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THE QUESTION OF CONTINGENT IMAGE SELF RECOGNITION IN APES AND MONKEYS

by

SUZANNE CALHOUN

A dissertation submitted to the
Graduate Faculty in Psychology
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy, The City
University of New York.

1983

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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Abstract

THE QUESTION OF CONTINGENT IMAGE SELF RECOGNITION IN APES AND MONKEYS

by

Suzanne Calhoun

Advisor: Professor Robert L. Thompson

G. G. Gallup, Jr. and colleagues have repeatedly reported that the chimpanzee recognizes its own image after a few days' exposure to a mirror, while monkeys show no evidence of self recognition. Four chimpanzees were tested in a systematic replication of Gallup's procedure with video tape documentation. Two demonstrated self recognition. Two tested negatively: one, a four year old wild born; the second, a laboratory reared 13 month old. Neither animal exhibited social responding or 'contingency testing' to the mirror. It was suggested that dissonant social feedback from the mirror facilitates differentiation of the self. The two positive chimpanzees retained self recognition over one year without intervening mirror experience, strengthening the contention that what is probed by the Gallup test has characteristics in common with human self awareness.

A pigtail macaque failed to demonstrate self recognition despite 11 months of mirror exposure and tactile access to the mirror. Toward analysis of the failure of monkeys in tests of self recognition, an instrumental paradigm permitted pigtail macaques to respond for video monitor views of social stimuli or video noise ('snow'). In two experiments no statistical significance was detected in responding for views of a colony mate or video noise with or without prior 24-hour visual isolation from the colony. Another experiment modified the Humphrey and Keeble (1976) procedure to provide alternating views of another monkey, the subject monkey in present time, and video noise. Only duration of responding for video noise approached significance (p=.09). Factors considered as influencing the results included screen brightness, the qualities of video noise, use of black and white instead of color video, and the possible aversiveness of the social stimuli. In a control experiment, frequency of responding was determined in some large part by a manipulative tendency, but duration of viewing was differentially sensitive to the presence or absence of visual consequences on the monitor (p=.05).

DEDICATION

In memory of Edward J. Calhoun whose love of learning and joy in life were infectious.

To Camilla Davis Calhoun Giusti whose competence, concern, and gentle graciousness are an inspiration and a comfort.

To Earl D. Walker for his unbounded generosity, patience, and clarity of mind.

To Marcella Calhoun Radano for her resourceful, enthusiastic spirit; for her touching expressions of love and pride.

I am deeply grateful.

ACKNOWLEDGEMENTS

I would like to thank my Committee members, Dr. Robert L. Thompson, Dr. James Gordon, Dr. Martin Chodorow, and my outside readers, Dr. Emil Menzel and Dr. Gordon Gallup, Jr.

I think Dr. Gordon's concern with the technical aspects of the visual stimuli are an important and often neglected consideration in this area of research. I thank him for that perspective.

I especially thank Dr. Chodorow for a conversation a long time ago which helped generate and clarify many ideas.

Dr. Menzel's particularly astute, both specific and global comments were much appreciated.

Over the years Dr. Gallup's interest and encouragement of my work has been most gratifying. The breadth of his contribution is obvious throughout.

Dr. Robert L. Thompson, my advisor, has played a critical role in my graduate career. I could not have managed without his responsiveness to the difficulties of my personal situation. And I could not have learned as much had his tutelage been less demanding. I greatly appreciate his allowing me to begin this project when it was a considerable departure from his previous work. The

counterpoint was not always harmonious, but has been a source of intellectual growth for both, I think. I thank him, too, for his humor, his professionalism, and for hardly ever saying, "I told you so"! I am grateful to have had such a fine scientist and delightful person as a mentor.

I would like to thank many other faculty members and fellow students who were helpful in so many ways. They gave their time, ideas, space, equipment, muscle, encouragement, computer programs, etc.: Drs. Sheila Chase, George Gourevitch, and his wonderful monkey lab crew, Rosa Abreu, Su Boatright, Pat Zaleski; Drs. Mandriota, Moller, Rettig, Turkewitz, Chen and Houben. Dr. Karen Gravelle deserves special thanks for running my experiment so that I could take a needed vacation. I thank Roberto Bermejo, Barbara Forman, Molly Laird; my lab mates, Alan Fried and Pat Kenny, Merry Platt and Frank Roche. Special thanks are due Stewart Riegler who helped so much through the tedious initial stages of setting up equipment.

Dr. Bernie Karmel helped me understand 'video noise'. Very special thanks to Ray Nutkis and his crew in the Audio Visual Department at Hunter College, who through the years have been an enormous help. Mary Lou Canton was an invaluable assistant on Experiment I.

Dr. Elizabeth Muchmore and the staff at the Laboratory for Experimental Medicine and Surgery in Primates (LEMSIP) were always so helpful, I am most grateful to them.

I would like to thank Dr. Philip Paully for being so generous with his time, and for the loan of his tapes. Dr. James Deich was kind enough to try to unscramble the statistical questions we faced.

Jo Ben-Atar's help with the Reference section was a critical time saver.

I thank Susan Rae Peterson for the excellent typing, done with great time constraints.

Thomas Amorosi did a fine job with the illustrations with similar time limits.

I thank those friends and family members who took a particular interest in the vicissitudes of these years. Their concern and support have meant so very much.

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INTRODUCTION

At some level, recorded thought is the story of the explicit or implicit relationship the thinker had with him or her self and the place of that self perceived in its world. The delineation of an explicit idea of an individual of itself, some feel, is a relatively recent achievement in human history (Jaynes, 1977; Popper, 1977; Wilbur, 1981). Though today a very large sample of people would affirm that they know what a concept of self is experientially, the attempt to analyze it has usually resulted in adding another to the plethora of definitions. These are more or less valuable in a philosophical and metaphorical sense, but usually fail to increasingly specify meaning in scientific terms. Though there are certainly dissenters, at least there is considerable support for the idea that the ability to conceptualize oneself is a product of natural selection, and a central factor in human behavior.

Karl Popper (1977) stressed the process of individuation as a biological phenomenon.

> What is usually described as the unity of self, or the unity of conscious experience, is most likely a partial consequence of biological individuation--of evolution of organisms with inbuilt instincts for the survival of the

> individual organism. . . consciousness, even reason, have evolved very largely owing to their survival value for the individual organism. (p. 114)

William James (1890) in a chapter on "The Consciousness of Self" examined the existential self in great depth.

> The consciousness of Self involves a stream of thought, each part of which as 'I' can 1) remember those which went before, and know the things they knew; and 2) emphasize and care paramountly for certain ones among them as '_me_' . . . The nucleus of the '_me_' is always the bodily existence felt to be present at the time. Whatever remembered past feelings _resemble_ this present feeling are deemed to _belong_ to the same _me_ with it . . . This me is an empirical aggregate of things objectively known. The I which knows them cannot itself be an aggregate. . . It is a _Thought_, at each moment different from that of the last moment, but _appropriative_ of the latter together with all that the latter called its own. (p. 400-401)

One of the basic problems in dealing with the 'concept of self' is that it is inferential in any one but oneself. This is true as well of other common attributions, although the nature of this inference makes it particularly problematic to deal with. Conceptualizing one's self never quite comes within our grasp. The attempt is to represent the whole, but it is ever failing because we cannot conceptualize the perceiving agent (oneself) except fractionally. This does not keep us from at times having the experience of making our idea of 'me' or 'I' the object of our attention. Numbers of philosophers, psychologists, evolutionary biologists and many, if not most, people explicitly and/or, implicitly attribute to their fellow conspecifics the capacity to conceptualize themselves in this way. It is one of the central assumptions society makes in dealing with individuals after a young age.

Although there are important objections to even dealing with a 'concept of self' or 'self awareness' in scientific discourse, others assert that it is an acceptable area of inquiry. Griffin (1981) pointed out that pursuing inferences has been the basis for some of the most important work done in science; genes, electrons, quarks, and evolution are examples. Mental experience is, in some cases, the most compelling inference, Morgan's Canon not withstanding (Adams, 1928, cited in Griffin, 1981) .

Hilgard (1949) in his presidential address to the American Psychological Association stated that human motivation would be meaningless unless a 'concept of self' were adopted. He called for an experimental approach to the problem which would allow one to infer a concept of self from data open to the external observer. An organizing principle such as a 'self concept' or 'self awareness' has been advanced as a result of experimental work in human developmental and social psychology (Amsterdam, 1972; Duval and Wicklund, 1972; Kagan, 1981; Lewis and Brooks-Gunn, 1979).

The observed behavior studied in some cases was self recognition, specifically mirror or video image self recognition. Although not all these investigators are willing to or interested in making any inference of a self concept from evidence of self recognition, it is self recognition which has been most extensively explored in the larger context of self awareness or a self concept.

Visual Self Recognition in Humans

Understandably, early accounts deal with children. Darwin (1877) attributed self recognition to his nine-month old child when he would turn to a mirror as his name was called and say "ah." Preyer (1893) reported that his son could recognize his own reflection at 14 months simply because he showed evidence of recognizing his mother's image at that time. James Dixon (1957), who appears to have done the first systematic developmental study on self recognition, stated that on the basis of the child's repetitive activity during intense periods of watching the mirror, he would place mirror image self recognition at approximately six to seven months. Further, since he reported on twins among his subjects, one of whom had been given daily mirror experience and the other kept from all but accidental contact with mirrors, he suggested that the achievement was largely a question of maturation. No difference was attributable to mirror experience. Dixon stated that the behavior he observed, repeated observation by the child of a hand or foot in the mirror; opening or closing the mouth; lifting itself up or down while watching the mirror image, was interspersed with social play, i.e., responding as though it were another child in the mirror.

Lewis and Brooks-Gunn (1979) working with video, have reported self recognition at age nine months. There are methodological problems, but they have shown that infants of that age respond differentially, turning to objects intruded into the background of the video display when the image was their own in present time, and not turning, when it was the image of another child of the same age, sex and dress.

Using a different measure, investigators working with human children and animals have reported self recognition at a later age. The technique was arrived at independently by Amsterdam (1972) and Gallup (1970). Amsterdam's work with human infants and Gallup's with pre-adolescent chimpanzees and monkeys employed a similar acute dye mark test, though for reasons which will be clear, Gallup's method is stronger. Gallup preceded the dye test with a ten day period of observation. Amsterdam marked the child on the nose with rouge with little or no attempt at subterfuge, and placed the child in front of a mirror. If the child touched the rouge or specifically examined its nose, self recognition was presumed. The rouge in Amsterdam's test may have been scented and possibly visible on the nose. Gallup's procedure required that the animal be deeply anesthetized when the dye marks were put on one ear and eyebrow ridge. The dye was odorless and without tactile effects. A pretest followed during which the animal, not exposed to a mirror, was observed to determine whether there was any mark directed behavior. When the mirror was reintroduced, mark directed as well as other mirror oriented (MO) behavior was scored. Gallup emphasized the importance of behavior seen during the observation period in conjunction with that seen in the dye mark test.

Using the Amsterdam procedure, human children between 18 and 24 months have been shown to recognize that it is their own image in the mirror (Amsterdam, 1972; Schulman and Kaplowitz, 1977). In a 1978 article, Mans, Cicchetti and Sroufe reported that Down Syndrome children between the ages of 36 and 48 months could recognize their own image in a mirror, lagging normal children by approximately a year. Neuman and Hill (1978) using a video 'mirror image' and a modified Gallup procedure found that six out of seven autistic children tested at ages five-eleven years exhibited self recognition by the dye mark and other criteria. Other investigators have found that severely retarded adults, marked while asleep, showed no evidence of self recognition upon exposure to the mirror. On a subsequent test, they were asked to discriminate their own photograph in a group of three, and were unable to perform this task (Pechacek, Bell, Cleland, Baum, and Boyle, 1973). Traub and Orbach (1964), using a distorted mirror-image, reported a difference in mirror-image self perception by normal individuals and schizophrenics. The schizophrenic subjects were unable to adjust the distortion to match the investigator's perception of the subject.

Self recognition, measured by video or mirror image Gallup-Amsterdam type tests, gains credibility as an important indicator of cognitive functioning as a result of recent work done by Jerome Kagan and his colleagues (1981). They have shown that a constellation of behaviors, all of which seem to indicate that the child has come to an awareness of itself in a new way, emerge at the same time as self recognition. The behaviors Kagan points to in this context are (1) the emergence of normative standards, (2) affect appropriate to successful or unsuccessful modeling, (3) mastery smiles, (4) directives to adults, and (5) self-descriptive utterances.

Self recognition is one way to approach the evolution of consciousness or awareness in non-human species.

As problems of this nature are again receiving serious attention from philosophers and scientists, we are hopeful that advances in brain research technology will provide converging and collaborating evidence for the higher cognitive functions we infer from behavior.

Is it appropriate to extend the inference of a self concept to some other animals? Are the representational capacities of our nearest living evolutionary relatives, for example, such that in any meaningful sense, they might be able to conceive of themselves as an object? It is our opinion that, as Griffin (1976, 1981) has proposed, we should be willing to entertain the hypothesis that nonhuman animals are in ways analogous to our own awareness, cognizant of some of their own behavior and possibly of themselves. We have little doubt that animals with complex nervous systems can feel pain, can have some sense of contentment or pleasure, that they can direct attention to parts of their body. But what we are interested in probing is 'objective self awareness' as defined by Duval and Wicklund (1972). It is the capacity to direct one's attention inward; to make one's own consciousness an object of attention. Objective self awareness is the focus of attention on oneself as an object in the world; the state of delineating or differentiating oneself from the environment. If an animal can represent itself in some way to itself, if it can make inferences about itself, if it can recognize itself, we suggest with Gallup (1979), that the inference of a concept of self is appropriate.

> One of the unique features of mirrors is that the identity of the observer and his reflection are necessarily the same. Therefore, if you do not know who you are, how could you possibly know who you are seeing when you look at yourself in a mirror? The capacity to infer correctly the identity of the reflection presupposes a sense of identity on the part of the organism making that inference. (p. 420)

We are not in any way attempting to deal with the substance or content of a self concept or to go beyond the assertion that self recognition is one of the criteria by which one may infer a concept of self. To paraphrase James, is itself, however formed or constructed, among the thoughts the animal has? We suspect that our understanding of a concept of self is crude, and we are, as with all experimentation, constrained by our own technology and thinking as we devise tests for probing this ideation and assessing the results of our attempts. But we are hopeful that this line of inquiry will have the effect of elucidating some basic ideas we have only begun to examine with scientific methodology.

Mirror Image Self Recognition in Apes

Some non-human primates have been shown to recognize themselves in mirrors using Gallup's procedure. Chimpanzees recognize the source of the mirror image (Calhoun-Radano, and Thompson, 1979; Gallup, 1970; Gallup, McClure, Hill and Bundy, 1971; Hill, Bundy, Gallup and McClure, 1970); Lethmate and Dücker, 1973; Suarez and Gallup, 1981; Thompson and Calhoun, 1982). Lethmate and Dücker (1973) extended these results to organutans (as did Suarez and Gallup in 1981) but not to gibbons. Curiously, gorillas, despite some thorough testing have not been successful on the self recognition task (Ledbetter and Basen, 1982; Suarez and Gallup, 1981).

There are some interesting instances of negative results with chimpanzees. As a control, Gallup (1970) tested two wild born chimpanzees, a male and female of approximately the same age as the four that were positive. These animals were given the acute dye mark test without the 10-day period of prior mirror exposure. They made no mark directed responses. In another article, Hill et al. (1970) reported on a 20 month old chimpanzee reared from birth and largely limited to auditory and olfactory access to other animals. Before testing he was given one month of visual access to peers. During nine days of mirror exposure and the dye test, this animal showed no self directed and no mark directed responses. Eighteen month old twins, who were raised in the same manner, but given one month of complete access to one another were able to recognize themselves in a mirror.

Failure to Find Mirror Image Self Recognition In Monkeys

Numerous attempts to find mirror image self recognition in monkeys have been made using the Gallup test or modifications of it. Results are summarized in Table 1. No self referred behavior and no mark directed responses have been reported. An early part of this thesis work was conceived to explore the then untried possibility that, given more time and multimodal feedback, monkeys would recognize their own reflection. A mirror was placed inside the cage so that tactile input would be added to the visual and proprioceptive information available in previous test situations (Calhoun-Radano and Thompson, 1978). A study by James Anderson (1983) which was completed after our work, is the most comprehensive and convincing demonstration that the negative results obtained by various investigators are reliable. Anderson reared several stumptail macaques (Macaca arctoides) from shortly after birth through the first year with two mirrors inside their cages. They were, in addition, given 6 months of group exposure to a large mirror outside their cages. No mirror-mediated self directed responses were seen. In another experiment a large mirror was placed outside the cage of an adolescent macaque who was sequentially marked on different parts of its body, moving at two day intervals toward the head. By the end of the two-day period the previous test's dye had faded and the new dye was vigorously investigated. It was not until the marks were on the head where they could be seen only in the mirror, that they were not touched. Anderson stated that the monkey would, while investigating the body mark, often look at the mirror and the marks in the mirror. Again, only when the dye marks were put on the head did the monkey fail to touch them. In yet another, though less formal attempt, he tried to 'encourage' self recognition by putting an adolescent female stumptail macaque on his lap in front of a mirror. He conducted 21 daily sessions during which, for between 30-60 minutes, he tried unsuccessfully to train her to respond to the word "go" by touching her head. He also groomed her very explicitly while trying to keep her looking at the mirror a meter in front of them. After three weeks of this daily exposure, she still exhibited social responses to the mirror and showed no mark directed behavior when dye was placed on her head.

These and other negative results with monkeys are not apparently ascribable to the monkeys' failure to understand the reflective nature of the mirror. There is a great deal of informal opinion among primatologists that monkeys will turn around to view events seen in a mirror or to grab food. Tinklepaugh (1928) describes more controlled instances of these phenomena. Brown, McDowell and Robinson (1965) reported that their rhesus monkeys used information available only in the mirror to discriminate which cord to pull to get a food reward. The failure of monkeys at the self recognition task is not apparently due to a lack of interest in marks on the body (Anderson, 1983; Gallup, Wallnau, and Suarez, 1980). It is obviously not a question of lack of manipulative ability or hand-eye coordination. Mark directed or self referred behavior which utilizes mirrored information requires appropriate integration of visual and proprioceptive feedback. Though not all the data are consistent, the performance of monkeys on this type of complex cross-modal task is not far below the performance of chimpanzees (Cowey and Weiskranz, 1975; Dolgin, Premack, and Spelke, 1980). They can distinguish among monkey faces in photographs (Rosenfeld and Van Hoesen, 1979), respond differentially to different monkey and other animal species seen on video monitors (Humphrey, 1974; Faully, 1982; Swartz and Rosenblum, 1980) and use a mirror to guide their own behavior (Brown, et al., 1965). The literature attests to the varied and sophisticated capacities of monkeys. Their social lives are, to our eyes, comparable in complexity to that of the great apes.

Perhaps there is evidence here for punctate evolution of mental experience. If this is true it appears to contradict Griffin's (1976, 1981) expectation of evolutionary continuity. But this, we think, would be a misreading of Griffin. The basic argument is not that some mental experiences do not differ in different species, that there are no discontinuities, but rather, that in general, there will be important overlapping or continuity of mental experiences at least in closely related species. He suggests that it is time to explore the commonalities rather than the differences which have seemed to some so important to stress, often, he contends, as a bulwark against the implications of taking evolution seriously.

Gallup (1977) has interpreted the monkey results as indicating that they lack a cognitive category essential for processing information about themselves. They cannot recognize themselves in a mirror-image situation, because this achievement presupposes an already existent sense of identity on the part of the animal making the inference.

There is one line of physiological research which, as it is pursued further, might give some support to the cognitive category idea of Gallup's. Geshwind and colleagues have shown that there are anatomical temporal lobe asymmetries in descending order of magnitude in humans, orangutans, chimpanzees and gorillas. Monkeys, apparently, do not have these asymmetries (Le May and Geschwind, 1975; Geschwind and Levitsky, 1968). Temporal lobe asymmetries are very interesting because of the language and representational capacities in this area of human brain. On the other hand, Dewson, Burlingame, Kizer, Dewson, Kenney and Pribram (1975) have found differential memory capacities in left-right auditory association areas in monkeys. It appears that at the functional level there _are_ asymmetries in monkey brain. We are a long way from refined correlations, let alone any causal physiological evidence for the failure of monkeys at the mirror image self recognition task, but this line of research is relevant and bears watching.

The purpose of the chimpanzee and monkey mirror self recognition work presented in Experiments I-III was (1) to replicate and extend Gallup's 1970 work with wild-born and laboratory reared chimpanzees; (2) to test a 13 month old animal in order to begin to probe the age/maturational onset of consistent success at this task for chimpanzees; (only one very young animal was available at that time in the LEMSIP facility); (3) to improve on the physical arrangement of chimpanzee vis-a-vis mirror and observer to provide a clear and close up view of the animal's behavior and visual orientation toward the mirror; and

(4) to document the process with video tape. We were also interested in assessing the ability of chimpanzees to recognize their mirror image after a long period of no mirror exposure. In order to extend Gallup's findings for monkeys, a pigtail macaque was given a year of mirror exposure, which at the time the work was done was the longest period of exposure reported. In addition she was given tactile access to the mirror, a manipulation also not previously reported in any systematic study.

