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SHORT COMMUNICATION

**Black-and-White Colobus Monkeys (*Colobus guereza*)
do not Show Mirror Self-Recognition**

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Mirror self-recognition (MSR) has been studied in many species of primates, but not previously in the black-and-white colobus monkey (*Colobus guereza*). A family group of five monkeys was videotaped in a baseline session with clear glass panel and nine sessions (270 min) with a mirror. All monkeys showed substantial interaction with the mirror. The monkeys show evidence of limited use of the mirror's reflective properties, but no evidence of behaviors indicating MSR. These data are consistent with the failure of other species of monkeys to show MSR and with the hypothesis that great apes are the only species capable of MSR.

The current body of literature suggests that there is a phylogenetic pattern to mirror self-recognition (MSR): most great apes appear to be capable of self-recognition whereas monkeys and lesser apes do not (De Veer & Van De Bos, 1999; Gallup, 1970; Povinelli, Gallup, Eddy, & Bierschwale, 1997; Ledbetter & Basen, 1982; Suarez & Gallup, 1981; Hauser, Miller, Liu, & Gupta, 2001; Anderson & Roeder, 1989; Mitchell & Anderson, 1993; Suarez & Gallup, 1986). The majority of the published work on MSR focuses on the chimpanzee (for a review, see De Veer & Van De Bos, 1999). The studies generally support the conclusion that chimpanzees are capable of self-recognition (Gallup, 1970; Povinelli et al, 1997), although there are reports that not all chimpanzees spontaneously demonstrate MSR (Swartz & Evans, 1991). The few experiments using orangutans show evidence of MSR ability; yet, those using gorillas generally have not supported the MSR hypothesis (Ledbetter & Basen, 1982; Suarez & Gallup, 1981). Nonetheless, this research is quite limited and is in need of replication (De Veer & Van De Bos, 1999). Additionally, several species of monkey have been tested, including cotton-top tamarins (Hauser, et al., 2001), capuchin monkeys (Anderson & Roeder, 1989), and many macaque species (e.g., Mitchell & Anderson, 1993; Suarez & Gallup, 1986); no evidence for MSR has been reported for any of these species. However, two species that have failed the mark test, elephants and macaques, were able to use mirror cues

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to discover hidden food (Anderson, 1986; Povinelli, 1989). This suggests that although these animals are not capable of self-recognition, they are possibly able to interpret some information from the mirror, such as the dual existence of objects both in the mirror and in the environment (Povinelli, 1989). The present study sought to explore mirror self-recognition in the black-and-white colobus monkey, a species previously untested in the MSR task.

MSR is an experimental method used to evaluate the presence of behaviors consistent with self-recognition in nonverbal organisms. A demonstration of MSR provides convincing evidence that an organism has the ability to distinguish itself from others, a fact consistent with self-recognition. However, MSR is not synonymous with self-recognition or self-concept. A complete self-concept does include MSR; however, other behaviors may also provide evidence toward some form of self concept. It should be noted, however, that there are alternative interpretations of MSR, including attempts to explain MSR using only associative mechanisms (reviewed in Swartz, 1998).

In the literature, a general consensus has been reached regarding which behaviors could indicate MSR (De Veer & Van Den Bos, 1999). It is accepted that animals must demonstrate an understanding of the reflective properties of the mirror. Evidence for this can be categorized in two ways: the use of the mirror as a visual referent or the use of mirror as a visual tool aiding in grooming or self-exploration. It is assumed that in order to have self-recognition ability, the animal must also understand that the mirror is a reflection of its environment. This could include activities such as using the mirror to view events or objects or using the mirror during play with others. Therefore, using the mirror to gather environmental information is a necessary but not sufficient condition for MSR. Using the mirror as a visual tool is traditionally defined by grooming behavior utilizing the mirror and observing parts of the body that are not normally visible without the presence of a mirror. There are also mirror-related behaviors that do not support the MSR hypothesis. These behaviors include any type of social solicitation or aggressive displays towards the figure in the mirror.

Method

Subjects

The subjects were a family group (1:1:3) of captive black and white colobus monkeys (*Colobus guereza*). There were a total of five group members: Springer (age 17 years), Coleus (age 13 years), Kiazi (2 years, 5 months), Kamba (1 year, 6 months), and Tamu (11 months). None of the subjects had previous exposure to a mirror. The group was housed together at the Philadelphia Zoo in a large two-story enclosure that included a 6-8 m high sloping ceiling, various structures that were designed to facilitate climbing, and two all-glass walls for viewing.

