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Science, New Series, Vol. 167, No. 3914 (Jan. 2, 1970), 86-87.

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studies (*1*, *8*) have employed broad band rather than monochromatic filters, and therefore do not test these predictions.

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10. We thank D. H. Hubel and T. N. Wiesel, in whose laboratory these experiments were done, for their advice and encouragement. We also thank D. Freeman, M. Francoeur, and J. Wiitanen for assistance. Supported in part by NIH grants NB 02260 and NB 05554, and by NIH special fellowships NB 1864 NSRA (A.L.P.) and NB 20241 VSN (N.W.D.).
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18 August 1969; revised 3 November 1969

Chimpanzees: Self-Recognition

Abstract. *After prolonged exposure to their reflected images in mirrors, chimpanzees marked with red dye showed evidence of being able to recognize their own reflections. Monkeys did not appear to have this capacity.*

When initially exposed to mirrors most animals with adequate visual sensitivity respond as if the image represented another animal. After prolonged confrontation with mirrors animals may learn to recognize their own images and cease to respond socially to the reflection, since this is what presumably occurs in man (*1*).

To test this conjecture two male and two female preadolescent chimpanzees (*Pan troglodytes*) with little if any prior experience with mirror-like surfaces were selected for study. All animals were born in the wild and their weights ranged from 14.75 to 21.75 kg at the beginning of the experiment. Each animal was placed by itself in a small cage situated in the corner of an otherwise empty room. After 2 days of isolation in this situation, a full-length mirror was positioned 3.5 m in front of the cage to provide for enforced self-confrontation. Observations of the animal's behavior were made by watching his reflection in the mirror through a small hole in an adjacent wall. After 2 days (8 hours each) of exposure to the reflected image, the mirror was moved to within 0.6 m of the cage and left in that position for 8 days, the total exposure time being approximately 80 hours.

Behavior (including social behavior such as bobbing, vocalizing, threatening, and so on) was sampled every 30 seconds and recorded in selected categories for one 15-minute session each morning and afternoon. Two observers recorded data and periodically compared results. The social stimulus properties of the reflected image are initially very much in evidence, but social responsiveness declines rapidly over a period of days (Fig. 1). Conversely, behaviors ostensibly directed toward the self with the aid of the mirror increase in all animals over a period of days (Fig. 2). Such self-directed responding took the form of grooming parts of the body which would otherwise be visually inaccessible without the mirror, picking bits of food from between the teeth while watching the mirror image, visually guided manipulation of anal-genital areas by means of the mirror, picking extraneous material from the nose by inspecting the reflected image, making faces at the mirror, blowing bubbles, and manipulating food wads with the lips by watching the reflection. In all instances of self-directed behavior, the self is the referent through the reflection, whereas in cases of social behavior the reflection is the referent.

The mean amount of time spent viewing the reflected self-image by all animals over the two sessions each day was recorded (Fig. 3). The increase in viewing time on day 3 was probably occasioned by moving the mirror to within 0.6 m of the front of the cage. But, it is at approximately this point that social responsiveness decreases and self-directed behaviors begin to emerge. This decline in social behavior accompanied by an increase in self-oriented behaviors supports a suggestion (*1*) that social responses would have to wane in order to be supplanted by self-directed responding.

In an attempt to add direct experimental support to the idea of self-recognition of the reflected image, animals were anesthetized with phencyclidine hydrochloride (Sernylan, 1 mg per kilogram of body weight), given an injection of atropine (0.5 ml), and removed from the cage after the 10th day of exposure to the mirror. With the animal unconscious, the uppermost portion of an eyebrow ridge and the top half of the opposite ear were then marked with a red alcohol-soluble dye (Rhodamine B base). When dry, the dye has virtually no olfactory or tactile cues, as determined by two experimenters applying the dye to their own skin and allowing it to remain for 24 hours. While anesthetized, the chimp was returned to the small cage and the mirror was removed. Approximately 3 hours after being anesthetized all ani-

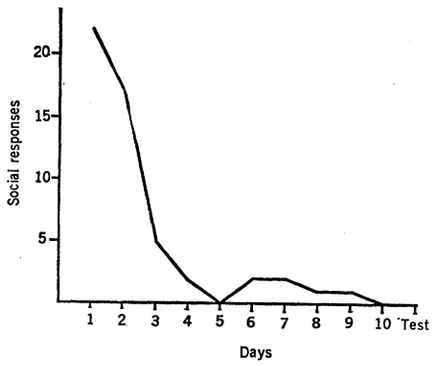

Fig. 1. Number of time-sampled social responses directed to the mirror image over days.

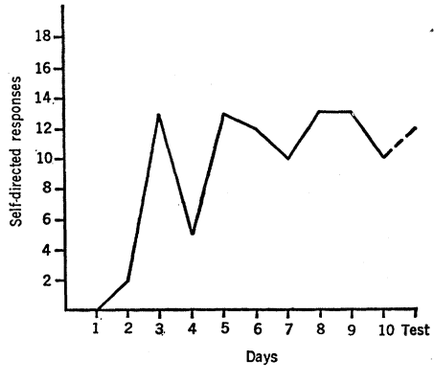

Fig. 2. Total number of time-sampled responses directed toward the self through the mirror reflection over days.