INTRODUCTION: PART II

Monkeys and Response Produced Visual Consequences

Whether or not monkeys have the neuronal substrate to have a complex representation such as that of one's self is outside the scope of this work. But if one allows monkeys the biological capacity, the next level of inquiry to which one might turn concerns the analysis of some social factors or intellectual skills which might throw light on the emergence and/or elaboration of the concept of self

Human self recognition and a self concept are generally considered to emerge out of complex social interactions (Cooley, 1902; Duval and Wicklund, 1972; Mead, 1934). Duval and Wicklund (1972) have suggested that certain interactions must take place in order for the child to differentiate itself as an object. The characteristics of these interactions are as follows:

> There must be another entity who has a differing point of view; the two different points of view must concern the same object. The child must be aware of the antipodal opinions simultaneously. If these three conditions are satisfied the child will realize that the other is not himself, thus beginning the process of self differentiation. (p. 43)

The necessary developmental work with animals has not been done, but some animal work has relevance. Hill et al. (1970) found that two chimpanzees given tactile contact with peers recognized themselves, whereas the one given only visual and auditory access to peers did not. Sackett (1965) reported large group differences between wild-born, lab-reared and isolated groups of monkeys in response to 13 categories of color slides which included views of monkeys with varieties of facial expressions and postures. Gallup and McClure (1971) found that, given a choice between viewing themselves in a mirror or looking at a conspecific, feral rhesus monkeys preferred to view conspecifics. In contrast, surrogate-reared animals (reared on artificial mothers) preferred to view the mirror. If the social context is critical to the development of a self concept, as inferred from self recognition, we need to begin to explore social stimuli with respect to preferences, reinforcing value and discriminability, as well as look more closely at the role of contingency in social interaction. Though the other modalities, particularly the tactile, are certainly of interest, the visual mode was the concern of this work.

In this context it is important to review briefly what evidence there is that monkeys will work to visually explore the environment; that in certain cases two dimensional stimuli are responded to as representational of the three dimensional object; that they discriminate social stimuli as such; and that they can distinguish individual exemplars of a species.

It has been established by many investigators that monkeys and chimpanzees will work to manipulate or visually explore the three dimensional environment; that they prefer to look at moving, animate objects, particularly other animals and conspecifics; and that they prefer to see them in a clear undistorted manner (Butler 1953, 1954, 1957, 1960; Harlow, Harlow and Meyer, 1950; Menzel and Davenport, 1961).

Butler (1961) and Butler and Woolpy (1963) were among the first to do a major investigation of visual stimuli presented to monkeys in a two dimensional medium. A paired comparison technique was employed to view motion, as well as static, pictures. Stimuli were presented in color and black and white; focused, unfocused; brightly or dimly lit. The most noteworthy result of this work was that the animals preferred the focused, correctly oriented stimuli, supporting the investigators' hypothesis that the subjects would respond to the two dimensional stimuli as representational of the three dimensional object. Further, of the wide range of stimuli presented, the monkeys preferred moving pictures of monkeys over monkey slides or other moving and still pictures. Redican, Kellicut, and Mitchell (1971) using rhesus subjects, showed that they would respond operantly to view slides of their own species in various communicative gestures such as lipsmacking, yawning, and threats. They spent more time looking at slides of juveniles lipsmacking, with a 'plain face', or yawning; the slides least responded to were those that contained an expression of fear or threat.

Video as a medium of stimulus presentation, though it has some drawbacks, gives a degree of flexibility not possible in another medium. In addition, it provides the opportunity to present an animal with its own image in the present, contingent condition and its own image in a past time, non-contingent condition.

Video displays of social gestures were first used specifically as information by Miller and his colleagues (Miller, 1967, 1971). The facial expressions of conspecific functioned as a discriminative stimulus for the subject monkey. The task for the observer animal was to respond appropriately either to get food or avoid shock, depending upon the facial expression of the 'actor' monkey. Socially reared monkeys were able to respond appropriately to the visual cues given by the 'actor' over the video monitor. Those reared in isolation could not successfully avoid the shock. In the later study Miller (1971) showed that the subject monkey could respond to specific individual 'actor' monkeys and disregard the facial expressions of those not designated 'actor' for them. This appears to be the first demonstration that a monkey would attend to and utilize images in the video medium. Humphrey and Keeble (1976) in a study that was quite ingenious in its conception but weak in design, showed that response duration to see a particular monkey on the video monitor was influenced by the opportunity for sequential comparison with another monkey. Pressing a lever produced an alternating blank screen and stimulus monkey, the stimulus condition remaining on as long as the lever was held down. Habituation to each of the two stimulus monkeys took place quite rapidly, but after 20 sessions of exposure to the second stimulus monkey, and upon presentation of the first monkey again, responding was longer than at any other time. Humphrey and Keeble's interpretation of this phenomenon was that the opportunity for sequential comparison gave individual stimulus monkeys greater interest value, measured as time spent watching the monkey's behavior. Presumably the information content of the stimulus becomes greater when it can be compared to other stimuli. In Humphrey's terms, the subject learns better how to perceive the stimuli presented. Rosenblum and Paully (1980) presented infant pigtail macaques with color video views of the infant's mothers, a familiar female and an unfamiliar female conspecific. Using vocalization and an approach-withdrawal measure, they showed that the infants vocalized significantly more to the mother, and that they went significantly closer to the video image when it was their own mother on the screen. Swartz and Rosenblum (1980) explored a variety of social stimuli using operant techniques. A still and moving image of conspecifics, a moving image of another monkey species and a tape of an empty chamber was shown. The most important result of this work was that the level of responding and mean duration of lever presses was considerably above that of previous reports with either slides or motion pictures, film or video. The mean duration of responding to the moving conspecific was significantly longer than for the other stimuli. There was, as is typical of this type of work, a great deal of individual variation in both the amount and pattern of responding.

In a dissertation which has recently come to our attention, Paully (1982) reported that four juvenile pigtail macaques required to discriminate their mothers (from whom they had been separated for two to three months prior to testing) from three unfamiliar adult female conspecifics, preferred to view the mother in 87.5% of the trials. The stimuli were presented on two large color video monitors located in a dark room, giving a relatively natural, lifelike impression.

While there are numerous questions of interest concerning the results of the studies mentioned, our central concern was self recognition and its potential place in the array of social stimuli. No one to our knowledge had presented a monkey with its own video image and compared it to its responses to another conspecific, and only one study has been reported making this comparison with a mirror (Gallup and McClure, 1971). In a comparative situation, a necessary step in the self recognition task must be differential responding to the image of oneself versus the image of another. It is of course not a sufficient step, as the monkey could simply prefer the image of one particular 'other' monkey which happens to be itself. We were interested in exploring whether a monkey would differentially respond for its own contingent image or that of another monkey in the video mode. To this end the subjects were tested under prolonged (ten days) social deprivation and given the possibility of viewing their own image, one of a colonymate, or a non-social stimulus. Preparatory to this study, the subject monkeys were given the opportunity to demonstrate a preference for viewing a video-taped colony mate and a non-social control. This preliminary work took the form of two studies, one in which the animals were not visually isolated from the colony before testing, and the second in which testing followed short-term isolation.

The first group of experiments (I-III) to be presented is the mirror image self recognition work discussed in the first part of the Introduction. The remaining work (IV-VII) was an attempt to approach the video image self recognition task from an operant perspective.

EXPERIMENT I

Mirror Self Recognition in Chimpanzees

For the purpose of systematically replicating and extending Gallup's (1970) work in which he reported that chimpanzees could recognize their image in a mirror as their own, four wild-born and two laboratory-reared chimpanzees were tested. Hill et al. (1970) have shown that chimpanzees of two years of age are capable of self recognition, and that even short term social 'enrichment' appears to have an effect on the performance of the self recognition task. Hill et al. found that one month of complete access of one chimpanzee with another facilitated self recognition in two subjects relative to one control subject. One of the subjects in the present experiment, Maho, a laboratory reared animal, was younger (13 months) than any animal previously reported. Having been housed since weaning at three months with a conspecific peer, it was considered that she might show an accelerated rate of development of the capacity to recognize herself.

In addition to the subject variables which extended previous research, there were apparatus changes which made observation of the responses of interest much easier. Videotaping was done to document the process. The general procedure followed Gallup (1970). There were two daily 15-minute observation periods during which a 30-second time sampling procedure was used to categorize behavior. Anesthetization and dye marking of the subject, as well as a pre-test control and an acute dye-mark test were then performed.

Method

Subjects. Six chimpanzees (Pan troglodytes) were tested, but for reasons explained in Footnote 1, only data from four will be reported. Two male animals, James and Barash, and two females, Mona and Maho, were used. James, wild born, was 3+ years of age and weighed 16.8 kg. Mona, also wild born, and 4 years, weighed 20.5 kg. Maho, laboratory born, weighing 7.0 kg was 13 months old. Barash, 3 years and 10 months old, laboratory born, weighed 16.4 kg.

At the time of the experiments the chimpanzees were housed at the Laboratory for Experimental Medicine and Surgery in Primates (LEMSIP), a facility of New York University in Sterling Forest, Tuxedo, New York. They were housed in individual cages in rooms containing at least eight other similarly caged conspecifics with whom they were in visual and auditory contact. The exception to this was Maho who, because of her age, was usually housed with another animal of approximately the same age. The chimpanzees were on a 12-hour light/dark cycle. Their diet consisted of standard lab chow and a variety of fruits and vegetables. Water was available on an ad libitum basis. Maho, the one year old was bottle fed milk six times a day in addition to having smaller portions of the solids described. The animals were in good health, their general condition considered excellent by the staff veterinarian. Behaviorally they were energetic, alert, and responsive to changes in the environment. Only Barash exhibited conspicuous 'abnormal' behavior, engaging in activity of a repetitive nature, rocking and stereotypic circling of the cage. Maho rocked occasionally.

The subjects were brought to the isolated experimental room in their home cage via a fork lift and placed side by side approximately 2 meters apart in the case of James and Barash, and 30 cm apart in the case of Mona and Maho. The males were tested at the same time and the females together at a later date. A plywood partition was placed between the cages of James and Barash, permitting auditory, but not visual contact. The plywood partition between Maho and Mona permitted them to be in visual contact through the mirror, but not directly. This was done for two reasons: 1) results of the previous experiment with James and Barash (completed before Maho and Mona were begun) suggested that mirror stimulation enriched by seeing one's self as well as the other animal might have facilitated self recognition, and 2) the LEMSIP caretakers requested that they be in visual contact, in order that the young Maho, previously housed with another animal would not be in complete visual isolation. In the arrangement with James and Barash, two virtually identical blinds, cameras, etc., were used at opposite ends of the experimental room.

Apparatus. All the work done with the chimpanzees was conducted with the same apparatus. The blind, a three-sided wooden structure, was constructed to support the one-way mirror, 78.6 cm x 78.6cm, as well as to 'house' the observers and video camera. It was painted flat black inside and out. A black felt drape covered the top and rear of the blind to keep light from entering the back of the one-way mirror. The mirror was in the middle of the front wall of the blind, making possible a full view of the chimpanzee from behind the mirror. This arrangement was particularly valuable in permitting clear observation of eye orientation of the subject animals. The blind was placed one meter from the cage, allowing the chimpanzee a nearly full view of itself, even when on the near side of the cage.

Two video systems were used: one, a Sony Video Camera (AVC-3260), a Sony Solid State Videocorder (AV-3650) and a Panasonic Video Monitor (WV-5400); the second, a Sony Video Monitor (CVM-920U). Each camera had a SONY TV Zoom Lens 1.1.8, f 12.5~75 mm. Sonocraft ½-inch black and white, 60-minute video tapes were used to record the sessions. A recycling timer signalled the 30-second time-sampling observations. Lighting for the video recording was provided by the incandescent house lights and two GE 150-Watt reflector flood lights.

Procedure. Replication of Gallup test. The subjects were housed for 24 hours in the experimental room with the blind in place and the mirror covered with opaque black cloth. The video equipment had been set up in the blind and the other equipment in the anteroom. For approximately 45 minutes before the experiment started each day, the extra lighting necessary for video-taping was put on, as was the 30-second timer.

After a 5-min. adaptation period with the observers in position in the blind, the mirror was initially exposed by pulling the cloth from over the mirror into the blind through a slot and baffle arrangement. The mirror then remained exposed 24 hours a day (effectively 12 hours a day, as the room lights were out for 12 hours) until the dye test on day 10 for James and Barash and day 12 for Mona and Maho. There were two 15-minute sessions daily, one in the morning and one in the afternoon, at which one, two, or three observers were in the blind. All of the sessions with James were videotaped, and selected sessions were taped of the other animals. Behavior was sampled every 30-seconds at the signal from the recycling timer. The subject's behavior at the time of the signal was scored independently by each observer on standard data forms (see Appendix 1). When only one observer was present, the camera was fixed in the most advantageous position, a balance between being focused closely enough so the eye orientation was clear and getting as much of the cage area in the picture as possible.

The 30-second time-sampled behavior was scored as mirror oriented (MO) or non-mirror oriented (NMO). Mirror orientation meant that the animal's gaze, however sustained or fleeting, was directed toward the mirror when the timer signalled. Mirror oriented was sub-divided into self-directed (self-referred), social, and other. Self-referred was defined as behavior in which the animal appeared to use the mirror to refer to its own body; such as watching the mirror while moving hands, tongue, mouth, or grooming parts visually accessible only by using the mirror. A behavior was not scored as self-directed unless the subject was, at the time of the 30-sec signal, specifically using the mirror. Social behavior was defined as mirror oriented behavior in which occurred the typical social repertoire of the species, as illustrated by van Lawick-Goodall (1968) and Berdecio and Nash (1981). This includes such postures and facial expressions as threats, bobbing, presenting, and observable physiological responses such as pilo-erection. 'Other' behavior was MO behavior in which there was little or no motor activity or behavior which could not be clearly identified as social or self-directed. The animals, particularly James, spent a considerable amount of time looking at the mirror while sitting, no other gross motor activity apparent.

The observational baseline segment of the study continued for nine days for James and Barash and eleven days for Mona and Maho. During those days, in order to assess any auditory or olfactory effect of the observers presence in the blind, four additional 15-minute sessions were added to the ongoing experimental sessions. The camera was placed in a fixed position, and the sessions occurred in an ABBA sequence, observers present first, for the regular session, and observers absent first, the regular sessions following. This procedure was used with James only.

On the test day following the observational period, the animals were anesthetized with Ketamine HCL (Vetalor, Parke Davis) in the amount appropriate for their weights, 5 to 7.5 mg/kg. One ear and the opposite eye-brow ridge were swabbed with an odorless red dye, Rhodamine B, dissolved in 70% ethyl alcohol. The solvent alone was used as a control on the subjects' non-dyed ear and eyebrow ridge. In the third dye test given Barash (Experiment IA) the 'dye' used on the ears was white Ko-rec-type Typewriter Correction Fluid, diluted slightly with 70% ethyl alcohol; Rhodamine B was placed on the right eyebrow ridge. The white 'dye' was used in the third test with Barash and the test with Maho and Mona as its visual salience was judged to be greater than that of the red Rhodamine dye against the skin color of these animals. After dye marking, the chimpanzees were returned to their respective cages. Three to four hours later, when the subjects had recovered from the anesthesia a pre-test was done. A black cloth had been put over the mirror while the animals were anesthetized. Though the mirror could not be seen by the subject, the subject could be seen with adequate clarity through the cloth. In the case of Maho and Mona, the partition between them was extended during the pre-test and dye-mark test so they were not in visual contact during this phase of the experiment.

The pre-test consisted of recording the behavior of the subject for 30 minutes. Any behavior directed to the dye-marked area was recorded. Following the pre-test, the mirror was exposed by pulling the cloth into the blind, as it had been on the first day of exposure. Any instance in which the subject touched the dye-marked area was recorded, in addition to scoring the behavior as described earlier in this section. The test period was 30 minutes. In view of unexpected negative results, Barash, the laboratory reared male, was given a second dye test on the following day.

EXPERIMENT IA

Extended Mirror/Social Experience

Sackett (1968) has suggested that defects in the development of laboratory reared rhesus monkeys (and, by extension, other nonhuman primates) are due to the fact that they have not had enough interaction with a sufficiently complex environment to support normal development. These animals prefer more simple stimuli than is appropriate at a particular age. Hill et al. (1970) allowed two year old lab-reared chimpanzees complete access to each other for a short period of time and this apparently facilitated self recognition. Just visual and auditory contact allowed another age mate did not. Though we could not give our subjects James and Barash complete access, we could provide auditory access, and visual access that was multidimensional, i.e., through the mirror and directly. It was hypothesized that longer and more varied exposure to the mirror might facilitate positive results on the dye-mark test in Barash.

Procedure. The subjects James and Barash were transferred to adjacent cages in their usual housing situation. The cages were approximately .5m apart, side by side, with a transparent Plexiglas partition between them. The blind containing the mirror was placed in front of their cages about 1 meter away. They could see one another in the mirror and through the Plexiglas. Although there were other animals in the room, they could not see the others in the mirror.

Six weeks after the initial dye testing, another dye test was performed on Barash using an alternative procedure. The unanesthetized animal was restrained in his home cage using the squeeze partition in the cage. With two experimenters working simultaneously in order to minimize cues to the animal, an eyebrow ridge was swabbed with Rhodamine B red dye; the opposite ridge with alcohol; both ears were painted with Ko-rec-type Typewriter Correction Fluid, which was diluted slightly with 70% ethyl alcohol. The cage was returned to its normal configuration, and the investigators returned to the blind. A 15-minute pre-test with the mirror covered was begun as in Experiment I. The acute dye test for self recognition was similarly attenuated to a 15-minute period.

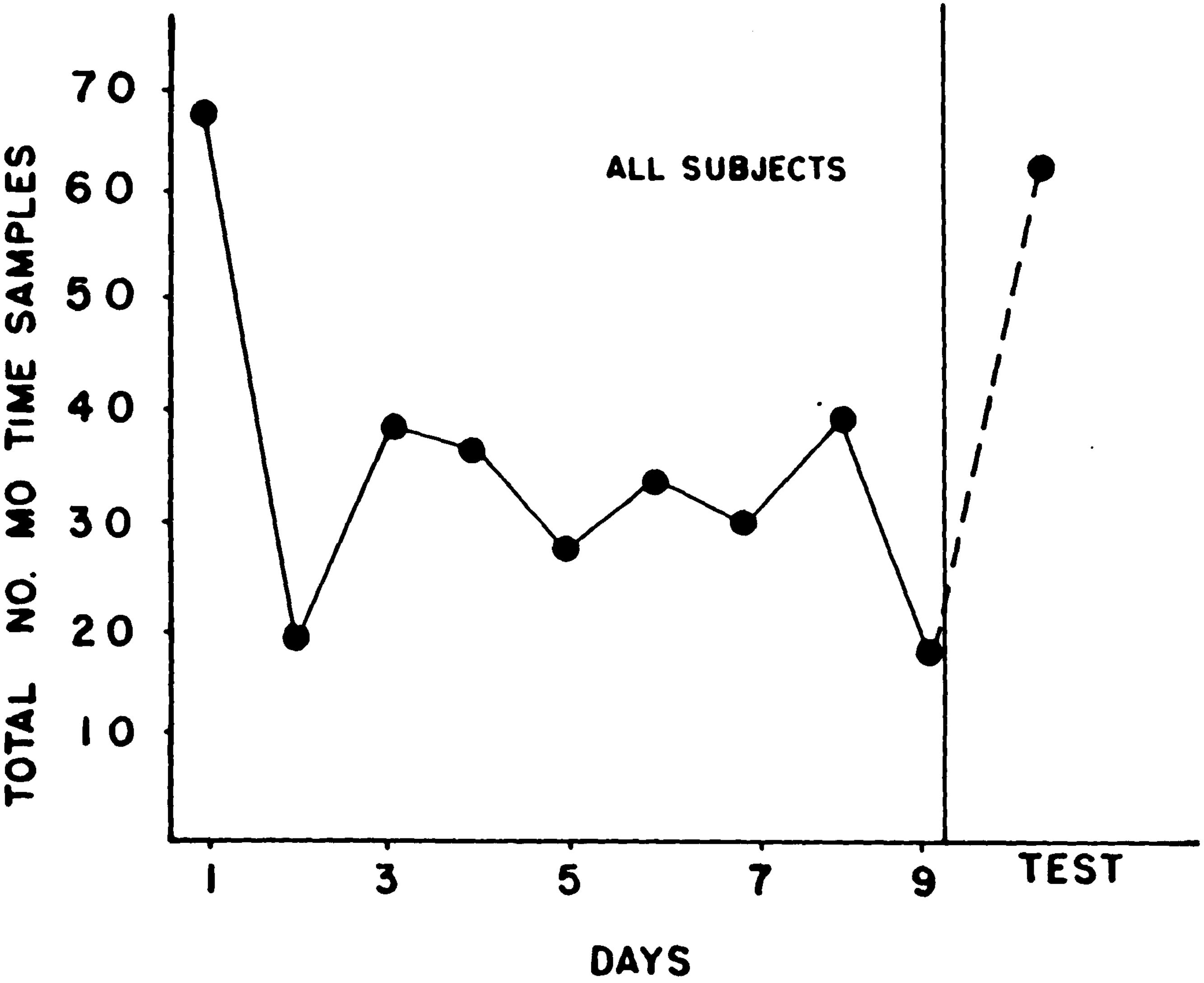
Results and Discussion (I and IA)

Observational Testing Period. Gallup (1970) inferred self recognition from three criteria: the emergence of self directed mirror oriented behavior during his ten day observation period prior to the dye test; an increase in time spent viewing the mirror image after the dye marks were put on; and, crucially, the occurrence of mirror oriented mark directed responses during the dye test.

Figure 1 shows the total number of mirror oriented time samples for the four subjects as a function of days of observation. On day 1, the novelty of the mirror occasioned frequent mirror orientation, and, for some subjects to be discussed below, social responding appropriate to the appearance of an unfamiliar conspecific (Gallup, 1968, 1970). After the first day, there was a decrement in MO responses as social responding declined. The increment on the third day was attributable principally to the initiation of self directed responding by James and Barash, and a modest (30%) increase in 'other' mirror orientation. Gallup (1970), Figures 2 and 3) also found increments in self directed responses and mirror viewing time on the third day of exposure. After the third day, MO behavior remained fairly stable. On the day of the dye test the total MO score rebounded nearly to the level of day 1, 61 MO time samples compared to 68 on day 1. Gallup (1970, Figure 3) showed a corresponding increase in his viewing time measure. Our time sampling procedure, recording behavior seen at each 30 sec signal,

FIGURE CAPTION

Figure 1. Total number of time samples showing mirror oriented behavior for four chimpanzees on successive days of exposure to mirror and on the dye test. Maximum possible score = 240.


ALL SUBJECTS
TOTAL NO. MO TIME SAMPLES
70
60
50
40
30
20
10
1
3
5
7
9
TEST
DAYS

though more conservative than Gallup's time measure, can be expected to correlate highly with it.