Table 1
Behavioral Events.

| Category | Definition | Examples |
|----------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | No interaction with the mirror | |
| 2 | Nonsocial interaction without evidence relevant to the MSR hypothesis | <ul style="list-style-type: none"> • Periodic visual contact with mirror looking around/behind the mirror |
| 3 | Behavioral evidence that does not support the MSR hypothesis | <ul style="list-style-type: none"> • Threat displays: bared teeth lip smacking barking cough fixed gaze staring • Social behaviors: licking the mirror jumping/hopping |
| 4 | Behavioral evidence that supports the use of the mirror as a visual referent | <ul style="list-style-type: none"> • Using mirror to examine other parts of the enclosure |
| 5 | Behavioral evidence that supports the use of the mirror as a visual tool | <ul style="list-style-type: none"> • Examining body parts visible without the mirror • Examining body parts visible with the mirror • Facial movements • Raising eyebrow • Grooming using the mirror |

Apparatus

The materials used in this study were an 8 mm digital video camera, a sheet of clear glass (46 cm by 46 cm), and half-silvered glass mirror (46 cm by 46 cm). All items remained outside the enclosure during the trials.

Procedure

The enclosure includes a large ledge 3 m from the floor adjacent to a glass wall facing an observation area. All trials were conducted through the glass at this location. A total of 10 trials, one baseline and nine experimental, were recorded (300 min total). One observer scored all of the trials. The trials were 30 min in length and began when the mirror was mounted on the outside of the exhibit with the center of the mirror at approximately face height for the animals. The video camera was placed directly behind the mirror. The lighting inside the enclosure was much brighter than the lighting outside the enclosure; therefore, the mirror retained a completely reflective appearance from inside the enclosure. At the end of each trial, both the mirror and the camera were removed immediately. Upon the recording of each session, and the removal of all the equipment, the tapes were scored at an alternate location.

Trials were conducted in the morning prior to the arrival of most zoo visitors. The baseline trial was conducted to measure the animals' behavioral activities before the introduction of the mirror. This trial included the clear glass mounted in the same position at which the mirror would be mounted on later trials. The zoo staff was present for the first mirror trial but absent from the remaining trials. It was agreed that if the animals exhibited signs of agitation or distress that persisted over time, the trials would be immediately discontinued, but this did not occur.

The behaviors critical to the MSR hypothesis were organized into an ethogram that contained categories of possible behavioral events (Table 1). These categories were organized in order to ease interpretation of the data. They included: no interaction with the mirror, interaction without evidence relevant to the MSR hypothesis, evidence that does not support the MSR hypothesis, evidence that supports the use of the mirror as a visual referent, and evidence that supports the use of the mirror as a visual tool. Relevant behavioral events were defined for each of the categories. To score the videotapes, the dependent measures were observed as two categories: punctate (short duration) events or continuous events. For punctate behavioral events, the frequency with which each occurred was recorded per animal. However, for behaviors that can be continuous, a time sampling procedure was utilized. If the animal was engaged in the continuous behavior for the first fifteen seconds of each minute, the behavior was recorded as occurring during that minute. The continuous behaviors recorded were: the amount of time spent within one body length of the mirror and the amount of time spent interacting with the mirror.

Results

During the baseline trial, all monkeys briefly investigated the mounted clear glass, possibly drawn by the duct tape used to mount it to the glass wall of the enclosure, but did not otherwise interact with it.

During the 9 mirror trials, individual monkeys spent 15-48% of the time within one body length of the mirror and interacted with the mirror 2.5-23% of the time. Time spent near the mirror was defined as being within one body length of the mirror; no interaction with the mirror was required. Interaction with the mirror was defined as either consistent eye-contact with or any behavior directed toward the mirror. As shown in Table 2, adults interacted with the mirror less than juveniles. Springer, the adult male, investigated the mirror on four separate occasions and Coleus, the adult female, was the least interactive with the mirror. There are considerable individual differences within the family group; this is most likely attributable to age. Most interactions with the mirror involved play or investigation, behaviors most often characteristic of juveniles.

As shown in Table 3, all the monkeys displayed social behaviors that suggest the absence of MSR (category 3 in Table 1). Among possible aggressive behaviors, four of five monkeys displayed the lip-smack (a mild threat); Springer also showed fixed-gaze staring. Other social behaviors displayed included mirror licking (four of five) and jumping or hopping (three of the monkeys).