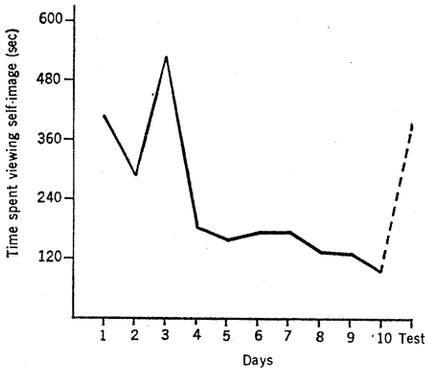

Fig. 3. Average amount of time, during two 15-minute sessions, spent viewing the reflected image in the mirror over days.

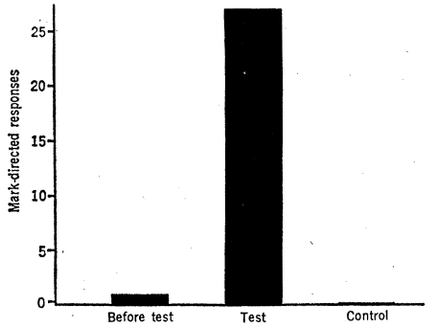

Fig. 4. Number of mark-directed responses made by experimental animals before being exposed to a mirror and by experimental and control animals during the test of self-recognition.

mals appeared to have fully recovered and were fed and watered. Four hours after having been marked, each animal was then directly observed for 30 minutes to determine the number of times any marked portion of the skin was touched spontaneously. The mirror was then reintroduced for a test of self-recognition at a distance of 0.6 m from the front of the cage, and behavior was monitored from behind the wall for an additional 30 minutes (Figs. 1–3).

The number of mark-directed responses went up dramatically upon reexposure to the mirror, as did viewing time (Figs. 3 and 4). During the test, the frequency of mark-directed responding per animal ranged from 4 to 10 as compared to only one response prior to exposure to the mirror, and viewing time increased over the previous two sessions by a factor of more than four. On occasion, mark-directed behaviors also took the form of direct visual inspection of the fingers which were used to touch marked areas even though the dye had long since dried and was not transferable to the fingers. In one particularly noteworthy instance there was olfactory as well as visual inspection of the fingers which had been used to touch marked areas.

As a further check on the source of these reactions two naive wild-born chimps, a male and a female, of approximately the same age as the previous subjects, but with no mirror experience, were also anesthetized, marked, and studied as controls. After they were marked and confronted the mirror for the first time, the controls made no mark-directed responses (Fig. 4), which indicates that the capacity for self-recognition had presumably been learned by the other animals sometime during the previous 10 days of exposure.

As a test for this capacity in other primate species, two male and two female adult stump-tailed macaques (*Macaca arctoides*; formerly *M. speciosa*) and two adult male rhesus monkeys (*M. mulatta*) were given prolonged exposure to mirrors in a comparable situation for 12 hours per day and tested in the same fashion as the chimps. Mark-directed responses were nonexistent in all animals after 14 days of mirror-image confrontation. Moreover, informal observation indicated little decline over days in the incidence of social behavior directed toward the mirror and virtually no evidence of self-directed or self-recognition patterns. As a further check, three male and one female preadolescent cynomolgus monkeys (*Macaca fascicularis*; formerly *M. irus*) were exposed for more than 250 hours to mirrors (3 weeks). Tests yielded uniformly negative results with, again, no apparent decrease in social responsiveness to the mirror image.

Such a decisive difference between monkeys and chimps is particularly interesting in view of the fact that most investigators have found only relatively slight quantitative differences on other, more traditional, behavioral tasks (*2*). Recognition of one's own reflection would seem to require a rather advanced form of intellect; it is known, for example, that at least some mentally retarded children apparently do not have the capacity to recognize themselves in mirrors (*3*). Moreover, insofar as self-recognition of one's mirror image implies a concept of self, these data would seem to qualify as the first experimental demonstration of a self-concept in a subhuman form.

Over and above simple self-recognition, self-directed and mark-directed behaviors would seem to require the ability to project, as it were, proprioceptive information and kinesthetic feedback onto the reflected visual image so as to coordinate the appropriate visually guided movements via the mirror. Our data suggest that we may have found a qualitative psychological difference among primates, and that the capacity for self-recognition may not extend below man and the great apes.

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4. Supported in part by NIH grant RR 00164 to the Delta Regional Primate Research Center. I thank M. K. McClure for help in data collection, W. A. Mason for helpful suggestions on preparation of the manuscript, and the Delta Regional Primate Research Center for the use of their animals and facilities.

10 November 1969

Lunar Surface Rocks and Fines: Chemical Composition

A critical examination of the chemical abundance data on 12 specimens of lunar surface material has led to several conclusions of remarkable geochemical and cosmochemical interest (*1*). It is indeed true that "The chemical composition of the Tranquillity Base fines and igneous rocks are unlike those of any known terrestrial rock or meteorite." Nevertheless, some abundance features appear to us to be distinctly eucritic.

Table 1. Average abundances of the major elements in eucrites and in rocks and fines from the Tranquillity Base.

Element	Tranquillity Base (% by weight)	Eucrite (% by weight)
Si	19.2	22.8
Fe	14.0	13.6
Ca	7.4	7.1
Al	5.9	6.7
Ti	5.7	0.47
Mg	4.8	3.9
Na	0.38	0.3
Cr	.36	.25
Mn	.27	.39
K	.11	.04