The MO time samples are also illustrated separately for James and Barash (Figure 2), the animals positive on the dye mark test,. and Mona and Maho (Figure 3), who were negative on the dye mark test. There were some procedural differences between these subjects and as such they are not strictly comparable. It was felt, however, that illustrating their different patterns of responding was relevant.

As may be seen in Figure 4, the level of social responding to the mirror was high (10 responses) on day 1, declined to zero on day 3 and was not seen after day 5, at which time James responded socially at two time samples. All of the social responding shown in Figure 4 was done by James and Barash. Neither Mona nor Maho made any social responses. They made only one self directed response each, whereas James and Barash combined, made 44 self directed responses during the observational period (Figure 5). Given Maho's age (13 months), it was not particularly surprising that there were no social responses and only one instance of a self directed response. The majority of human children do not

FIGURE CAPTION

Figure 2. Total number of time samples showing mirror oriented behavior in two chimpanzees positive on the dye test. Maximum possible score = 120.

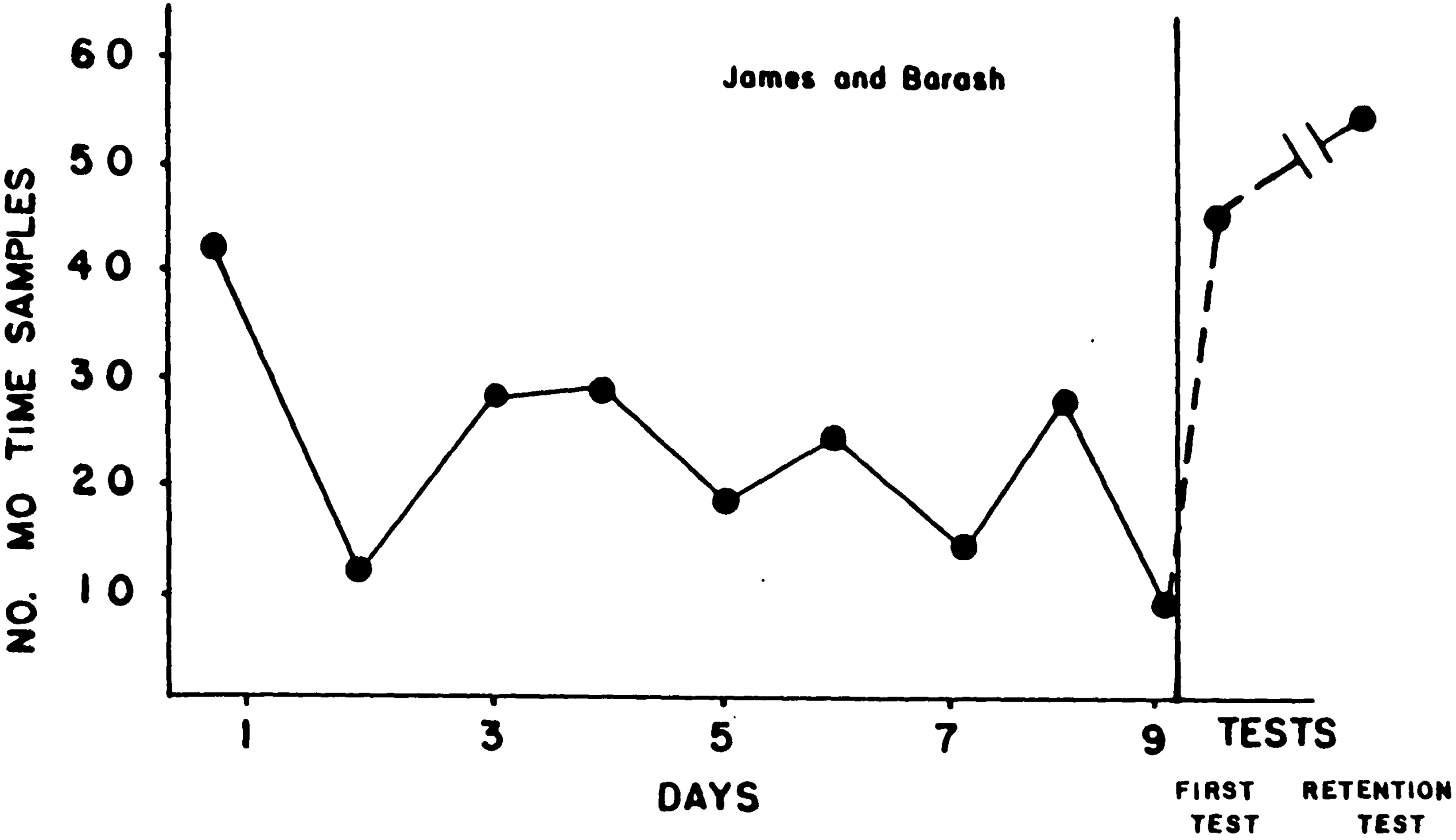

James and Barash
NO. MO TIME SAMPLES
60
50
40
30
20
10
1
3
5
7
9
TESTS
DAYS
FIRST TEST
RETENTION TEST

FIGURE CAPTION

Figure 3. Total number of time samples showing mirror oriented behavior in two chimpanzees negative on the dye test. Maximum possible score = 120.

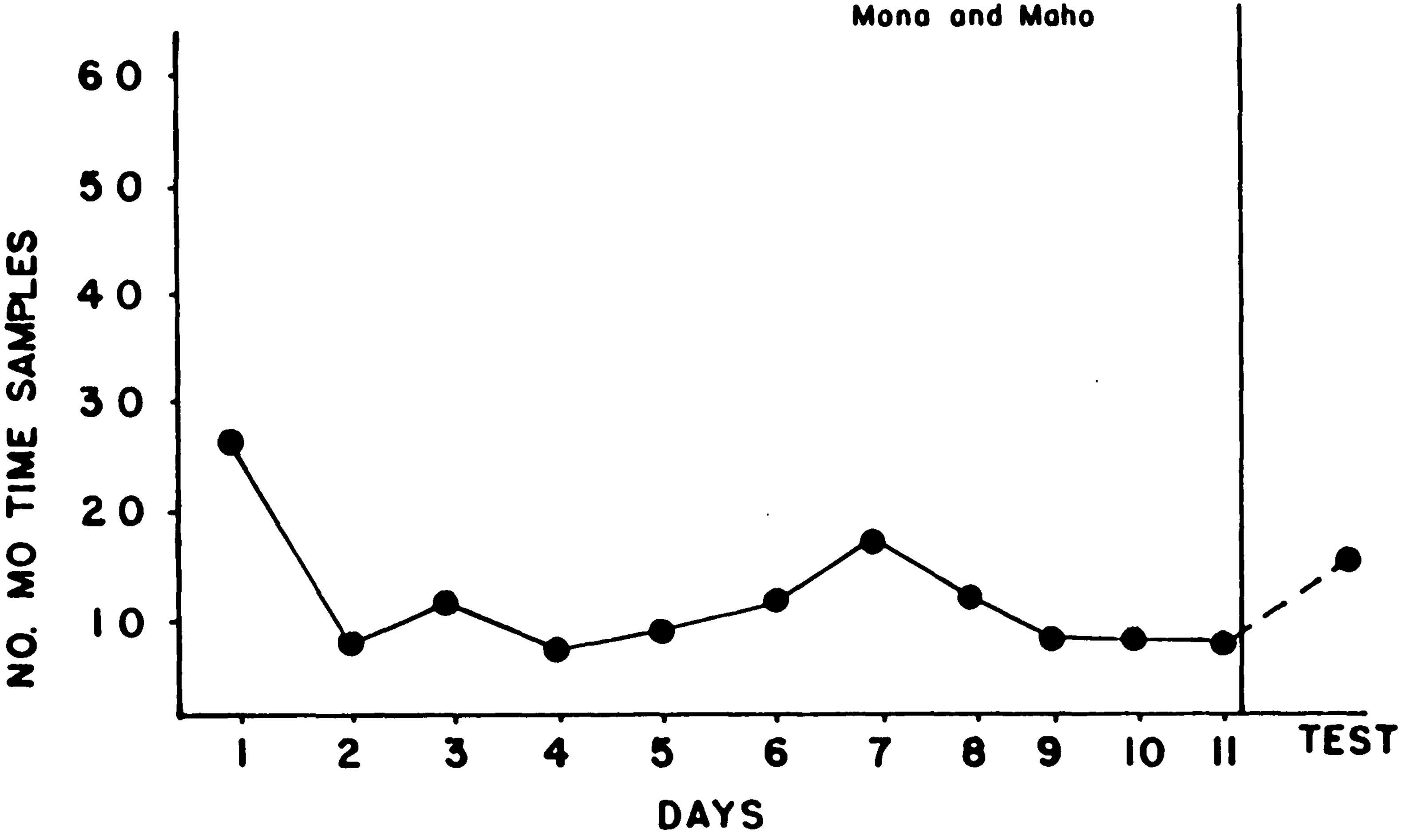

Mona and Maho
NO. MO TIME SAMPLES
60
50
40
30
20
10
1
2
3
4
5
6
7
8
9
10
11
TEST
DAYS

FIGURE CAPTION

Figure 4. Total number of time samples showing mirror oriented social responses in two chimpanzees, James and Barash.

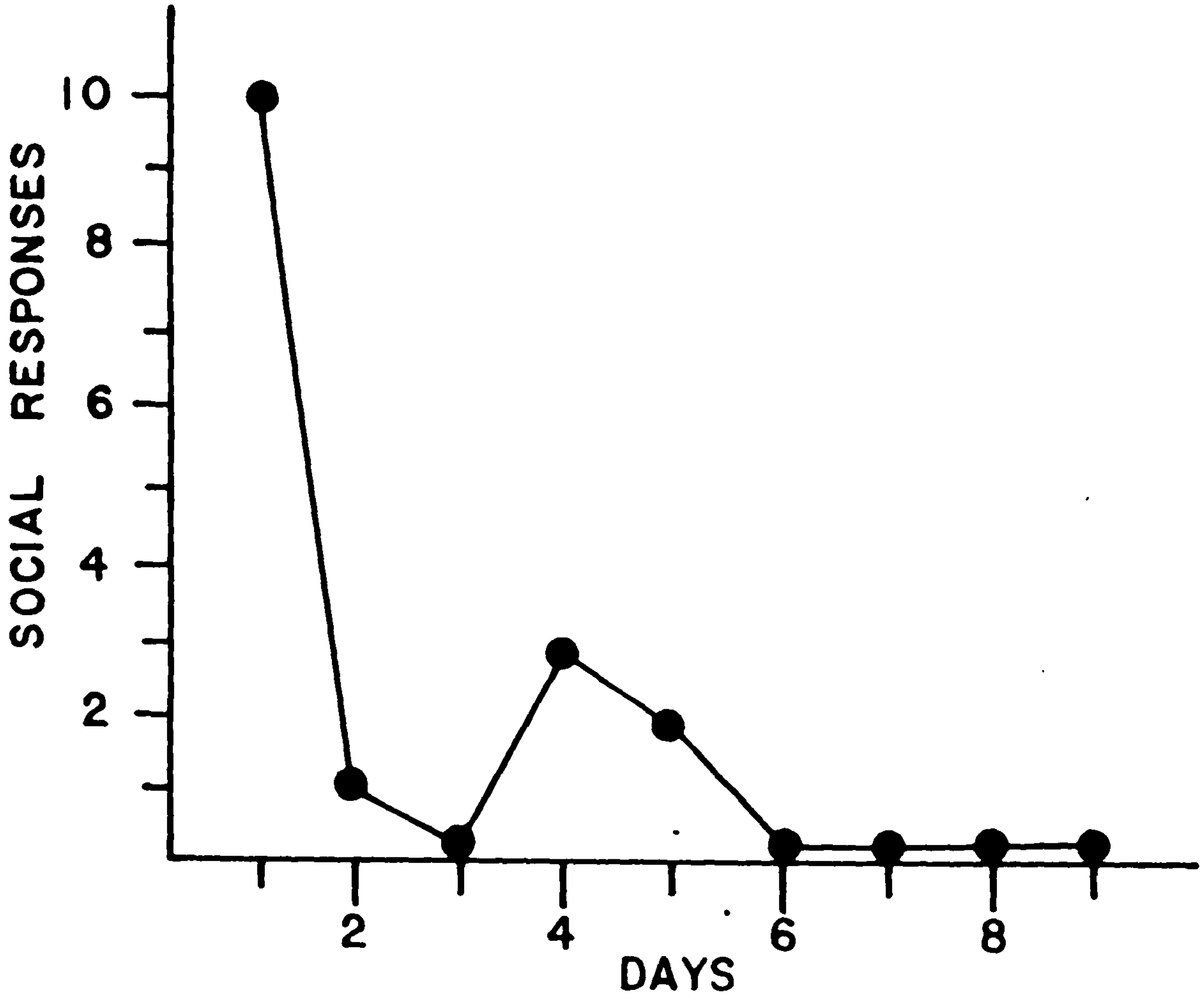
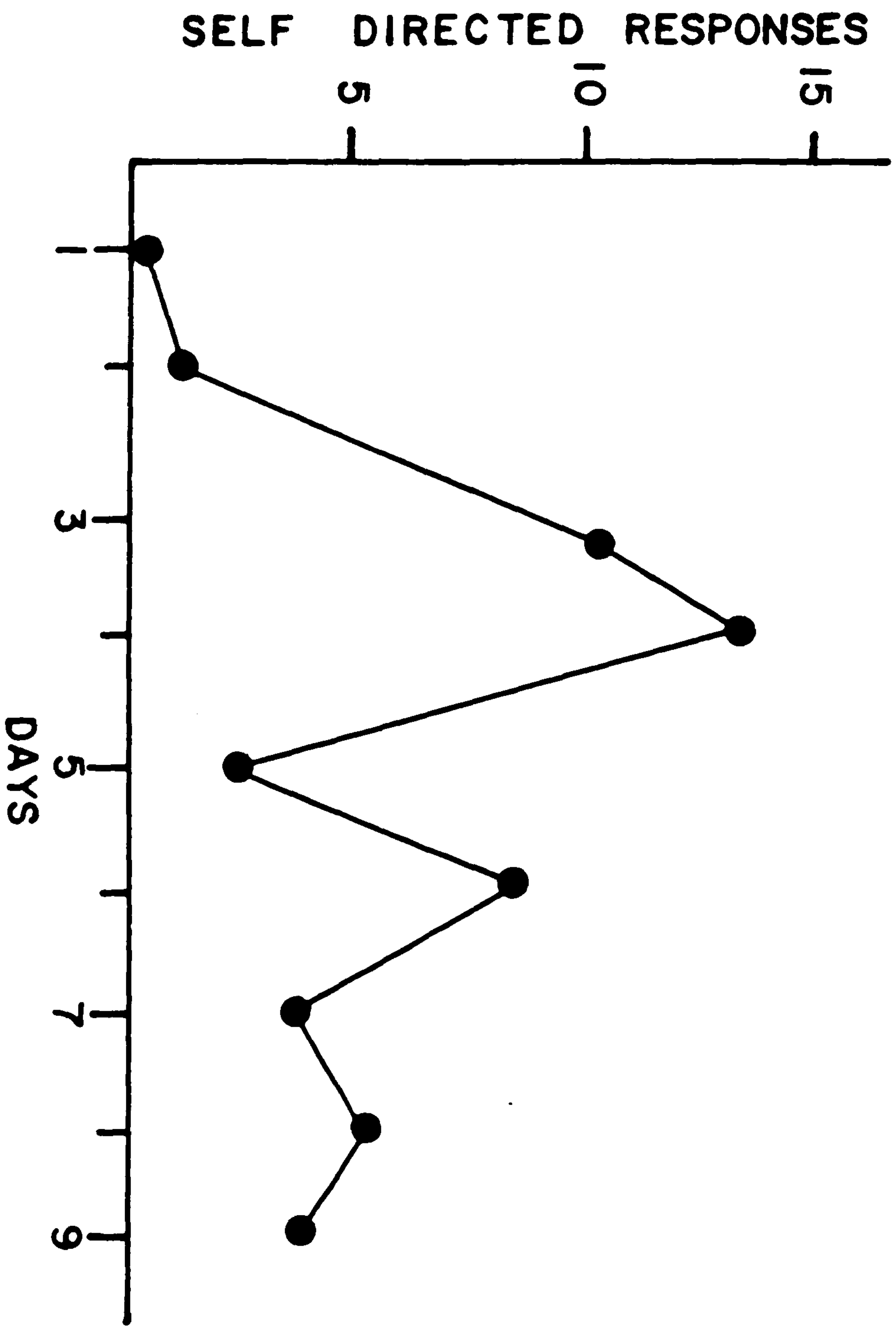

SOCIAL RESPONSES
10
8
6
4
2
2
4
6
8
DAYS

FIGURE CAPTION

Figure 5. Total number of time samples showing mirror oriented self directed behavior. Data from four chimpanzees, although two animals contributed only one response each over the nine days.


SELF DIRECTED RESPONSES
5
10
15
DAYS
1
3
5
7
9

recognize themselves by similar criteria until 18-24 months (Amsterdam, 1972). The results with the wild-born four year old, Mona, on the other hand, were puzzling. The fact that there was no social responding from Mona is suggestive of why she made only one self directed response.

The theoretical position that self awareness or a concept of self emerges out of social interaction, particlarly of a dissonant nature (Duval and Wicklund, 1972) might be logically extended here to suggest that social responding to the mirror is necessary, though not sufficient, for an accurate assessment of the mirror image to emerge. For example, one might suppose Mona would come to understand the source of the image, given her age, results with other like aged females (Gallup, 1970); and a 'normal' social history (she was a wild born animal). In order to come to that understanding, however, she must interact with the mirror in ways that make apparent the contingency inherent in the situation. Social behavior directed toward the mirror would seem to provide both the contingency information and the quality of conflict or dissonance which Duval and Wicklund (1972) suggested is necessary at the level of self concept acquisition. The mirror image does not respond in a normal way when the animal makes a social gesture. Animals do not mirror each other in social encounters, instead there is a dialogue of gestures. At some point in the mirror image interaction, some chimpanzees seem to apprehend the inappropriateness of this exchange. Upon reaching that point, the chimpanzee is potentially 'forced' to entertain other hypotheses about the image. Our own socially inexpressive Mona, and the isolation-reared chimpanzees in Gallup et al. (1971), not having responded to the mirror socially, did not have the opportunity to perceive the peculiarity of the social 'exchange'. It may of course be that these animals, as a result, perhaps, of insufficient social experience, did not bring to the mirror image situation the pre-existing sense of self deemed necessary for success at the self recognition task (Gallup, 1977b). We suggest that it is important to separate the self recognition task into two aspects. If an animal does not respond socially to the mirror and does not make self directed or mark directed responses, the presumption should not first be that it lacks a sense of self. Rather the first level of analysis should be whether the animal's behavior vis-a-vis the mirror was sufficiently elaborate that it had multiple opportunities to experience both the contingency relationship with the image, and the anomoly of the social exchange. Only after some judgment is made at the first level should one consider the question of whether or not the animal has brought to the situation some pre-existing sense of identity.

Dye Mark Test. Chimpanzee James was positive on the first test. He made two mark directed responses. The initial mark directed response was followed by his putting the finger used to touch the mark to his nose, appearing to smell it. Gallup (1979) has reported the same behavior. During the dye mark test, James responded socially six times. This is potentially of interest, given the positive results of the dye mark test. We, however, think the reason for the resurgence of social behavior is attributable to a rather mundane artifact. The black cloth that was placed over the mirror for the pre-test (permitting observers to see the animal, but not allowing the subject to see the mirror) was pulled into the blind very quickly and made a snapping noise at it was pulled. The animal was suddenly exposed to the mirror and, of course, the image of a chimpanzee. The animal appeared frightened, there was piloerection and a high level of activity and vocalization. James ran through a number of threat and submissive social gestures. Four of the six social responses were within the first three minutes of the session. This represents a more concentrated cluster of social responding than we saw in any of the observations. The puzzling juxtaposition of social and self-referred responses during the dye mark test was, we suggest, artifactual.

Barash was negative on the first and second dye test but positive on the third test (Experiment IA) which was done after a six week period of socially enhanced mirror exposure. He made five mark directed responses, one of which was a manipulation of the dye marked ear for about 5 sec while staring at the mirror. The third test, given as it was, without anesthetization, and with the application of both Rhodamine B dye used in the first two tests and the new white typewriter correction fluid, is not strictly comparable to the other dye mark tests, but it turned out to be the most clearly defined occurrence of mark directed behavior. There is no reason to believe that Barash could not see the Rhodamine B dye, to the observers' eyes it was salient on the animal's skin, but the fact is that all of the five mark directed responses made during the third test were made to the white marks. Thus we are left uncertain about whether the extended and enriched social mirror exposure during the six week interval was the facilitating factor, or whether the apparently heightened salience of the white as compared to the red dye was the crucial variable. It should be recalled here that the profile of Barash during the observation period was that of an animal we would expect to be positive on the dye mark test. As Gallup (1982) has pointed out, the self recognition test is not just the acute dye test, but the pattern of responding that is seen in the observational period, in conjunction with positive results on the dye test that draws a convincing picture.

Neither Mona nor Maho made mark directed responses. Maho, the 13 month old, gave no indication that there was any awareness of the altered image in the mirror. Her apparent obliviousness to the dye marks is reminiscent of monkeys' indifference in the same situation. Mona, on the other hand, spent as much time (by time sample measures) viewing the mirror as she had on the first day of exposure. It seems reasonable to suggest that she noted the alteration in the image, a plausible intermediate step between no response to the altered appearance of the image and recognition of it as an image of oneself. Without further testing, it can be only a tentative suggestion.

An informal review of the video tape done as a control for assessing the possible effect of the observers' presence in the blind revealed no obvious differences in the subject's behavior whether the investigators were or were not present in the blind.