The monkeys also showed additional interactions with the mirror, some of which demonstrated an attempt to use the mirror to gather environmental information. Springer and the three juveniles had multiple instances of attempting to look behind the mirror; and Coleus and the three juveniles showed used the mirror as a visual referent (see Table 4).

Table 2
Time Spent Near Mirror and Interacting with Mirror.

| Subject | Near mirror (within one body length) | Interacting with the mirror |
|----------|--------------------------------------|-----------------------------|
| Springer | 40 min 18 s= 17% | 6 min 32 s= 2.5% |
| Coleus | 35 min 57 s= 15% | 5 min 33 s= 2.5% |
| Kiazi | 104 min 51 s= 44% | 44 min 18 s= 18% |
| Kamba | 114 min 43 s= 48% | 54 min 43 s= 23% |
| Tamu | 40 min 30 s= 17% | 13 min 48 s= 6% |

Table 3
Frequency of Behavioral Events Across all Experimental Trials.

| Subject | Aggressive Behaviors | | | Social Behaviors | |
|----------|----------------------|--------------------|---------------|------------------|--------------------|
| | Lip smacking | Fixed gaze staring | Barking cough | Jumping/hopping | Licking the mirror |
| Springer | 2 | 2 | 0 | 0 | 0 |
| Coleus | 2 | 0 | 0 | 0 | 5 |
| Kiazi | 10 | 0 | 0 | 37 | 5 |
| Kamba | 20 | 0 | 0 | 94 | 0 |
| Tamu | 0 | 0 | 0 | 11 | 1 |

Table 4.
Frequency of Behavioral Events Across all Experimental Trials.

| Subject | Looking around/ behind the mirror | Using mirror to examine enclosure |
|----------|-----------------------------------|-----------------------------------|
| Springer | 4 | 0 |
| Coleus | 0 | 1 |
| Kiazi | 19 | 4 |
| Kamba | 15 | 14 |
| Tamu | 6 | 4 |

Discussion

The behavior of the black-and-white colobus monkeys did not appear to reflect the classification of either of the first two categories described in Table 1 (i.e., no interaction with the mirror and interaction without evidence relevant to MSR). Most of the interactions with the mirror fit into category 3, behaviors that did not support the MSR hypothesis. As a group, the black-and-white colobus monkeys consistently demonstrated

high levels of interest in the mirror, but displayed mostly aggressive and social behaviors toward the figure in the mirror. However, there were some behaviors recorded that supported the use of the mirror as a visual referent (i.e., category 4 in Table 1). Four of the five animals displayed behaviors that could be seen as evidence for using the mirror as a visual referent, which is a necessary precursor to self-recognition. Nonetheless, none of the animals exhibited any of the behaviors from the fifth category, that is those that would have demonstrated the use of the mirror as a visual tool for examining the self. The fifth category is the only category that provides clear evidence to support the MSR hypothesis. Therefore, these observations do not support MSR ability in the black-and-white colobus monkey. This conclusion is consistent with the pattern of results demonstrated in the literature: no species of monkey has clearly demonstrated MSR (De Veer & Van De Bos, 1999).

Black-and-white colobus monkeys also periodically demonstrated some measure of using the mirror as a visual referent. This was evident by the use of the mirror to view events and objects in the enclosure and the use of the mirror during play by the juveniles. There were multiple instances in which one juvenile would spot another approaching in the mirror and would turn to meet them before their arrival. Although the use of auditory cues cannot be ruled out, anticipatory turning behavior without mirror mediation is infrequent during play. Additionally, there is a microphone located in the enclosure to allow zoo patrons to hear communication between the animals. There was no noise apparent to human observers recorded on the videotapes that was created by the approach of another juvenile.

Although the majority of the evidence points to a rejection of the MSR hypothesis for the black-and-white colobus monkey, There is evidence that these animals may have some of the necessary precursors to MSR. This study introduces evidence that black-and-white colobus monkeys may understand that the mirror is a reflection of the environment. Using the mirror to obtain environmental information or participate in group interactions is one of the necessary preconditions of MSR. These results are similar to the finding that macaques and elephants, animals that have not demonstrated self-recognition, were able to use mirror cues to guide their searches for food (Anderson, 1986; Povinelli, 1989). This group of studies could imply that an ability to understand the duality of objects in the mirror and the environment is not limited to animals that have demonstrated self-recognition. Furthermore, this ability may be another step in the phylogenetic pattern to MSR.

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