of the adult male Cm was strikingly different from those of his cagemates. Whereas the females showed affiliative behavior, including patterns typical of courtship (Weigel, 1979; Visalberghi & Welker, 1986), the male was hostile to the mirror. He showed threats and fear reactions, and as the experiment went on he appeared increasingly distressed.

Cm's behavior was unexpected, both from the lack of similar reports in the literature and from the normal behavior of this subject not only in his group but also in a variety of other tasks and challenging problems. In fact, this monkey was the most proficient subject in several tool-using experiments and other tests in which he was routinely separated from the rest of the group (Visalberghi & Antinucci, 1986; Visalberghi & Trinca, 1989) without incident.

Cm was the only subject to perform non affiliative behaviors in front of the mirror, such as threats. **A** possible explanation for Cm's distress is that the he was affected by the the other monkey in the mirror (i.e., its reflected image) which did not retreat when Cm threatened it. nor attacked when Cm was submissive. **A lack** of understanding of this inappropriate behavioral sequence may have led to psychological distress. In contrast, it should be noted that the affiliative behaviors shown by the other capuchins, do make sense if the image responded similarly. It is common to receive affiliative behaviors in response to affiliative behaviors.

Mirror avoidance has also been described in human infants immediately prior to reaching the stage of self-recognition (Zazzo, 1979; Bischof-Koelher, pers. comm.), and in some nonhuman primates. Anderson and Bayart (1985) described an avoidance response in rhesus macaques; these authors however, did not notice any distress reactions. Further testing, and possibly physiological assessments to measure stress, are needed to evaluate whether cross-species differences, within species interindiviual variability, or factors specific to the present experiment are responsable for Cm's unusual behavior.

Cm's behavior elicited grooming by cagemates, whose intervention seemed to soothe him. Recent studies have shown that affiliative behaviors such as grooming can reduce stress, both at behavioral **and** at physiological levels of analysis (Boccia, 1987, Schino et al., 1988). It should also be noted that in capuchins social grooming is far less frequent than in other monkey species (Barton, 1983), and that in the

group of capuchins studied here grooming almost never occurs. This makes the reactions of the two females toward Cm all the more striking.

Finally, despite the fact that we used tool-using capuchins and we provided them with experimental conditions most suited to elicit self-recognition, no evidence of such a capacity was found. It seems therefore that McGrew (1989) argument about a possible relation between self-recognition and tool use does not hold generally. In contrast, our data support McGrew's view that the amount of animal protein in the diet may be a better indicator of tool-use capacity (McGrew, 1989). In fact, wild capuchins feed on a large variety of animals including insects, mollusks, amphibians, birds, and small mammals (Izawa, 1979, Terborgh, 1983, Fedigan, 1990).

(For those who are particularly interested in capuchins' mirror rcsponscs, an edited movie is available on request).

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