EXPERIMENT II

Long Term Retention of Mirror Image Self Recognition

Gallup (1970) reported that two chimpanzees who had not been exposed to a mirror prior to the dye mark test were not successful on the test of self recognition. It is apparently during the observational period, when the animal has the opportunity to explore the situation, that chimpanzees learn that the mirror image corresponds to their own body. The pre-dye mark period is typically ten days, but it appears that four days are adequate (Suarez and Gallup, 1981). Once acquired or manifest, is the behavior indicating self recognition retained, or does it resemble other laboratory-learned complex discrimination tasks, e.g., cross-modal problems, that fade from memory when no longer exercised explicitly? If self awareness is a building block for the continuing elaboration of a repertoire known as 'mind' we would expect it to be a continuing property of the individual.

In human children the apprehension of the idea of self is a developmental phenomenon, which in the normal course of events is enriched and elaborated as the developmental process continues (Dixon, 1957; Duval and Wicklund, 1972; James, 1890; Kagan, 1981). If animals who had been positive on the self recognition test were to retain that capacity over a long period of no mirror exposure, it would bespeak a more solid conceptual achievement than if it were a task that they needed to re-learn each time they were exposed to a mirror image.

With a view toward substantiating or not the long-term retention of self recognition in chimpanzees, the following experiment was done.

Method

Subjects. James and Barash, two of the chimpanzees used in Experiment 1, were tested one year later for the retention of mirror image self recognition. During the year they had been housed in the quarantine section of LEMSIP, where they were subjects in a viral hepatitis study. This disease is asymptomatic in chimpanzees. Upon release from the study, they were declared in good health. We tested them the day after release from quarantine. Their diet and essential elements of housing, cages, etc., were the same in the quarantine unit as described in Experiment I . The difference was that the unit restricted human traffic. The declaration by the caretakers that the animals had had no mirror experience during the year can be accepted with confidence.

Apparatus. The apparatus was the same as used in Experiment I. The physical arrangement of the cages was the same as that used with Mona and Maho during the dye test with the exception that the partition in this case was an opaque black Plexiglas rather than a wood divider. There was no visual contact of the animals with each other during the test.

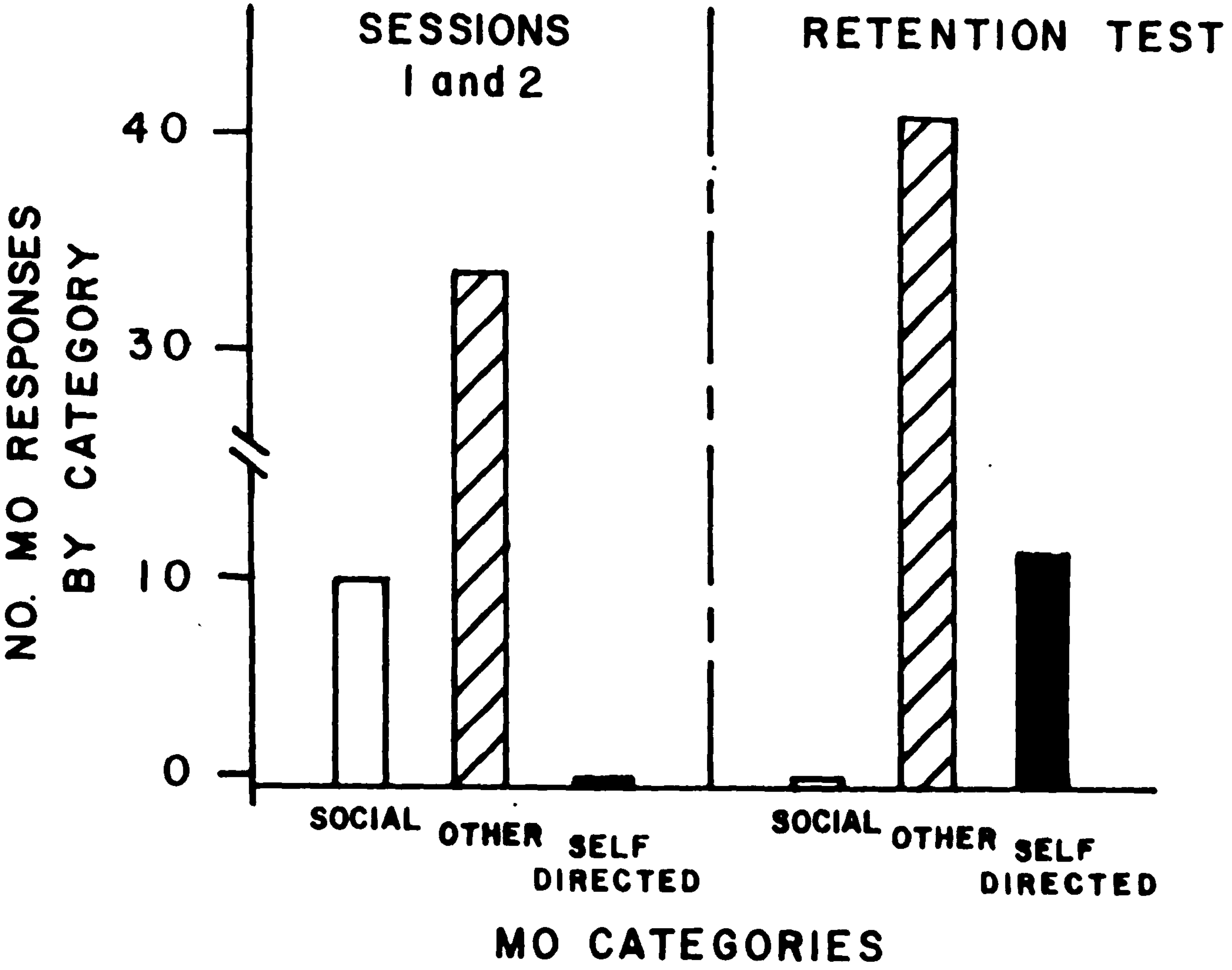
Procedure. The nine-day period of mirror exposure that these animals had had a year before was, of course, not repeated. They were fork lifted to the experimental room in their cages, anesthetized without any mirror exposure, and dye marked as in Experiment I. Ko-rec-type Typewriter Correction Fluid was used. As there was only one observer, the video camera was in a fixed position. The session with Barash was successfully videotaped, the following session with James was not. As in Experiment I, after recovery a pre-test was done to control for mark directed behavior which was not mirror mediated. The mirror was then exposed as in Experiment I and the dye mark test followed during which the observer recorded all mark directed responses as well as scoring the behavior of the subject using the 30 sec time-sampling technique. At the conclusion of the test the animals were returned to the colony room.

Results and Discussion

Figure 6 compares the mirror oriented responding of chimpanzees James and Barash on the retention test, after one year of no mirror exposure, with their responding during the first two sessions of exposure one year earlier. During the retention test there was no social responding. The number of mirror oriented 'other' responses sampled at 30 sec intervals for 30 minutes was higher than on initial exposure: James 13 versus 9; Barash, 26 versus 23. The number of self directed responses (other than mark directed) totalled 12, James contributing 7 and Barash contributing 5. Gallup's 1970 data showed a mean of 3 self directed responses per animal on the first dye test, while our observations indicated 3.5 on the comparable occasion. Each of the subjects made 2 mark directed responses not included in the self directed category. (Mark directed responses are recorded whenever observed, self directed responses are counted only when they occur at the time sampling signal.) The numbers convey only partially the very high level of interest in the mirror. Barash, particularly, happened upon information which was the focus of a great deal of MO behavior. He was in the process of getting his permanent dentition, and at one point he appeared to notice the spaces in his mouth. He came forward to the mirror, opened his mouth wider, stuck his finger and later his tongue in the spaces, backed away, came forward again, turned away, and vocalized repeatedly. He seemed highly aroused and the combined facial expression and vocalization possibly indicated distress (van Lawick-Goodall, 1968). This elaborate interaction with the mirror seemed to this writer to be a singularly dramatic demonstration that Barash recognized his own image in the mirror. The evidence from these two animals indicates that mirror self recognition was retained over one year without practice and is consistent with the attribution of some sort of concept of self in the chimpanzee.

FIGURE CAPTION

Figure 6. Retention of mirror image self recognition by two chimpanzees, James and Barash, after one year of no mirror exposure. The left panel shows total number of time sampled observations of mirror orientation by categories on session 1 and 2, one year earlier. The right panel shows these time sampled observational categories in a 30-min session following dye marking one year later.


SESSIONS
1 and 2
RETENTION TEST
NO. MO RESPONSES
BY CATEGORY
40
30
10
0
SOCIAL
OTHER
SELF DIRECTED
SOCIAL
OTHER
SELF DIRECTED
MO CATEGORIES

EXPERIMENT III

Mirror Mediated Behavior in a Monkey

Monkeys have been consistently negative on the Gallup test of self recognition (Table 1). Gallup (1970) tested four Macaca arctoides and two Macaca mulatta in a situation comparable to the chimpanzee experiments. After 14 days no self referred behavior was seen, nor were there any mark directed responses seen during the dye test. Another crab-eating macaque was negative after five months of mirror experience (Gallup, 1977a). In addition he tested four Macaca fascicularis for three weeks with similarly negative results. Gallup, Wallnau and Suarez (1980) used mother-infant and infant-infant pairs of rhesus monkeys. Though these investigators found a high level of interest in the marks when applied to areas they could see without using the mirror, and there were some differences in the type of responding done by adults and infants, no self referred behavior developed over 14 weeks of exposure. Benhar, Carlton and Samuel (1975), using the Gallup procedure as well as specific training procedures designed to teach baboons to recognize themselves in mirrors, were not successful. As shown in Table 1, many other simian species were tested with the same negative results. James Anderson (1983) has recently reported that even after exposure from birth to 18 months, no mirror oriented self referred behavior is observed, nor does prolonged specific training change the negative outcome.

When work for the following experiment was done, there had been no reported long-term mirror self recognition study done with monkeys, nor had there been any study in which monkeys were given tactile access to a mirror. The experiment we did was based on the hypothesis that tactile experience with a mirror would provide substantial information that could facilitate the acquisition of self recognition, and that, given a negative result on the first dye test, a substantial extension of exposure time would promote a change in that result. The successful learning of cross-modal discriminations by monkeys was taken as a promising indication that tactile experience with a mirror should be provided as a ready sequel to other studies of monkeys and mirrors.

Method

Subject. The subject was a female pigtail macaque (*Macaca nemestrina*), Niko, approximately five years of age at the time of testing. She was born in the wild and had been part of the Hunter College monkey colony for about three years. Her general health and condition were considered excellent. Her weight was 5 kg and she was sexually mature. The Hunter College colony consisted of eight to ten conspecifics, all of whom were purchased from Primate Imports, Port Washington, N.Y. All animals were wild born and captured at some time in their second year. Each animal was housed separately in cages considered standard for the species. Diet consisted of daily feedings of approximately 16 Purina Monkey Chow pellets and a weekly variety of fruits and vegetables. Water was provided either ad libitum from bottles on the cage or from the water system that was controlled so that water was available for a few hours a day. The colony light/dark cycle was not regulated, but in general the room lights were on from 9 a.m. to 7 p.m. There were several windows, which, though shaded, allowed some natural light. The arrangement of the room is such that each animal was in visual contact with most of the animals and in auditory contact with all of the other animals in the colony. During the experiment, the subject's food and water schedules were maintained as described. A plywood partition with peepholes was placed approximately .5m from the side of the cage. This functioned as a means of concealing the observer(s) during the experimental sessions and as a way of limiting the monkey's visual access to only two colony mates. We expected that this moderate restriction of her visual field would encourage orientation toward the mirror. Although there is no way to be absolutely sure she had had no previous experience with a mirror, it is a relatively safe assumption.

Apparatus. A circular 30 cm diameter polished chromium-brass metal mirror which gave a clear, undistorted image was used. The placing of the plywood partition at approximately 0.5m from the side of the cage, permitted a full view of the cage through the small observation holes.

Procedure. The subject was removed from her cage and the mirror attached to the inside of the bars at the back of the cage. The mirror was covered with a cloth. Three observers were positioned behind the plywood partition. When the monkey was returned to her cage, the cloth was slowly pulled from over the mirror. Observations were made by each observer for a period of 15 minutes. The observations focused on the facial expressions of the subject, though general posture and movement were taken into account. The classifications used by van Hooff (1967) were used. The mirror was left in the cage for the next 13 days. The procedure during the observational period was as follows: the subject was observed by the experimenter each day for two 15-minute periods separated by not more than ten minutes. During the observation period every 30-sec interval was considered as a single unit. If there was mirror oriented (MO) behavior during the 30-sec period it was described, but regardless of how many mirror orientations took place during the 30-sec period, it was scored as one unit of MO behavior. This gave a conservative measure of MO activity and eliminated effectively the problem of defining what a single unit of behavior consisted of. Any behavior judged to be mirror oriented was classified as either self directed, or social/neutral. Self-referred behavior was defined as a use of the mirror as a tool to visually aid in examination, manipulation, cleaning or grooming of the subject's body. Social/neutral were those behaviors directed toward the mirror such as looking into it, touching it, posturing or grimacing at it, or attempting to look or feel behind the mirror. The choice of a 'social/neutral' category rather than just a 'social' one used by most authors, was a somewhat more inclusive way of characterizing such MO behavior as gazing into the mirror, etc. 'Neutral' as used here is the same as the 'other' categorization in Experiments I and II, but in contrast to those experiments it was not treated separately. The number of times the subject touched her eyebrow ridges or ears was recorded whenever observed. At the end of each observation period the mirror was cleaned.

On day 14 of the experiment the monkey was anesthetized with phencyclidine hydrochloride (Sernylan), 1 mg/kg of body weight. She was removed from the cage when deeply anesthetized and her right eyebrow ridge and left ear were painted with red dye, Rhodamine B in 70% ethyl alcohol. As a control, her left eyebrow ridge and right ear were swabbed with the alcohol solvent used in preparation of the dye. The mirror was removed from the cage and the subject put back to recover. The following day the monkey was observed for a fifteen minute period by two observers. The number of times the eyebrow ridges or ears were touched was scored. The monkey was then removed from the cage and the mirror replaced. When she was put back in her cage, a fifteen minute observation period began. The number of mirror oriented mark directed behaviors were recorded.

The mirror was left in place for a period of 11 months, during which informal observations were made of the type of mirror oriented behaviors that appeared. The mirror was then removed.

After a hiatus of approximately one year, Niko was exposed to a large mirror (76 cm x 76 cm) mounted in a blind. (The blind and mirror were those used in Experiment I). A 0.5 hour video tape was made of her response to the new mirror situation. The mirror and blind were removed after video taping.

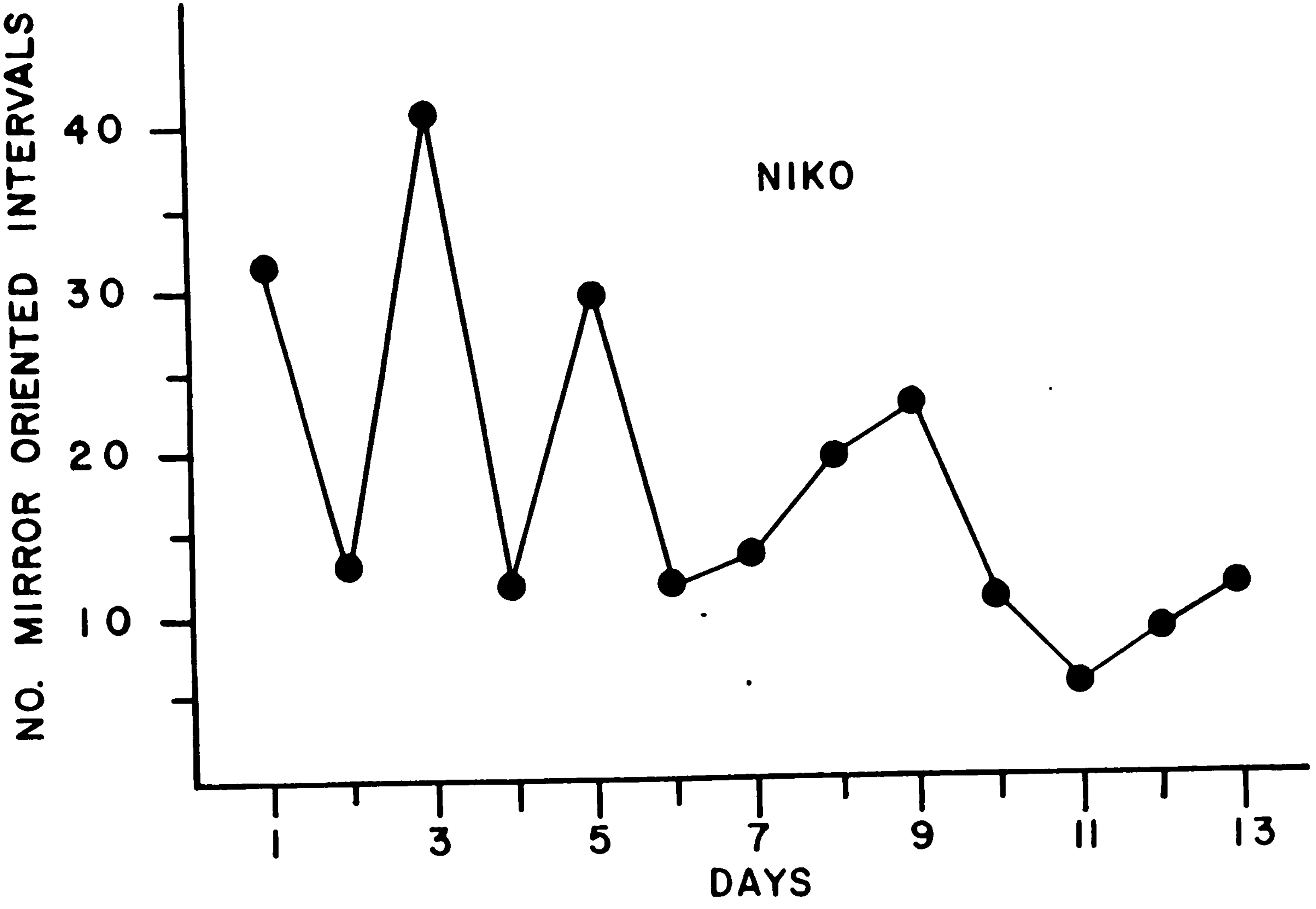
Results and Discussion

The subject monkey, Niko, made no mark directed responses during the dye test and no self referred behavior was observed either during the initial two weeks of testing nor at any time in the subsequent year when the mirror was left in her cage. Figure 7 shows the number of 30 sec intervals with 'social/neutral' responses toward the mirror. The maximum possible number is 60. Though there was a great deal of variability from day to day, the mean number of social/neutral responses was maintained for 13 days at 18. Mirror oriented social behavior was observed throughout the year. When after a hiatus in mirror exposure, she was placed in front of a mirror in which she could see her whole body, there was again a great deal of social behavior directed toward the mirror while the half hour of video taping took place. No formal analysis of the tape was done, but review of the film gave no indication that she regarded the mirror image as anything but another monkey.

Niko's social responding encompassed most of the gender-appropriate gestures and expressions described by Van Hooff (1967). She made threat gestures of varying degrees of intensity, accompanied by body postures ranging from a teeth bared open mouth thrusting of her whole body toward the image, to a slightly open mouth, accompanied by withdraw-

FIGURE CAPTION

Figure 7. The total number of 30 sec time sampled intervals with social or neutral orientation to a mirror as a function of days of exposure to the mirror. The maximum possible number per day is 60. The subject is Niko, a pigtailed macaque.


NO. MIRROR ORIENTED INTERVALS
40
30
20
10
NIKO
1
3
5
7
9
11
13
DAYS

al from the image. She made facial expressions with hind quarter presentations characteristically seen in sexual solicitation. Of greatest interest was the tactile exploration of the mirror with her hands, observed on days 2, 4 and 10. There was a pattern of moving her hands slowly across the mirror surface, picking up her hand, looking at it, then returning the hand to the mirror. This was the only action that remotely resembled a self referred behavior. This is perhaps critically different from the chimpanzee 'contingency testing' (see general discussion section) where the animal alternated his gaze from hand to mirror, moving it while watching it, and the mirror image of it. The only consistent behavior included in the 'social/neutral' category that was neutral rather than social was the subject's attempts to look behind the mirror or thrust her arm behind the mirror as well as moving her fingers around part of the rim while watching the image.

At the time this experiment represented the longest amount of time reported for a laboratory monkey exposed to a mirror, and the only study in which the subject was given tactile access to the mirror. Despite these factors, the results confirm those of Gallup and many others, summarized in Gallup et al. (1980) that monkeys give no evidence of discerning the source of the mirror image. Recent data by Anderson (1983) show that monkeys raised with and/or trained specifically to use mirrors do not show self referred behavior or responses directed to dye marks when the mark is visible only by use of the mirror. It is appropriate to again point out that monkeys are apparently able to comprehend the reflective nature of the mirror (Brown, et al., 1965; Tinkelpaugh, 1928). The task of successfully integrating the mirror image information is undoubtedly a complex cross modal problem, but recent data from Premack's laboratory (Dolgin et al., 1980) indicate that monkeys may be much better, even at a young age, at cross modal tasks than had been previously reported. Following the suggestion put forth in the discussion of Experiment I, might it be that monkeys do not perceive the peculiar nature of the social interaction with the mirror? This does not seem likely, and in fact, the succession of social gestures from the dominant/aggressive type to the submissive/sexual and various permutations of these, might suggest that the animal is essentially trying out various gestures, since none of them 'work' in the usual way.

A great deal of research will be necessary before we can delineate the problem experimentally, let alone have answers that we can feel confident about. There are at least three levels of inquiry: the experimental paradigm; social/developmental histories; and cognitive capacities.

Are the self recognition tasks given monkeys sensitive enough or motivating enough for the monkey to show some level of awareness of itself? Or are we dealing with laboratory animals who have not had full socialization and experiences which generate some type of objective self awareness? Or as Gallup (1979) suggested, is it a lack of a cognitive capacity, of the basic neuronal equipment to handle a concept as complex as the representation of one's self? That monkeys do not meet Gallup's criteria for self-recognition is not easily dismissed as their having had no training in the stimulus-response-reinforcement contingencies inherent in mirror use as suggested by Epstein, Lanza, and Skinner (1981), nor can we agree with Premack (1983) and attribute the monkeys' problem to gaze aversion, as there is ample indication of inter-monkey visual recognition (Cheney and Seyfarth, 1982; Gallup, et al., 1980; Humphrey and Keeble, 1976; Rosenfeld and Van Hoesen, 1979). Further, in focusing on the reflection of, say, one's brow, eye contact is not made with the reflection.

EXPERIMENT IV

Responding for Social Stimuli

Recognizing one's reflection in a mirror as one's own reflection may be done on the basis of pattern discrimination (the reflection matches what one sees or has seen of oneself) and of contingency (the reflection's movements match--are controlled by oneself). Orienting to and attending to the reflection has the (operant) consequence of seeing the reflection and permitting further discriminations to be made. It is well established that monkeys are highly curious visually and recognize individual monkeys by sight. They certainly demonstrate 'interest' in the mirror. But are the consequences of seeing the particular image that is one's own disconcerting or aversive because of their social incongruity, their proximity, or other features? Can the video medium prove effective in manipulating the consequences of looking at the mirror/video monitor?

Experiments IV, V and VI explored the reinforcing value of some social stimuli presented in the video mode, as response consequences, including, finally, the stimulus of central concern, the subject monkey itself. If the concept of self emerges out of a tapestry of social interaction we should get some insight into the reasons it does or does not appear in particular groups of animals by exploring the ways in which social stimuli are responded to or responded for. The technical problems inherent in using mirrors (which would have been desirable for reasons of comparison to previous mirror studies) were insurmountable under present circumstances. In addition, we were interested, as have been other investigators in the area (Paully, 1982; Rosenblum and Paully, 1980; Swartz and Rosenblum, 1980), in greater latitude to manipulate images and broader ability to standardize the stimulus presentation than is afforded by mirrors and other three-dimensional stimulus situations such as the Sackett 'self-selection circus' (Suomi, Sackett, and Harlow, 1970). Video was the medium of choice for the above reasons and because it alone provides the opportunity to present a monkey with comparisons of itself, in present or past time, with other social and non-social stimuli.

As described in greater detail in the Introduction, monkeys presented with social stimuli in the video medium evidenced individual recognition by utilizing facial cues of particular conspecifics to avoid shock or obtain food (Miller, 1967, 1971). Humphry and Keeble (1976) affirmed individual discrimination, though in a less clear cut manner. Paully (1982) has shown that whether the social stimulus is a consequence of operant responding by the subject or is presented by the experimenter, the dependent measures show species and individual discrimination in both the 'active' and 'passive' situations. His work also suggested that it is the area around the eyes that gives the most salient identity cues.

The following experiment was done with a view toward establishing whether the video taped activity of a familiar conspecific would be preferred over a non-social visual condition (video 'noise') which had a motion component. Presumably video noise ('snow') has no social connotation such as might the oft used empty cage control (Paully, 1982; Swartz and Rosenblum, 1980).

Method

Subjects. Three female pigtail macaques were used. The monkeys, Wife, Bibi, and Niko, were part of the Hunter College colony of eight to ten conspecifics, all of whom were purchased from Primate Imports, Port Washington, New York. All were wild born and captured at some time during their second year. At the time of these experiments Niko was approximately 9 years old, Wife and Bibi, about 25 and 8 years, respectively. Their mean body weights were 8.6kg (Niko), 5.0kg (Wife), and 6.2kg (Bibi). They had been subjects in discrimination experiments exposing them to various still and moving video tapes, largely of conspecific and other animals. This work used a Lindsley-type manipulandum and liquid food reinforcement. Previously, Wife had a history of work in auditory localization experiments. Niko and Bibi had been subjects in auditory experiments for a short period of time. Niko, the animal described in Experiment III, had been exposed to a mirror for a year. Diet, housing and other aspects of their daily routine were as described in Experiment III. It is important to note that the visual system of macaques is virtually the same as the human visual system (Devalois and Jacobs, 1971), facilitating the optical aspects of the following experiments.

Apparatus. The experimental space was a commercial monkey cage, 62.5cm x 66.2cm x 92.5cm, housed in a small ventilated cubicle. The cage was secured to the wall with L brackets on two sides. A metal frame, modified from a bench-top relay rack, held the video monitor and Plexiglas operandum 0.5cm outside one wall of the cage. The video recorder and relay equipment were in an adjacent sound-attenuated cubicle. The operandum, a clear Plexiglas panel, 28cm x 48cm, was constructed and suspended on a hinge 8 cm. in front of the video monitor screen. The subject could produce the stimuli by pushing the panel and displacing it with sufficient force (0.4-0.5kg) to close the microswitch located behind it. Switch closure required that the panel be displaced 1.5cm. Movement forward, or beyond that was limited by metal plates. We consider that the response panel, constructed as it was and placed 4cm from the inside of the cage bars, represents an improvement over operandi conventionally located inside the animal's cage where inadvertent responding is more probable. Further, the spatial contiguity of the response panel with the stimuli presented on the video monitor should facilitate attention to the stimuli (Jarvik, 1956; Harlow and McClearn, 1954). Though the manipulandum does not resolve all problems, it increases confidence in the purposeful nature of the response, and that the response was produced by the animal pushing with its hands, which in turn increases the probability that visual orientation will be in the same direction.

The video tape recorder used was a Panasonic color VTR, model NV-3130; the monitor, a high resolution Panasonic black and white Video Monitor, model 5400, with a 12-inch screen. Sony brand ½-inch black and white video tape was used.

The two stimuli were a video tape of Pavlova, a conspecific colony-mate approximately four years old, weighing 5.2kg and video noise ('snow'). The video tape of Pavlova was recorded in the experimental cage. Virtually all of the tape shows her oriented toward the camera. The video noise was produced by the video tape deck in the 'stop' mode. The brightness of the stimuli are shown in Table 2.

Data were recorded on a Gerbrands Cumulative Recorder, running time meters and various magnetic counters. Standard audio white noise was used in the experimental cubicle. The stimulus presentations on the video monitor were programmed by electro-mechanical equipment.

Procedure. The subjects were shaped to push the Plexiglas response panel by holding a small piece of fruit behind the panel and giving it to the animal as a consequence of responding appropriately. When the animal responded twenty times, it was considered shaped.

During the experiment the subjects were removed from their home cages and placed in the experimental situation where they were allowed 10 minutes adaptation before beginning the experiment. The cubicle light was then turned out and the equipment started. The sessions lasted forty minutes during which time the two stimuli were available for successive 10 min periods in an ABBA sequence. When the animal was not responding, the monitor screen was blank, though illuminated (see Table 2 for measures). Each response of sufficient force to close the microswitch produced three seconds of the stimulus. If the panel was held down, the stimulus would be present for the duration of the response. If there was discrete responding during the three seconds of stimulus presentation there was no cumulative effect on the length of stimulus presentation. At the beginning of the session and at each change of stimulus the investigator gave the monkey a chance to view the new stimulus for 20 seconds by displacing the response panel. That amount of time was sufficient to have the animal visually orient toward the monitor at least three times. At the end of the session, the subject was removed from the cage and returned to its home cage. Six sessions, run on consecutive days, were carried out for Niko and Wife. Bibi was discontinued after three sessions of no responding. The dependent measures were frequency of responding and overall pattern of responding.

Results and Discussion

The left panel of Figures 8 and 9 show the cumulative frequency of responding for subjects Wife and Niko. The subject Bibi was discontinued after three sessions of no responding. As far as could be ascertained there was no apparatus failure--the subject did not press the panel. Both Niko and Wife showed a higher cumulative level of responding for the video tape recording of a familiar conspecific than for the video noise stimulus, although in

FIGURE CAPTION

Figure 8. Cumulative responses over sessions for videotaped views of a colony mate or video noise. The subject is Wife, a pigtailed macaque. The left panel shows sessions run with no prior visual isolation (Experiment IV); the right panel shows sessions run with prior 24-hour visual isolation (Experiment V).

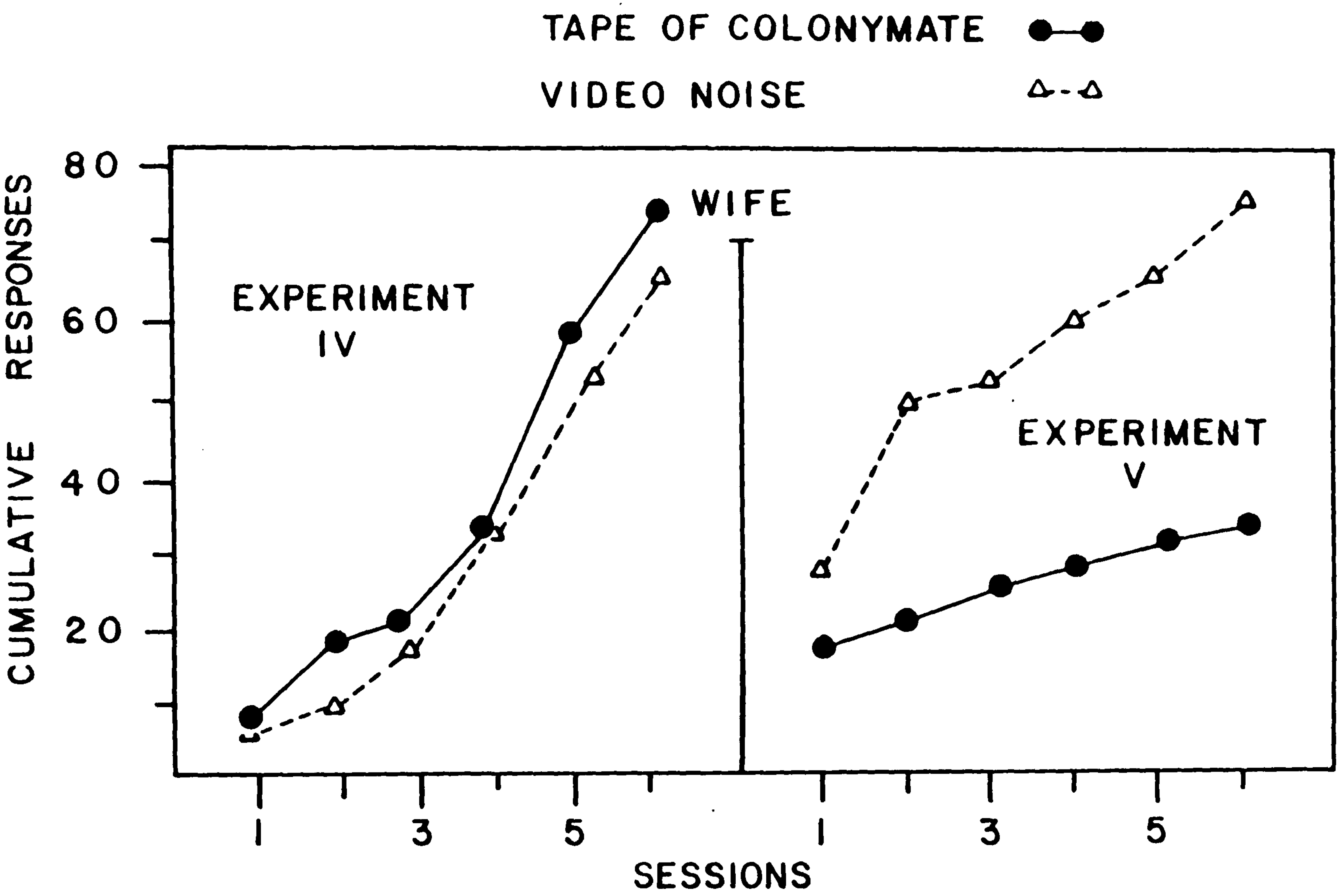
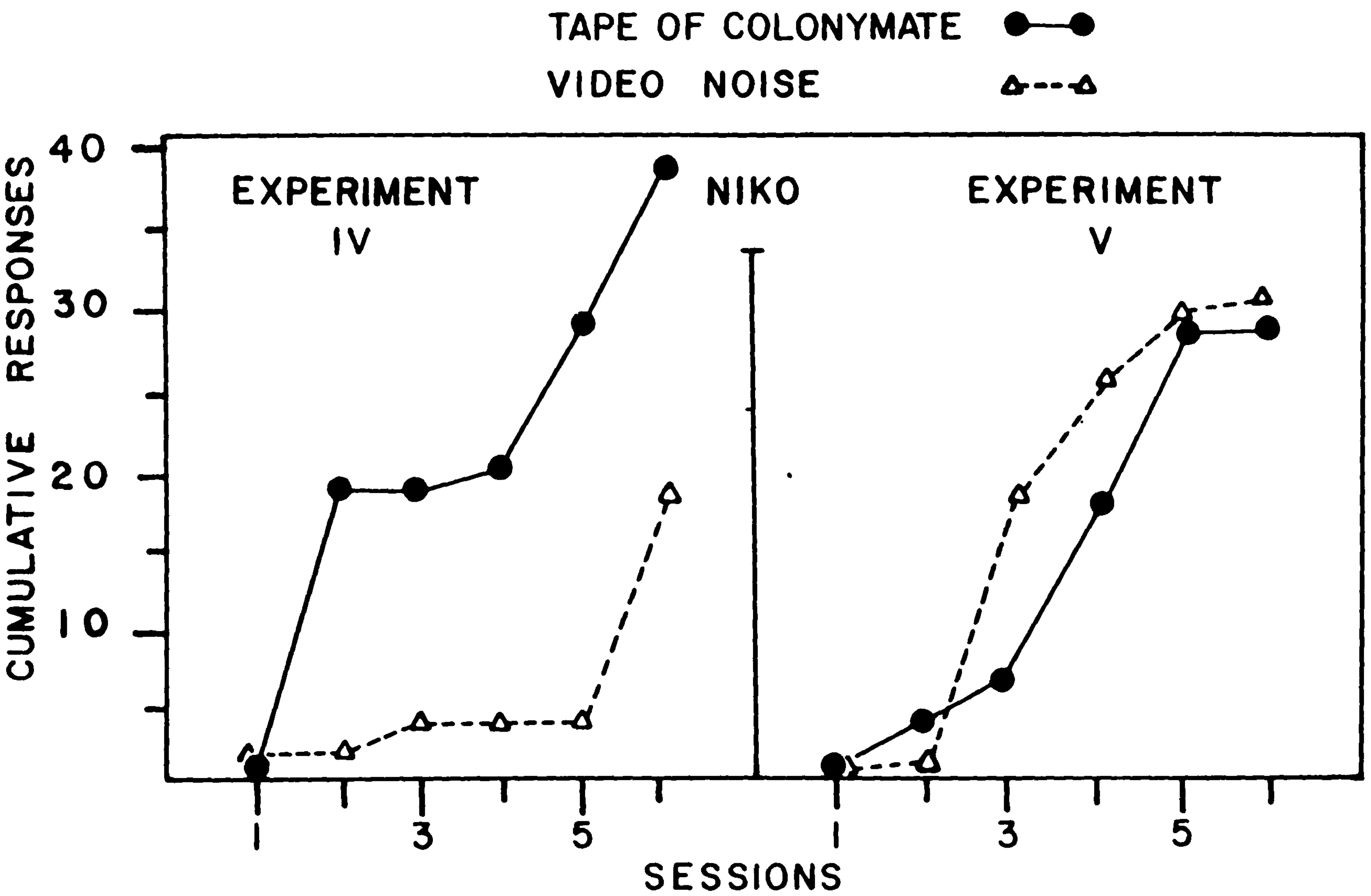

TAPE OF COLONYMATE ●—●
VIDEO NOISE △--△
CUMULATIVE RESPONSES
80
60
40
20
EXPERIMENT IV
WIFE
EXPERIMENT V
1
3
5
1
3
5
SESSIONS

FIGURE CAPTION

Figure 9. Cumulative responses over sessions for videotaped views of a colony mate or video noise. The subject is Niko, a pigtailed macaque. The left panel shows sessions run with no prior visual isolation (Experiment IV); the right panel shows sessions run with prior 24-hour visual isolation (Experiment V).


TAPE OF COLONYMATE ●—●
VIDEO NOISE △---△
CUMULATIVE RESPONSES
40
30
20
10
EXPERIMENT IV
NIKO
EXPERIMENT V
1
3
5
1
3
5
SESSIONS

Wife's case the difference was slight. For Niko 'preference' for the taped colony mate was due largely to responding during sessions 2 and 5, i.e., in only one-third of the sessions.

Figures 10 and 11 illustrate the frequency of responding as a function of sessions. These show more clearly than do the cumulative frequency graphs the amount of daily variation. Within sessions there was no systematic overall pattern of responding, except for a slightly higher rate of responding at the beginning of the session. Analysis of variance for repeated measures showed no main effect of sessions or treatments. There was, however, a significant interaction of treatments and sessions (F=5.96, df=5/5, p=.03).

Preference for viewing a moving conspecific is supported by much of the literature (Butler and Woolpy, 1963; Paully, 1982; Swartz and Rosenblum, 1980). The simple statement of preference, however, overlies a very complex and contradictory story which will be dealt with in the general discussion.

FIGURE CAPTION

Figure 10. Total responses per session for videotaped views of a colony mate or video noise. The subject is Niko, a pigtailed macaque. The left panel shows sessions run with no prior visual isolation (Experiment IV); the right panel shows sessions run with prior 24-hour visual isolation (Experiment V).

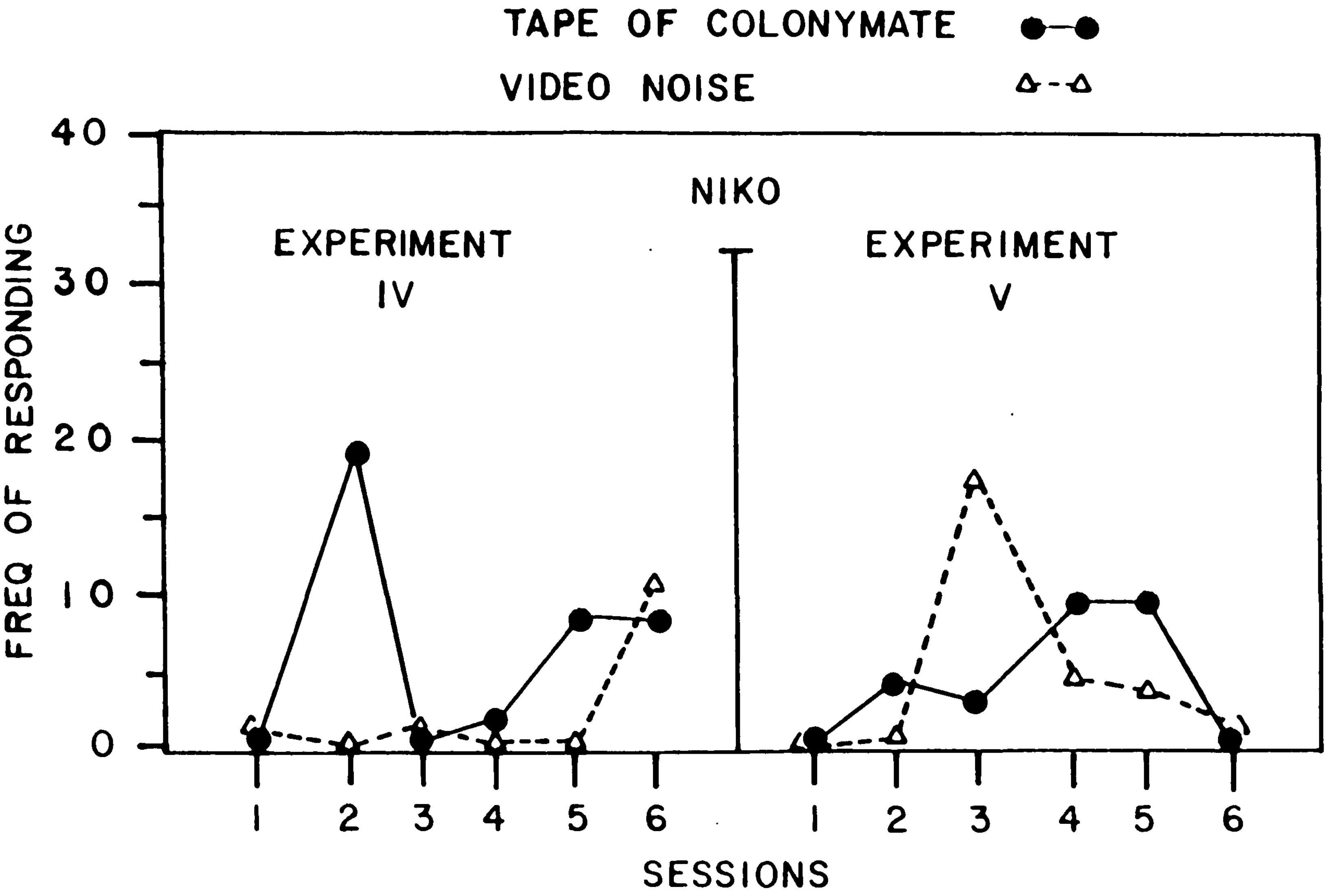
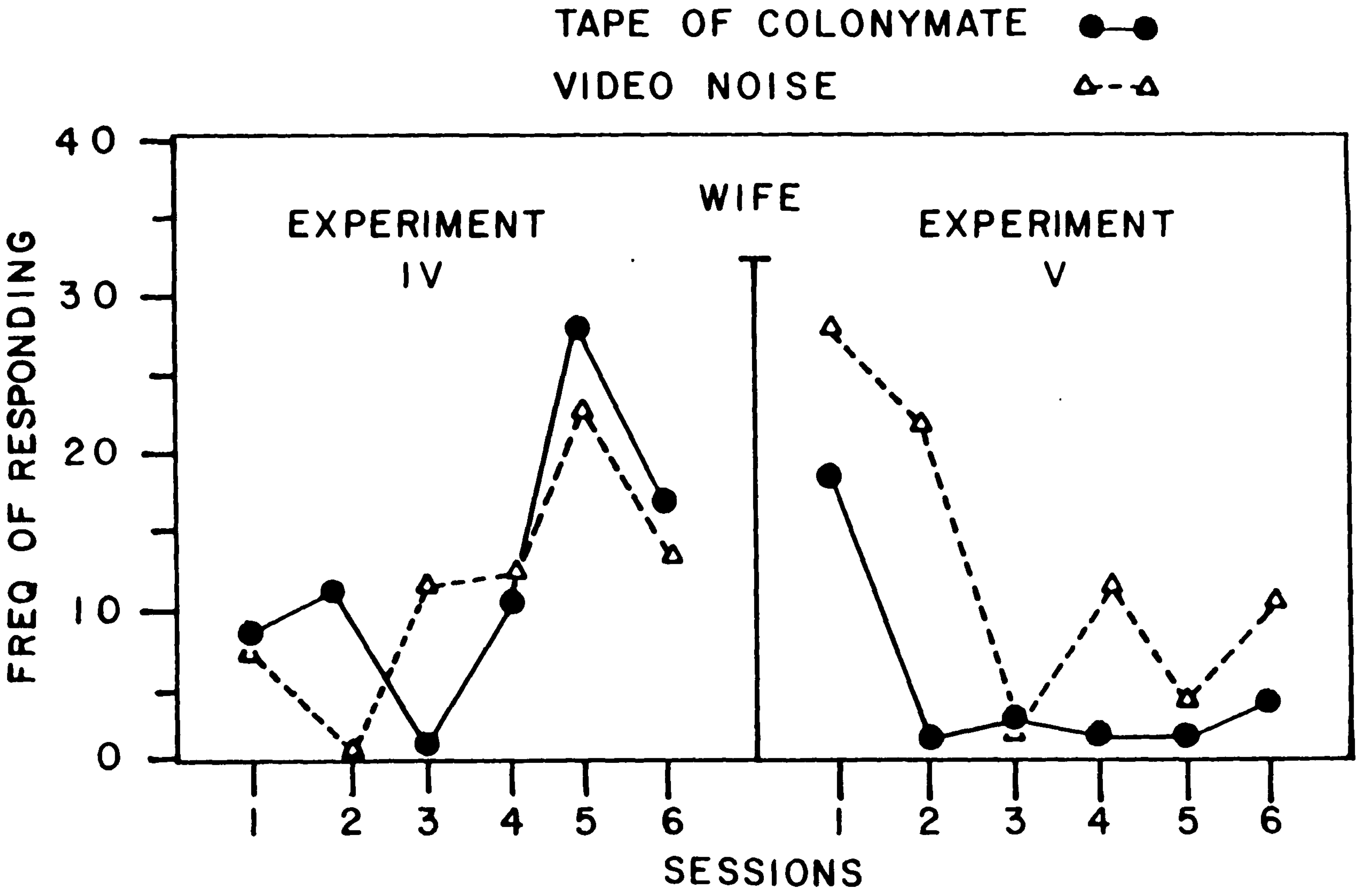

TAPE OF COLONYMATE ●—●
VIDEO NOISE △--△
NIKO
EXPERIMENT IV
EXPERIMENT V
FREQ OF RESPONDING
0
10
20
30
40
1
2
3
4
5
6
1
2
3
4
5
6
SESSIONS

FIGURE CAPTION

Figure 11. Total responses per session for videotaped views of a colony mate or video noise. The subject is Wife, a pigtailed macaque. The left panel shows sessions run with no prior visual isolation (Experiment IV); the right panel shows sessions run with prior 24-hour visual isolation (Experiment V).


TAPE OF COLONYMATE ●—●
VIDEO NOISE △--△
FREQ OF RESPONDING
40
30
20
10
0
EXPERIMENT IV
WIFE
EXPERIMENT V
1
2
3
4
5
6
1
2
3
4
5
6
SESSIONS

EXPERIMENT V

Short Term Social Deprivation

Butler (1957) has shown that monkeys deprived of visual contact with colony mates and of a 'varied visual environment' sustain a higher frequency of responding for visual incentives than those tested without deprivation. It was hypothesized that a 24-hour period of social isolation from the colony would increase the frequency of responding and heighten the reinforcing value of views of a colony mate in the video medium, as it had done in the Butler work for a live view of the monkey colony.

Method

Subjects. The same subjects were used as were in Experiment IV.

Apparatus. The apparatus was the same as that used in Experiment IV.

Procedure. The procedure followed that of Experiment IV with the exception that the subjects were placed in the experimental cage approximately 24 hours before the beginning of each session. They were, therefore, out of visual contact with their colony mates during those hours.

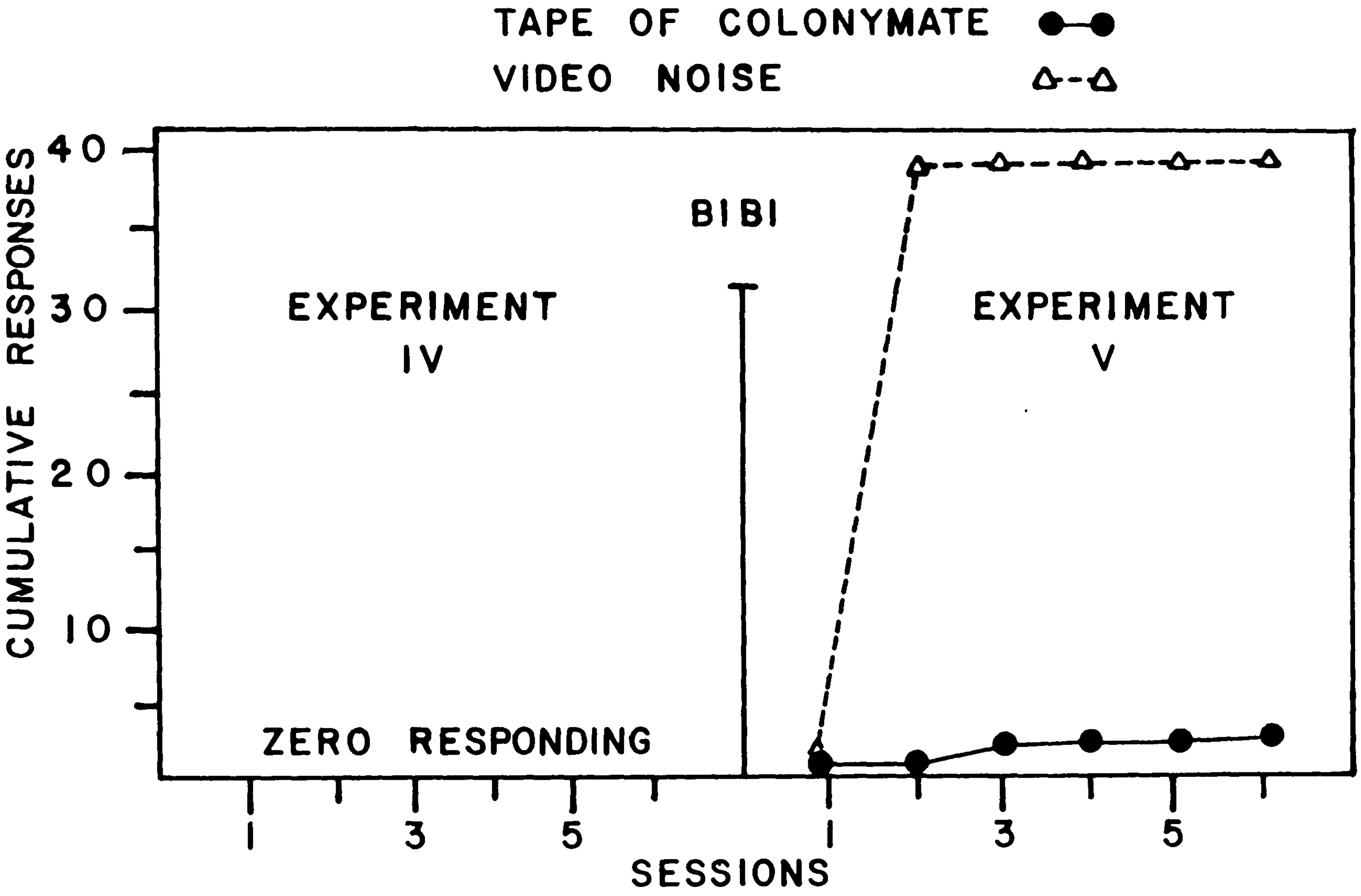
They were not completely out of auditory contact with the colony when those in the colony were vocalizing loudly, such as at meal time. The animals were fed and watered in the experimental cage and the light-dark cycle was maintained as in the colony room (see Experiment III). In general, each animal had a hiatus of two days out of the experimental cubicle before being returned to the experimental situation for the next deprivation and session sequence. When the experimental session was not in progress, the Plexiglas panel operandum was secured in a fixed position. A session was begun by turning out the cubicle lights, turning on the monitor and giving the subject a 20-second sampling of the stimulus. When the stimulus was changed, it was similarly preceded by a 20-second sample. After the session, the subject was returned to its home cage.

Results and Discussion

In Figures 8, 9, and 12, the right panel shows the cumulative frequency of responding for video noise and the video tape of a colony mate after the subject had been isolated from the colony room for 24 hours before the start of the experimental session. Contrary to expectation, the video noise yielded higher numbers of cumulative responses

FIGURE CAPTION

Figure 12. Cumulative responses over sessions for videotaped views of a colony mate or video noise. The subject is Bibi, a pigtailed macaque. The left panel shows sessions run with no prior visual isolation (Experiment IV); the right panel shows sessions run with prior 24-hour visual isolation (Experiment V).


TAPE OF COLONYMATE ●—●
VIDEO NOISE △--△
CUMULATIVE RESPONSES
40
30
20
10
BIBI
EXPERIMENT IV
EXPERIMENT V
ZERO RESPONDING
1
3
5
1
3
5
SESSIONS

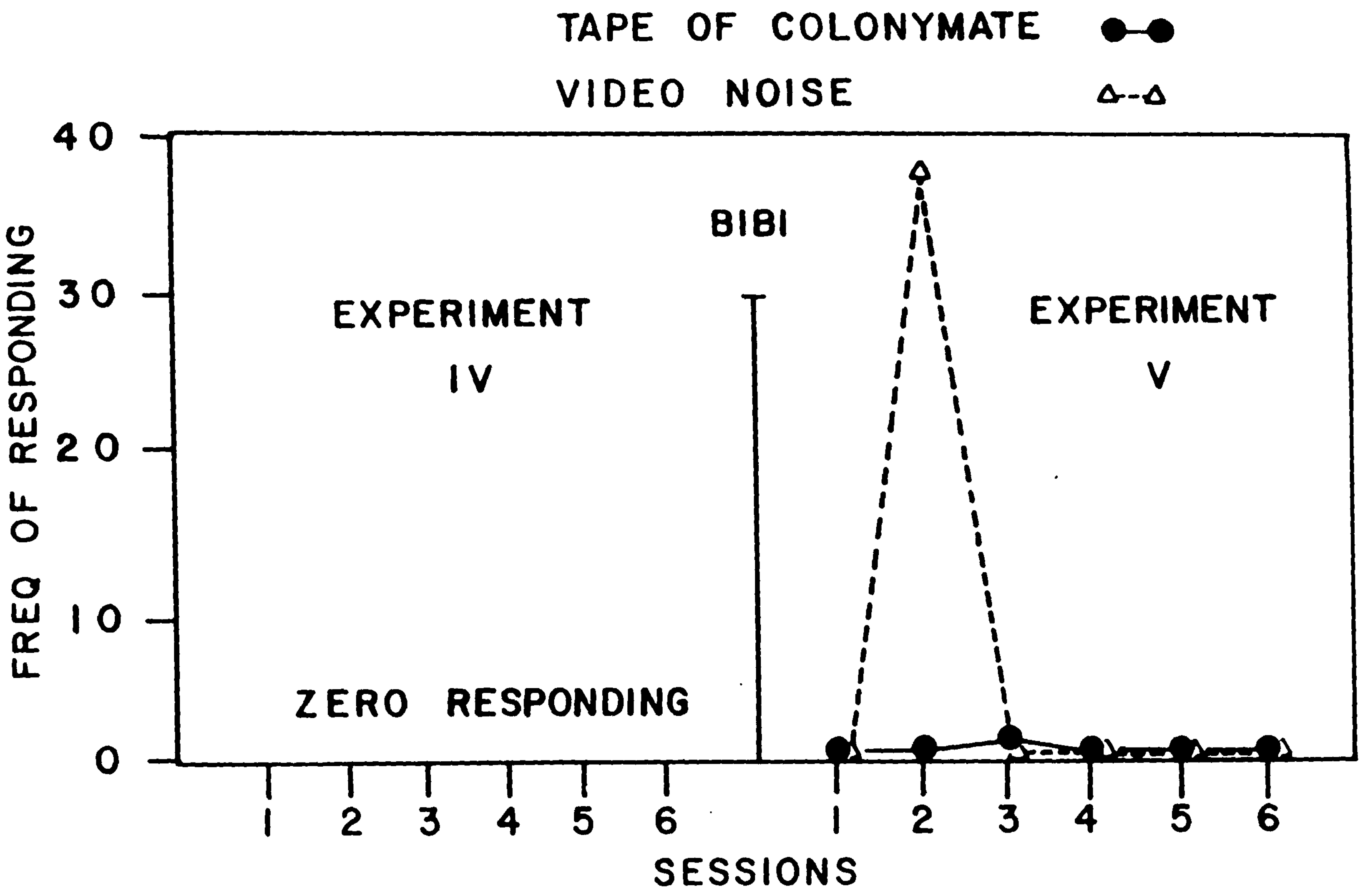
than did the taped colony mate. The right panels of Figures 10, 11 and 13 show responding over sessions. Niko's data show a 'preference' for the video noise (VN) only on session 3. On 5 of the 6 sessions, Wife responded more for the VN condition. Bibi responded almost exclusively for VN, but in only one session. This is an unusual pattern, but there was nothing in the cumulative record to suggest that it was an artifactual one.

The term 'preference' needs to be understood in a qualified sense as the total number of responses over all sessions can result in a different ordering of conditions (colony mate or noise) than the number of sessions showing more responses for one condition over another.

The strength of responding to the VN was a surprise. It had been used as a non-social but 'interesting' control. The individual data (Figures 10, 11 and 13) do not help in determining the reasons for this outcome. Wife's pattern of responding over sessions for the colony mate tape in Experiment V shows that after the first day there was very little responding for it in

FIGURE CAPTION

Figure 13. Total responses per session for videotaped views of a colony mate or video noise. The subject is Bibi, a pigtailed macaque. The left panel shows sessions run with no prior visual isolation (Experiment IV); the right panel shows sessions run with prior 24-hour visual isolation (Experiment V).


TAPE OF COLONYMATE ●–●
VIDEO NOISE △--△
FREQ OF RESPONDING
40
30
20
10
0
EXPERIMENT IV
BIBI
EXPERIMENT V
ZERO RESPONDING
1
2
3
4
5
6
1
2
3
4
5
6
SESSIONS

subsequent sessions. This might be interpreted as a loss of interest in the particular, now non-novel stimulus monkey. This is not, however, indicated in Niko's responding pattern. Interest in control stimuli is not without precedent in the literature, for certain stimuli, blank screens and empty cages, for example, support substantial levels of responding (Butler and Woolpy, 1963; Humphrey, 1974). Because of apparatus and procedure differences, it can not be determined confidently if these stimuli have been responded to proportionally as much as the video noise was in the experiments presented here.

Brightness may be a factor in responding for video noise (Table 2) but using Humphrey (1972) as a guide, it does not account for all the difference in responding. He has shown that there is an orderly relationship between increasing brightness and preference for a white or colored illuminated field which, within the range of -1.0 to 1.0 log foot-lamberts, is as follows: there is a .30 increase in response preference for every log unit increase in brightness.

In addition to the brightness factor, video noise stimulates all temporal frequencies and as such may be a positively reinforcing stimulus, within a wide brightness range. If video noise was responded for more in Experiment IV as well as in V, one might with some confidence suggest that the brightness and temporally stimulating qualities were critical, but it is not convincing that 24 hours of isolation from the colony would have made these aspects of the stimulus much more reinforcing to the point of getting the opposite results, that were in fact seen.

It is possible that viewing monkeys on video under these conditions is aversive. The whole question of the aversiveness of social stimuli has not been specifically tested. Some of Sackett's and Butler's data are suggestive, but to our knowledge explicit work with monkeys or apes to ascertain the potential aversiveness of various social stimuli has not been done. The assumption has been that social stimuli would be positively reinforcing in general.

But low levels of responding for these types of stimuli reported in the literature and in the present data indicate that it is time to examine this assumption closely. It may be that investigators (Swartz, Rosenblum and Paully) who have seen decided preferences and high levels of responding, have done so because they used juvenile and infant monkeys. Clearly shown preferences in the literature come from infants responding for views of their mothers. This is presumably the least threatening of relationships. By sexual maturity, it is conceivable that most conspecifics are potentially aversive for one another. To operantly produce an image of a monkey on a screen before one, then, is not likely to support high levels of responding or illustrate unequivocal preferences for social over non-social stimuli. Butler (1961) has reported an interesting case that runs contrary to this hypothesis. He showed high frequency, but low duration responding to view a snake that is a predator of his subject monkeys. Butler's interpretation was that the snake was aversive for the monkey to view, but that it continued to respond to get information. Data in Experiments IV, V and the one to follow (VI) might reflect something of the same kind. If it is aversive to see another monkey on a monitor close to the cage you are in, responding to produce that image will be reduced, but that will be balanced perhaps by the need for the animal to understand where that other animal is. Animals need information about potential threats and competitors, and though it may be frightening or aversive to get that information, it is critical. To tease out these variables is a necessary and exciting direction for research in this area.

EXPERIMENT VI

Cumulative Social Deprivation

The following experiment was conceived for the purpose of adding to the stimulus consequences the subject herself, 'live' on the video monitor, in what we call the contingent condition. In view of the fact that the 24-hour social isolation did not enhance responding as had been anticipated, a number of changes were made. Based on the generally held principle that, barring extremes, increased deprivation will strengthen responding for the absent stimuli, it was decided to test the subjects throughout a relatively long period of cumulative social isolation. During a ten day period of cumulative deprivation and with 8 hours a day in which to respond, one should be able to view cumulative effects of social deprivation on responding for social and non-social stimuli. Butler and Alexander (1955) and Moon (1961) have shown that animals tested for 10 hours in the first case and 10 consecutive days for 2.5 hours a day in the second, maintained a high and sustained level of performance for three dimensional social rewards. These animals were, however, returned to the colony after testing each day.

The stimuli potentially available to our subjects were presented on a video monitor in contrast to 'live' views as above. Also, they were not the complex visual pattern of the whole monkey room as in the Butler and Alexander (1955) case. It was assumed that the most reinforcing aspect of the colony room would be views of colony mates. Following Humphrey and Keeble (1976), it was supposed that our subjects would, as had their rhesus subjects, work to see the 'private behavior' of a colony mate presented on video. 'Private behavior' was defined by these authors as the whole range of behavior that a monkey engages in when it is visually isolated from its mates and does not know it is being observed. There is apparently behavior seen that is not commonly seen when either a human observer is present or the animal is in view of its colony mates.

It was thought that this stimulus would be more varied, natural, and, therefore, reinforcing than a tape of a conspecific in the experimental cage as in the two preceding experiments (IV and V). In short, the combination of a more heterogeneous stimulus in the social 'other monkey' category, more and cumulative social deprivation, and an extended opportunity to respond should yield more information about the reinforcing value of the stimuli and be more illustrative of the subjects' capacities and preferences.

The stimuli, (1) the other monkey, (2) video noise and (3) the subject herself in present time (the contingent condition) were available in a strictly alternating sequence, essentially replicating Humphrey's (1972) methodology but adding a third stimulus. When the panel operandum was sufficiently displaced, one of the stimuli would be seen for as long as the panel was held. Upon release the screen was blank. The next response produced the next stimulus and so forth. This manner of stimulus presentation was adopted in order to counteract the tendency to rapidly habituate to a repeatedly presented stimulus (Butler and Woolpy, 1963; Humphrey, 1972) and for practical reasons involved with the 8 hour session length.

Method

Subjects. The subjects were those in Experiments IV and V, plus Roberta, a robust female of approximately four years of age. She weighed 5.6 kg at the onset of the experiment. She was wild born and had been a member of the colony for 8 months.

Apparatus. In addition to the equipment used in Experiments IV and V, two Sony Video Cameras, models AVC 3260 and AVC 3200 were used. Both had Sony TV Zoom lens, 1:1.8, f 12.5-75mm. Lighting was provided in the colony room, where one stimulus originated, by the incandescent house lights, an auxilliary, 68-watt incandescent light fixture and a 150-watt reflector flood light. Lighting for the contingent self stimulus was from the incandescent house lights in the experimental cubicle. The video noise was produced in the same way as described in the previous experiments. Programming of the contingencies was through electro-mechanical and solid state modules. As in Experiments IV and V, a Gerbrands Cumulative Recorder provided an on-line record of the experiment.

Procedure. Each subject was placed in the experimental cage and left for about 15 minutes. After the equipment was turned on the Plexiglas operandum panel was released from its locked position. The experimenter then held some pieces of fruit behind the panel (as was done in shaping) to start the animal responding on the operandum. Five responses were rewarded. The cubicle was then closed and the experimental session begun. The daily sessions were from approximately 9 a.m. to 5 p.m. At the end of the experimental day, the equipment was turned off, the panel immobilized, subjects fed and cleaned. At the end of the 10th day of testing the animal was returned to its home cage. (Niko was terminated at the end of 8 days because of apparatus problems.)

The stimuli for this experiment were the video noise of the previous experiments, a colony mate, Roberta, housed in a cage in the colony room, and the subject monkey herself, live in present time. When Roberta was a subject, Niko was the stimulus monkey. The cage in the colony room had been modified with a clear Plexiglas side which afforded a full view of the monkey in every part of the cage. A video camera was placed so that all but the top of the cage could be seen on the video monitor, thus giving the subject monkey the opportunity, upon responding, of watching a colony mate in her cage in the colony room. The visual angle subtended on the video monitor when the stimulus animal was standing bipedally in her cage was between 20° and 51°. The range in this and the cases to follow represent the visual angle when the subject monkey was at the minimal and maximal distance possible while responding. When the stimulus animal was sitting or on all fours, the range of visual angles subtended was 14° to 40°. The third stimulus, the subject monkey herself, was presented on the video monitor by mounting a video camera at the side of the monitor, 54.5 cm from the cage. The resulting picture occupied approximately 70% of the monitor screen, about an equal amount being cut off on each vertical border of the screen. No other camera placement afforded a better view of the subject. The camera view covered all of the experimental cage with the exception of approximately 20cm on the far left side as one faced the monitor, and the bottom or top of the cage where the monkey rarely was. The visual angle subtended by this stimulus on the monitor was between 10° and 40°. Whenever the subject responded, and the video-self stimulus was available, the probability was high that a substantial portion of her body was reproduced on the monitor. As the subjects had extended opportunity to explore the stimuli, the 3-sec minimum hold per response used in Experiments IV and V was discontinued. Duration was the principal dependent measure. Data for each stimulus were recorded separately on running time meters and a counter. The overall pattern of responding as well as frequency and duration was reproduced on the cumulative record.

Results and Discussion

Figure 14 shows the cumulative duration for all subjects combined. Video noise was produced for a longer duration than the social stimuli. In each individual case (Figures 15-17), the duration of video noise was greater than the other two stimuli. The largest difference between the two social stimuli (the other monkey and the subject herself) was seen in Figure 17 in Roberta's case. The data for the fourth subject, Wife, is not presented in graphic form, as she responded only nine times, and with very short duration responses. The fact that she

FIGURE CAPTION

Figure 14. Cumulative duration of response produced video views of self, another monkey, and video noise for four pigtailed macaques. Session length = 8 hours/day.

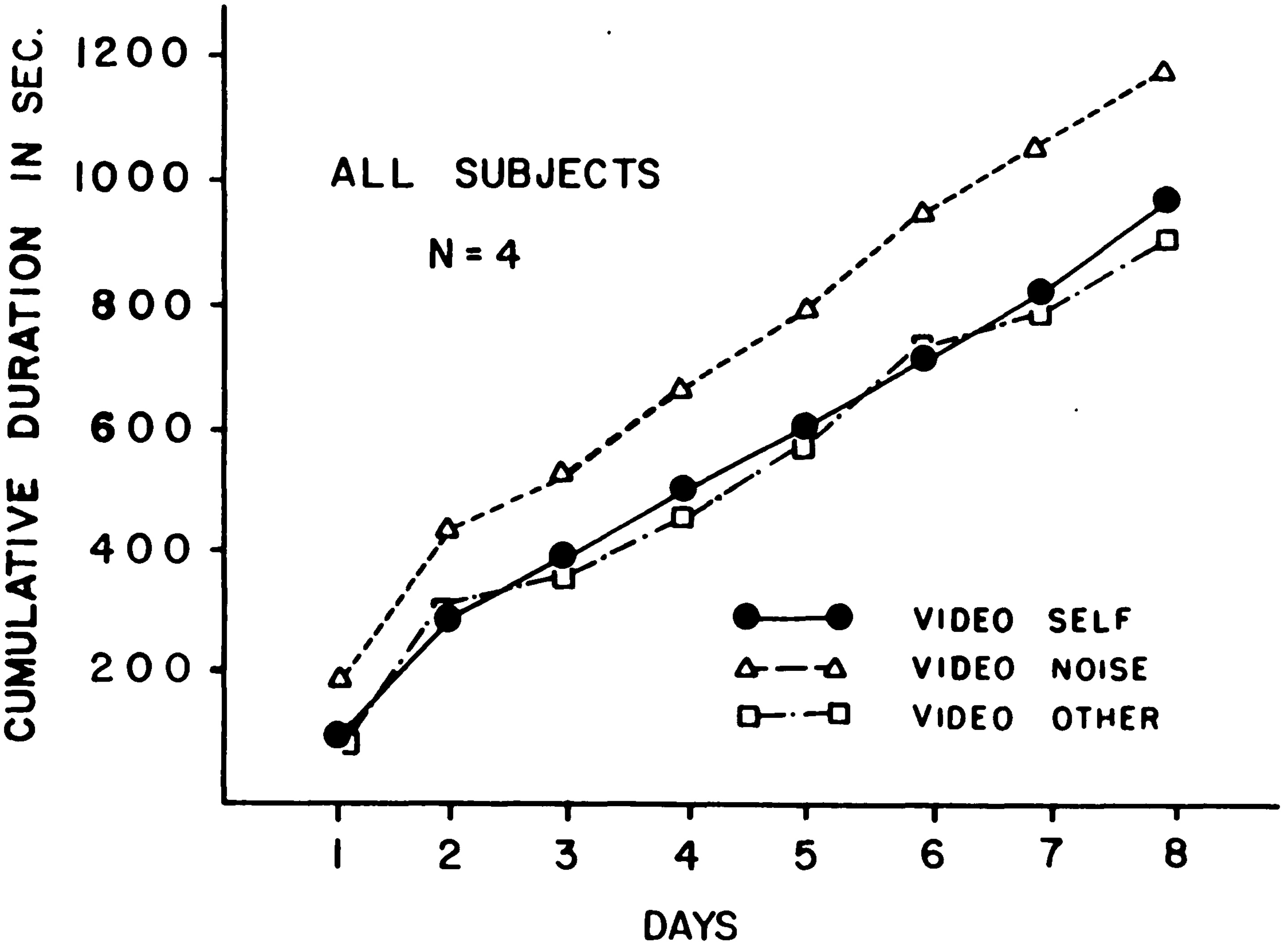

ALL SUBJECTS
N = 4
CUMULATIVE DURATION IN SEC.
1200
1000
800
600
400
200
DAYS
1
2
3
4
5
6
7
8
VIDEO SELF
VIDEO NOISE
VIDEO OTHER

FIGURE CAPTION

Figure 15. Cumulative duration of response produced video views of self, another monkey, and video noise. The subject is Niko, a pigtailed macaque.

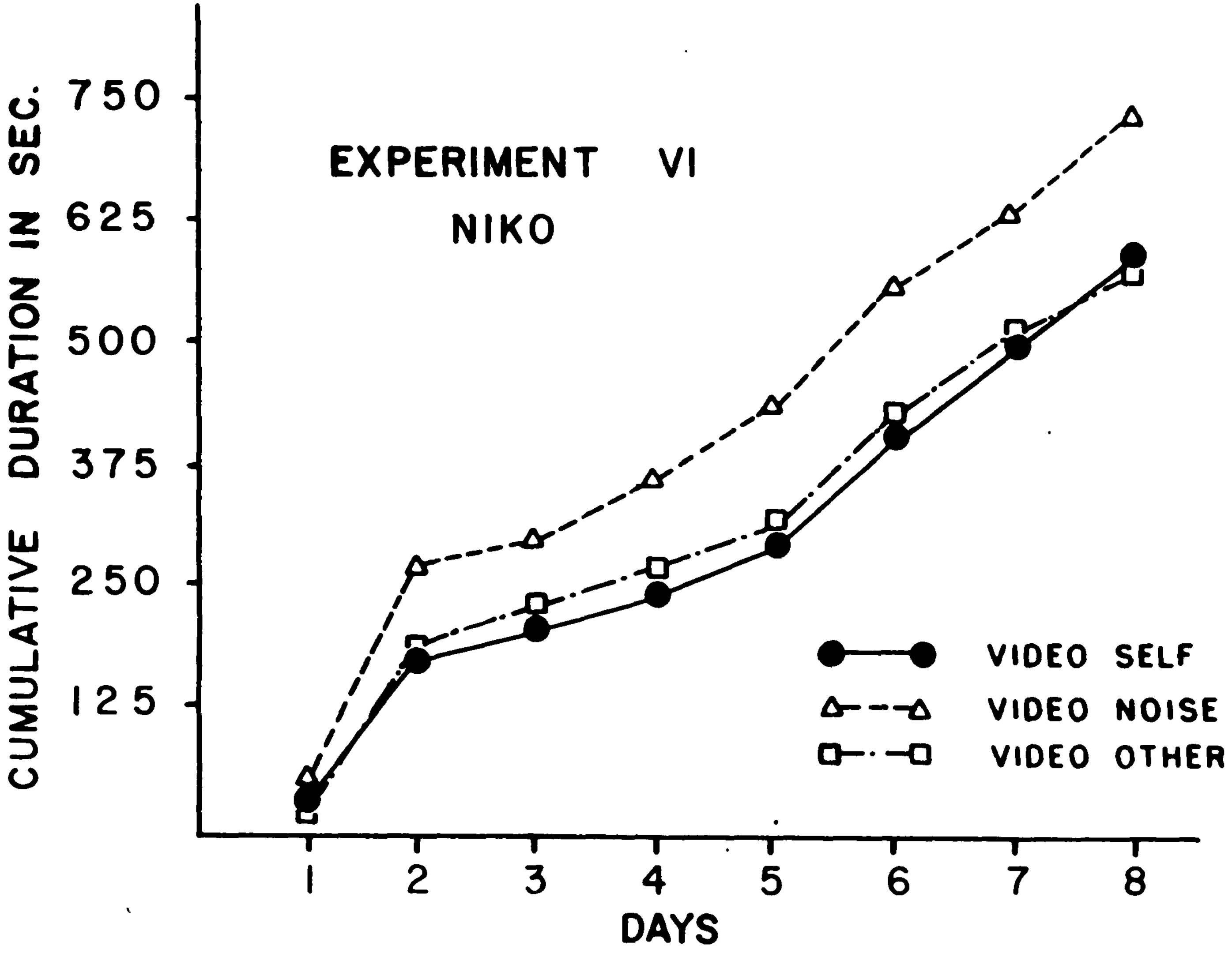

EXPERIMENT VI
NIKO
CUMULATIVE DURATION IN SEC.
750
625
500
375
250
125
1
2
3
4
5
6
7
8
DAYS
VIDEO SELF
VIDEO NOISE
VIDEO OTHER

FIGURE CAPTION

Figure 16. Cumulative duration of response produced video views of self, another monkey, and video noise. The subject is Bibi, a pigtailed macaque.

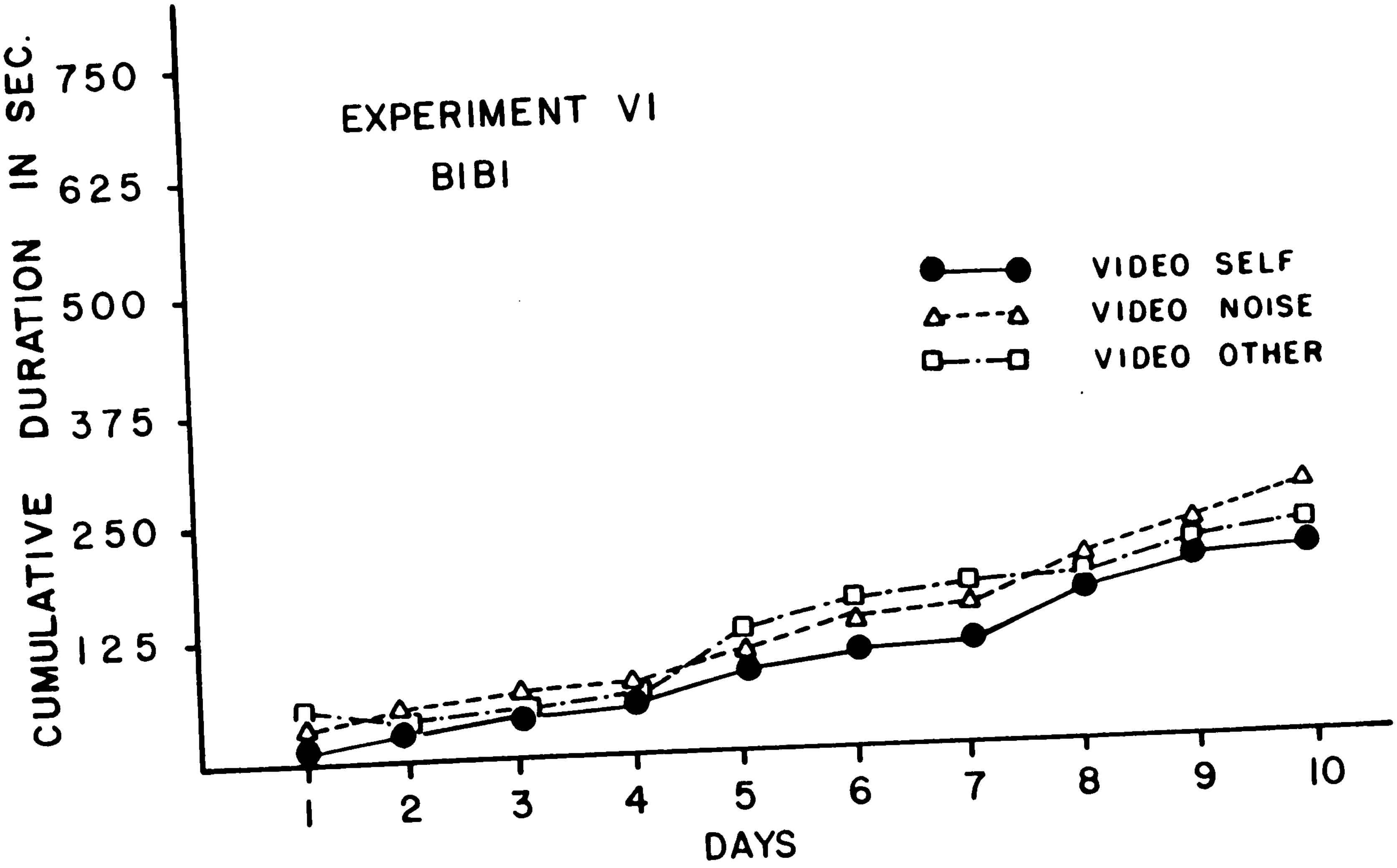
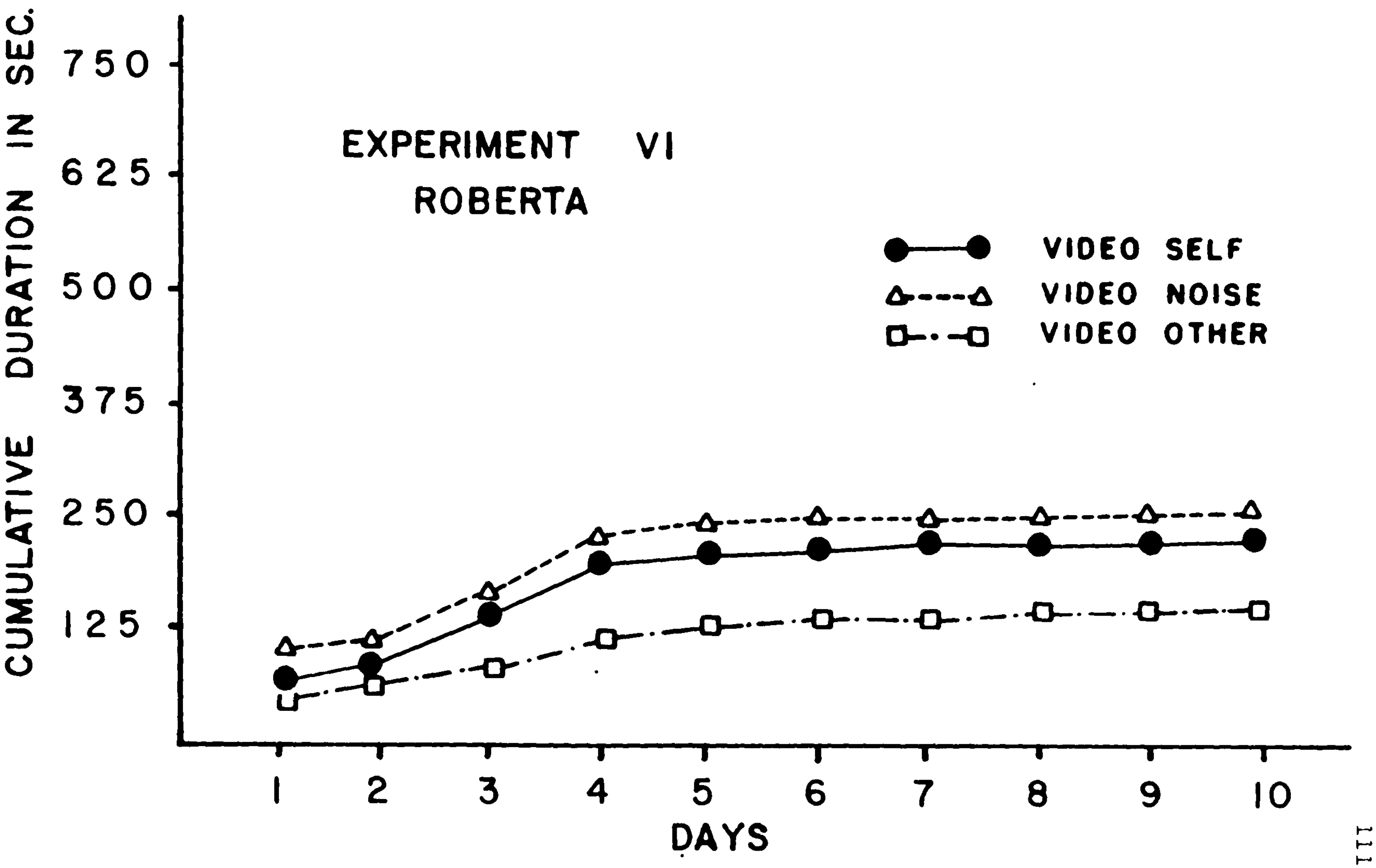

EXPERIMENT VI
BIBI
VIDEO SELF
VIDEO NOISE
VIDEO OTHER
CUMULATIVE DURATION IN SEC.
750
625
500
375
250
125
1
2
3
4
5
6
7
8
9
10
DAYS

FIGURE CAPTION

Figure 17. Cumulative duration of response produced video views of self, another monkey, and video noise. The subject is Roberta, a pigtailed macaque.


EXPERIMENT VI
ROBERTA
VIDEO SELF
VIDEO NOISE
VIDEO OTHER
CUMULATIVE DURATION IN SEC.
750
625
500
375
250
125
1
2
3
4
5
6
7
8
9
10
DAYS

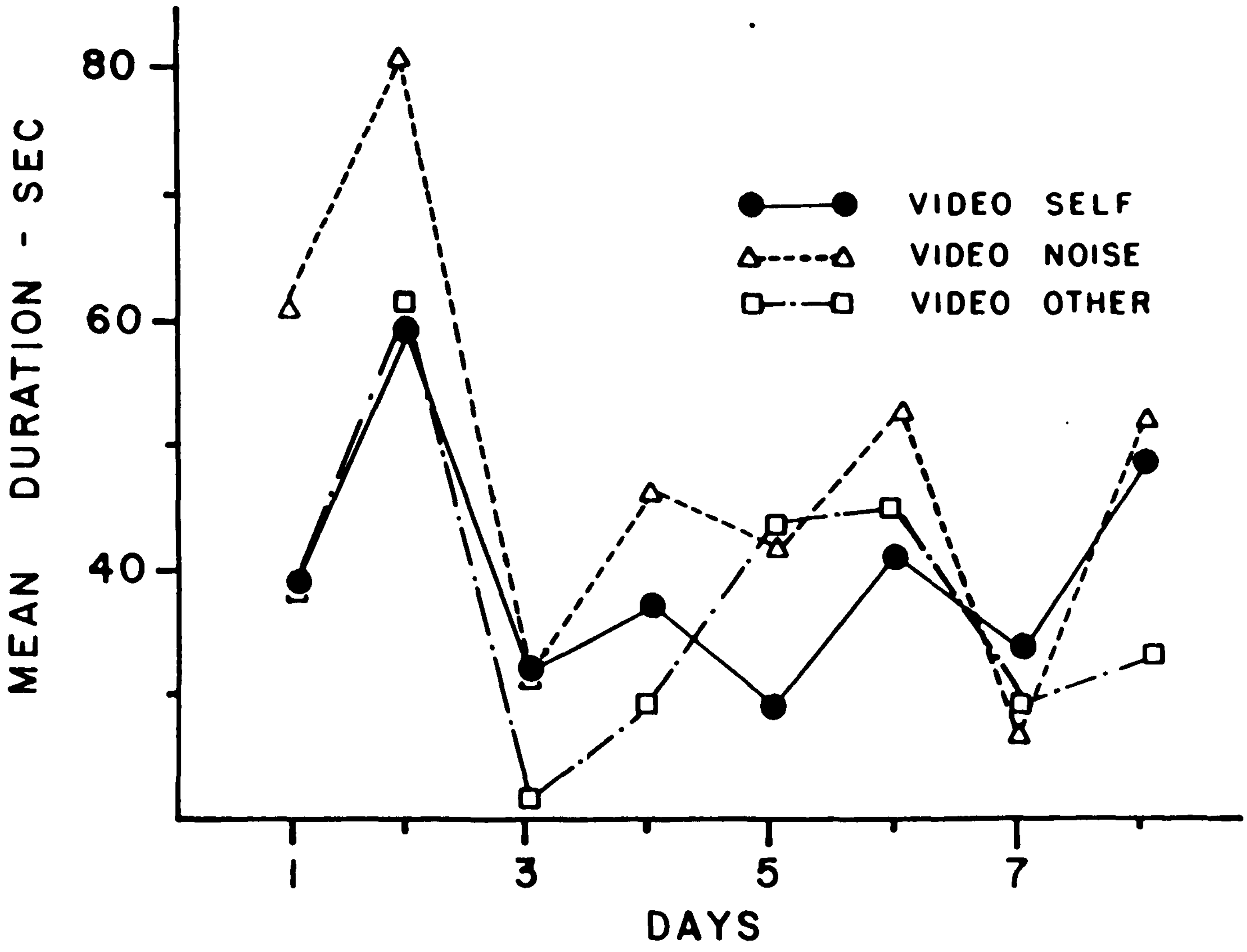
responded so little was peculiar, as she was the best responder in Experiments IV and V.

A cumulative effect of social (visual) isolation from the colony did not materialize. It was hypothesized that responding for social stimuli would increase as a function of the number of days of deprivation, even though these stimuli are considered by some as weakly reinforcing (Kish, 1966). Only in Niko's case was there anything that resembled a positive accelerating function, and this is not straightforward because more responding took place on day 2 than any other day, and on day 3 and 4 there was little responding. After that there was an increase in the frequency, but not the duration, of responding.

Video noise, the other monkey, and the contingent self were respectively the stimuli with the highest mean duration/response for 16, 10 and 5 days of the total testing period (Table 3). When the highest mean duration was shared by more than one stimulus in the same day, all were counted as having the highest mean duration. (All 38 days are not represented because there were days when no responding took place.) Combining subjects, video noise was held on the monitor longer than the other stimuli in five out of eight days. (Note 2) (Figure 18) An analysis of variance, repeated measures design was done.

FIGURE CAPTION

Figure 18. Mean duration of response produced video views of self, another monkey, and video noise over days. The subjects were three pigtailed macaques. Session length was 8 hours/day.


80
60
40
MEAN DURATION - SEC
VIDEO SELF
VIDEO NOISE
VIDEO OTHER
1
3
5
7
DAYS

The results did not reach significance, but they suggest that video noise was the preferred stimulus, (F=4.57, df=2/4, p=.09). There was no effect of days or interaction shown of days and treatments. The data on the subject monkey (video self) and the other monkey (video other) suggest that the animals were not discriminating a difference in the monkeys, or that given the discrimination, they did not have a preference for either stimulus. If the monkey had been interested in 'playing with' the contingency inherent in the video self in present time situation, a differential level or pattern of responding would have developed. To our knowledge a monkey has not before been given an opportunity to respond operantly for a video image of itself in present time. The fact that no differential responding appeared between the two monkey stimuli is consistent with the results of the mirror image self recognition work. Monkeys do not seem to recognize the source of a contingent self image, be it under their control or not to produce the image. Rather, they respond as they do for a conspecific. In the mirror image work this conclusion is reached from observation of the animal's interaction with the image; in the video work presented the conclusion is reached from the absence of differential responding to video 'other' or video self. Due to the relatively low response rate and need for greater refinement in the video technique for handling the video self stimulus, this can only be a tentative conclusion. Ideally, the video self might be set up in such a way that the variability of the stimulus was minimized.

The present technique has limitations. Although it provided a means of comparing our results with those of Humphrey's group, the contingencies' effect on duration of any one stimulus are complex. A short duration both terminates the prevailing condition and provides opportunity for the next condition. A long duration preserves the prevailing stimulus and postpones the next opportunity to respond. In order to recover a given stimulus, the subject must produce the other two stimuli, however briefly.

EXPERIMENT VII

Control Procedures

It was important to ascertain whether responding in Experiments IV, V and particularly VI could be attributed to the visual consequences of responding. The well established value for monkeys of manipulative opportunities might be a factor in these circumstances (Harlow, et al., 1950; Harlow and McClearn, 1954). Further, we were interested in documenting visual orientation while responding.

Method

Subjects. The monkeys, Bibi, Wife, Niko, and Roberta, who participated in Experiments IV-VI were used. Details of their housing and condition were indicated in Experiment VI.

Apparatus. The apparatus was the same as used in Experiment VI with the following additions: To video tape the performance and visual orientation of the subjects while a session was in progress a hole was cut in the cubicle wall. The camera was a Sony AVC 3450, with a Sony TV Zoom lens, 1:1.2, f 12.5~50mm. The video tape recorder used was a Sony Videocorder AV 3650. A Hewlett-Packard Wide Range Oscillator, model 200CD was used to signal responses on the tape.

Procedure. The subjects were placed in the experimental cage and allowed to remain for 10 minutes during which time the response panel was in a fixed position and the TV monitor was off. The equipment was then turned on, the panel was released, and the animal was reshaped by placing a raisin in back of the panel. On the first day the number of raisins given depended upon how long it took to reestablish the response. On subsequent days before the experimental session was begun, five priming responses were rewarded with a raisin or 90 mg banana pellet. The stimulus available on the monitor after these responses were made was the first condition of the day.

There were two conditions: (1) the same stimuli as in Experiment VI--the colony mate (video other), video noise, and the subject herself in the contingent condition (video self), available in alternating sequence, and (2) no visual consequences, the screen remaining blank. The conditions were counterbalanced between and within days in an ABBA, BAAB design. When the condition changed during the day, the investigator pressed the response panel to give the subject a sample of the condition. By watching the animals' visual orientation, typically five presses were necessary to assure that the animal had seen the monitor. As in Experiment VI, the sessions were eight hours, usually 9 a.m. - 5 p.m. The experiment continued for four days, after which the subject was returned to her home cage. With some exceptions when other times in the sessions were sampled, the first hour of the session was taped for review of the subject's orientation during responding. A tone was present on the video tape for the duration of each response.

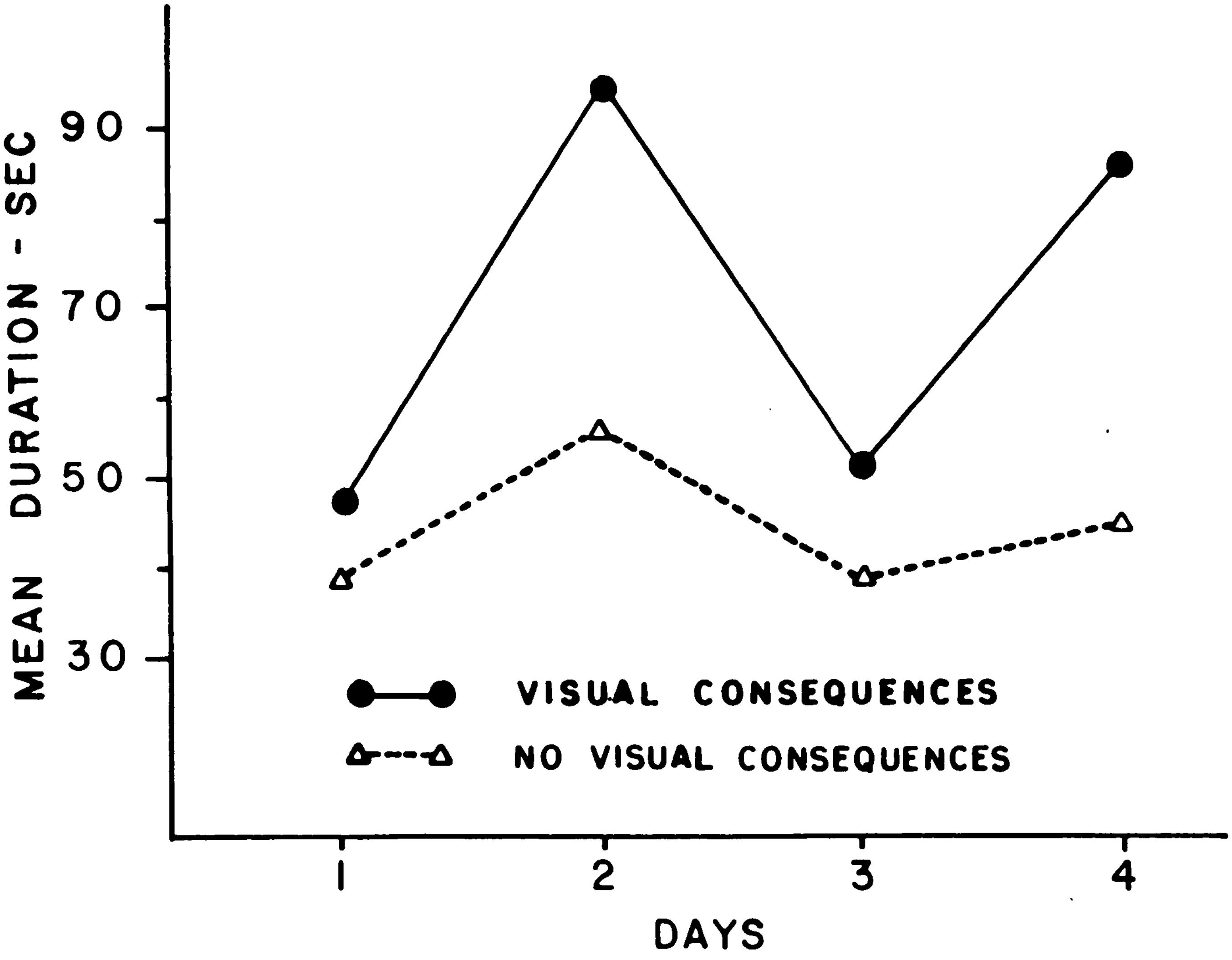
Results and Discussion.

The subjects responded with approximately the same frequency for visual or no visual consequences. On the duration measure, however, there was a statistically reliable difference between the conditions (Wilcoxin sign test; p=.05). Figure 19 and Table 4 combine the data for three subjects. The fourth subject, Wife, did not respond at any time during the four days.

The second question asked in the experiment was whether or not the subject was visually oriented to the monitor when making a response. A related question is whether there was a relationship between visual orientation and the consequences of responding. A Chi Square analysis indicated no significant relationship between visual orientation and the consequences (Table 5).

FIGURE CAPTION

Figure 19. Mean duration of responding for video consequences or no consequences (extinction). The subjects were three pigtailed macaques.



MEAN DURATION - SEC
90
70
50
30
VISUAL CONSEQUENCES
NO VISUAL CONSEQUENCES
1
2
3
4
DAYS

However, of the observed sample of responses, regardless of consequences on the monitor, 66% were judged to be oriented to the monitor. Of those, 61% occurred when there were visual consequences on the screen. Although there is not a significant relationship, there is some indication that visual orientation to the monitor is higher when there are visual consequences on the monitor.

Although the data indicate that considerable responding is maintained by the reinforcing value of pushing the response panel, the duration measure shows that the visual incentive is responsible for sustaining the response. These results support much of the literature that indicates that duration measures are critical in accurate assessment of visual incentive work (Butler, 1961; Butler and Woolpy, 1963, Paully, 1982; Swartz, 1977).

GENERAL DISCUSSION

The issue of central concern in the work presented is contingent image self recognition. We have replicated and extended data on the ability of the chimpanzee to recognize the source of its own mirror image (Gallup, 1970). We have ascertained that chimpanzees retain the ability to recognize their mirror image over a year without intervening mirror exposure. Further, we have looked for mirror self recognition in a monkey (*M. nemestrina*) after prolonged exposure to a mirror inside the home cage, allowing tactile exploration. The monkey's failure to demonstrate mirror image self recognition led to an attempt to analyze the pattern and contingency components of the self recognition task. Though this line of research was conceptually sound, it was not successful for a variety of reasons. The subsequent work which comprises Part II of this dissertation attempted to assess the relative reinforcing value of video presentation of some social stimuli, including the contingent video image of the subject animal. To our knowledge, monkeys have not been given the opportunity to produce their own video image. It was hypothesized that removal from visual contact with the colony (social deprivation) would heighten the value of opportunities to view familiar conspecifics.

Experiments IV, V and VI showed no preference for video-presented social stimuli over video noise in either the frequency or duration measure. A possible exception to this was the subject Niko in Experiment IV. Reinforcement by video noise ('snow') was seen in all subjects in Experiments V and VI, but may be, at least in part, attributable to greater brightness of the noise condition. The anticipated effect of cumulative social deprivation did not materialize.

A complex nexus of reasons for these results are suggested. If we postulate that the video noise stimulus is positively reinforcing, and that the production of images of monkeys on a screen near the subject monkey's cage is aversive, the pattern of responding is reasonably explained. It is not, however, a completely encompassing or satisfying explanation. The monkeys in our colony frequently grimace to each other and are watchful of each other in even these restrained conditions. In the field, monkeys constantly monitor each other visually (Gautier and Gautier, 1977). Butler and his colleagues (1954, 1955, 1957) have shown high and sustained levels of responding for live views of colony mates. When monkeys are presented with social stimuli in slides, motion pictures and video, the interpretation is more complex. The robust responding seen for live stimuli very often collapses. Even some of the classic papers in the area, e.g., Butler (1961), have some ambiguous results. A blank screen, for example, may support as much responding as slides of monkeys. One monkey maintained almost continuous visual contact with a film of a snake predator of the species. Another monkey responded only once under the same circumstances. There is need for analysis of the interaction of variables in this area of research.

In circumstances of social deprivation, black and white video is not a recommended medium on which to present social stimuli. There were some indications of the inability of black and white video to support substantial responding (Humphrey, 1974; Humphrey and Keeble, 1976) but there is so little consistency in methodology or uniformity of apparatus that it is difficult in many cases to assess what are the important variables. There are, on the other hand, reports of high levels of responding and successful discriminations using black and white video (Miller, 1967, 1971).

The most successful response requirement-stimulus production combinations seem to be those that utilize the manipulative capacities of the monkey and produce a stimulus which is convincingly life-like. This has been variously achieved by nearly life size images on color monitors in a darkened room (Paully, 1982; Swartz and Rosenblum, 1980). Miller (1967, 1971) required that a monkey look down a tunnel to see the image. Butler (1961) had the stimuli appear at the far end of a small ante chamber as a result of opening a door. Future research in the area would be greatly facilitated by greater emphasis on the subjects' perception of the stimuli rather than focusing on the stimulus material per se. At best, parametric work would establish the importance of these variables and their interaction. There is a need for inclusion of information on discriminability and visual angles so that accurate assessments might be made of the subjects' visual experience. The importance of hues, luminance of various features, apparent distance of the stimulus, and the like should prove important.

In two of three subjects in Experiment VI responding to video self and video other was virtually the same; the third subject responded less to video other than to video self, though the difference was small. Either the subjects had no preference for video self or video other, or they could not discriminate the two stimuli. That they could have failed to distinguish the two stimuli as different is highly unlikely. Miller and his colleagues (1967, 1971), Humphrey and Keeble (1976) and Rosenblum and co-workers (1980, 1982) have all shown that monkeys can discriminate individual conspecifics on black and white and color video. In the case of our subjects, the suggestion is that the stimuli were weakly reinforcing, that motivation was insufficient. We suggest that the monkeys did not respond differentially to video self and video other because they regarded both as other monkeys. The extended mirror image work reported here with a pigtail macaque and numerous reports in the literature (Table 1) have shown consistently that monkeys, after prolonged exposure and tactile access to a mirror image, after specific training and exposure of many animals together, appear to regard the image as another animal. What does this mean? It means that in all the thousands of hours that the collective monkey subjects have been exposed to mirrors there has never been a report that one responded as though it perceived the contingency inherent in the situation. Whether the contingent image is operantly produced by the monkey, as in Experiment VI, or available for the animal to look at, as in the mirror image work, the monkey does not perceive the contingency. There are differences in the pattern and/or intensity of the social behavior directed to a contingent mirror image, on the one hand and a live conspecific on the other, but these differences are most likely attributable to the anomalous social interaction. A way to clarify the critical question of monkeys' ability to discriminate contingency in contingent image situations would require that the subject's image be presented in present (contingent) and past time conditions, very recent past time being the most rigorous test.

It is precisely in the apprehension of the contingency that we see the remarkable difference between the way chimpanzees and monkeys behave with respect to the mirror. Chimpanzees, as do monkeys, respond initially to their mirror image as though it were another conspecific. But typically, and in the case of two of our four chimpanzee subjects, as the social behavior drops out there occurs what might be called 'contingency testing'. We observed that the animal began to move its body or parts of it, while maintaining visual orientation to the mirror. If moving a part of the body that could be seen without using the mirror, the gaze would shift from the body part to the mirror and alternate a few times. There was a quality about these initial 'contingency tests' that we noted especially in the case of James, the wild born male, which though not easily quantifiable, should be noted. There is an impression that the animal is watching the image with a special intensity, there is a level of tension in the posture of the body which suggests attention and a state of alertness, and there is a slowness of gesture which suggests purposefulness. Many of the 'contingency tests' we observed seemed to have their origin in a social expression. For example, James would, by the second day, make a teeth-bared threat gesture watching the mirror, then hold his mouth open, relax the facial muscles, and begin to move his mouth and extend his tongue while maintaining the type of visual contact with the mirror described above. Barash, the other male who was positive on the third dye mark test, did not respond as often socially, thus this transformation from social gesture to 'contingency test' was not seen as clearly. This is possibly due to the fact that he was a laboratory reared animal, had had some mirror experience, and had a social repertoire less elaborated or honed than one would see in a wild-born animal of his age. That Mona, the four year old wild-born female, did not appear to understand the source of the mirror image is curious. As discussed in Experiment I, our suggestion is that because of her lack of social responding, she did not have sufficient opportunity to experience the dissonance of the social interchange and the contingency information inherent in the mirror image. In order to successfully negotiate the self recognition task, we suggest with Gallup

(1979) that the animal must have some concept of self, some awareness of itself as an object, which it brings to the mirror situation. In addition, we suggest that the subject in this paradigm must provide by its own behavior sufficient opportunity to experience the contingent relationship with the mirror. Would a chimpanzee, for example, deprived of the opportunity to monitor its gross motor interaction with the mirror, solve the problem by visual or small motor movements?

James and Barash apparently retained for a year, the ability to recognize themselves in a mirror. This adds weight to the initial achievement and strengthens the assertion that we are probing a conceptualization in the chimpanzee which has characteristics in common with our human experience of self-awareness.

TABLE 1

PRIMATE SPECIES TESTED FOR MIRROR IMAGE SELF RECOGNITION

Species	Author	Social Responses	Self Directed Responses	Dye Test
Homo sapiens	Amsterdam, 1972, Mans et al., 1978	+	+	+
Pongo pygmaeus	Lethmate & Ducker, 1973, Suarez & Gallup, 1981	+	+	+
Pan troglodytes	Gallup, 1970,71; Lethmate & Ducker, 1973; Calhoun-Radano & Thompson, 1979	+	+	+
Gorilla gorilla	Ledbetter & Basen, 1981; Suarez & Gallup, 1981	+	-	-
Hylobates lar	Lethmate & Ducker, 1973	+	-	-
Hylobates agilis	" "	+	-	-
Cebus apella	" "	+	-	not tested (nt)
Ateles spec.	" "	+	-	nt
Papio hamadryas	" "	+	-	nt
Mandrillus sphinx	" "	+	-	nt
Macaca silenus	" "	+	-	nt
Papio Anubis	Benhar, Carlton & Samuel, 1975	+	-	-
Macaca nemestrina	Calhoun-Radano & Thompson, 1978	+	-	-
Macaca arctoides	Gallup, 1970, Anderson, 1983	+	-	-
Macaca mulatta	" 1970, 1980	+	-	-
Macaca fascicularis	" 1970, 1976	+	-	-

(+ means positive or behavior shown, - means negative or behavior not seen)

TABLE 2

LUMINANCE AND ILLUMINANCE MEASUREMENTS OF STIMULI

	Spectra 1° Photospot Meter (luminance measure)				
Conditions of Measurement	Blank Screen	Video Self	Video Noise	Video Other	Pavlova (Experiments IV & V)
45 cm from video monitor	3.5 fl	2.8 fl	2.9 fl	2.1 fl	2.4 fl
30 cm from middle of cage wall opposite monitor	2.4 fl	2.4 fl	2.3 fl	1.6 fl	2.0 fl
	UDT/OPTO Meter (illuminance measure)				
30 cm from video monitor	1.1 fc	2.2 fc	4.3 fc	2.0 fc	2.5 fc
15 cm from middle of cage wall opposite monitor	1.0 fc	1.0 fc	1.1 fc	0.8 fc	1.0 fc

TABLE 3

MEAN DURATION/RESPONSE IN SECONDS

Niko	Video Self	Video Noise	Video Other
Day 1	1.25	2.00	1.14
2	1.40	2.07	1.57
3	1.55	1.38	2.11
4	1.17	1.88	1.14
5	1.11	1.58	1.00
6	0.84	0.99	0.91
7	1.35	0.91	0.98
8	1.21	1.38	1.04
Bibi			
Day 1	1.14	2.34	2.50
2	1.38	1.52	1.29
3	2.53	2.70	1.39
4	3.27	1.96	3.27
5	1.90	2.21	4.01
6	2.81	5.40	2.02
7	1.80	4.33	4.33
8	7.27	5.60	2.40
9	4.00	4.20	6.70
10	2.80	23.10	9.00

TABLE 3 Continued

MEAN DURATION/RESPONSE IN SECONDS

Roberta	Video Self	Video Noise	Video Other
Day 1	4.92	6.92	4.00
2	5.10	2.25	2.10
3	8.48	8.60	3.40
4	8.47	9.51	5.10
5	1.05	3.00	3.60
6	0.60	0.90	3.30
7	0.90	1.50	1.50
8	0.00	0.00	0.00
9	0.00	0.00	0.00
10	0.60	0.60	0.00

Wife

Day 1-3 no responses with duration long enough to be recorded.

4	0.66	0.66	1.00

5-10 no responses with duration long enough to be recorded.

TABLE 4

RESPONDING FOR VISUAL CONSEQUENCES (A) OR NO VISUAL CONSEQUENCES (B)

	A		B	
	Freq.	Dur. (100/min)	Freq.	Dur.(100/min)
Day 1	45	176	59	144
2	95	315	58	184
3	53	179	57	131
4	95	287	67	152
Totals	288	957	241	611

TABLE 5

OBSERVABLE RESPONSES

VISUALLY ORIENTED (O) OR NOT (NO)

			O	NO
CONDITIONS	Visual Stimuli	A	40	17
	Blank Screen	B	26	17

APPENDIX 1

30 second behavioral sample sheet.

MIRROR SELF RECOGNITION PROJECT
(LEMSIP)

Chimpanzee________________ Date __________ Session ___________

	MIRROR ORIENTED		NOT MIRROR ORIENTED	DYE AREA TOUCHED
Self Directed	Other	Social		
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				

Footnotes

[1] Factors of cage design and lighting made observation of two animals difficult. In addition technical delays on the dye test day complicated matters sufficiently that we had no confidence in the data.

[2] Analysis was done on eight rather than ten days, as one subject, Niko, had to be discontinued at the end of eight days because of apparatus problems.

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