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A New Telestimulation Technique for the Study of Social Behavior of the Squirrel Monkey

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Specific behavior elements and reactions such as vocalization, orientation, affective reactions, genital responses, urination, salivation, changes in EKG, breathing frequency, and hippocampal activity and motoric responses could be elicited in various combinations by electrical brain stimulation. Some of these reactions are important elements of socially significant behavior.

In order to investigate such questions as can social behavior be elicited by stimulation of specific brain structures and if so, how stimulated and non-stimulated animals react within their social group in various situations, all animals must be free moving. In addition, it is important that a receiving device does not produce major changes in appearance of the animals.

A remote control receiver including batteries that can be worn on the head of a 500 g to 900 g animal with a brain weight of 26 g must be small and lightweight. In order to reduce electrolytic brain lesions from repeated stimulation it is necessary to use a biphasic pulse.

An apparatus which fulfills these basic requirements will be described.

Two independent transmitters control the negative and positive pulse, respectively, of a biphasic stimulus of the calibrated receiver. The transmitters are controlled by square wave generators. Each pulse lasts as long as the appropriate transmitter runs, thus frequency, pulse duration, train duration and pulse delay can be entirely controlled at the transmitter. The amplitude must, for the time being, be manually set on the receiver but is independent of the field strength. Full current flows over the electrodes only when the field is above the minimum operating level of the receiver, otherwise there is no measurable current flow. Leakage current of the entire receiver is ca. 4 m A. The life for a set of batteries is about one year. The batteries last ca. 100 hrs. with continuous biphasic stimulation (30 cps, 1 ms pulse duration and maximum amplitude). The entire receiver including batteries, battery case and twenty-pole plug for electrode connections weighs ca. 11 g.

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Cultural Acquisition of a Specific Learned Response Among Rhesus Monkeys

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A. Introduction

KAWAMURA (1959) and later KAWAI (1963), in their discussion of field studies of Japanese macaques, described behaviors which were peculiar to certain troops of these monkeys. Food habits, usually learned by infants from their mothers, were found to be specific for each troop. Within a troop, there may be sub-populations which exhibit particular habits. For example, in 1956, females and juveniles of the provisioned Koshima troop exhibited Sweet Potato Washing Behavior, while peripheral adolescent males did not. KAWAI (1965) suggests that reduced social interaction between these parts of the troop makes it unlikely these peripheral males will acquire Washing Behavior. ITANI (1958) has referred to the above behaviors as culture.

WASHBURN and HAMBURG (1965), from observations by DEVORE, describe an incident which had profound and long term effects upon the subsequent behavior of members of a baboon group. Prior to the shooting of two members, the group could easily be approached in a car. The authors comment, «...it is very unlikely all the animals in the group saw the shooting...» but eight months later this group «...still could not be approached, even though the animals must have seen cars almost daily in the interval». The experience of some of the animals had apparently become part of the whole group's behavior, an event suggestive of cultural transmission.

JOSLIN, FLETCHER and EMLEN (1965) examined the reactions of rhesus monkeys to snakes. They found that wild-reared animals would not reach toward a live snake or snake-like model to retrieve a food reward, while lab-reared animals, in the same situation, showed little hesitancy in reaching for the reward. In explanation, they proposed that, in the wild, young rhesus monkeys learn to fear snakes from the reactions of older members of the troop to which they belong; lab-reared monkeys, never exposed to snakes or to adult reactions toward snakes, do not acquire the response. In this view, the transfer of information underlying responses of the wild-reared monkeys could be regarded as cultural in the sense of Itani.

I regard culture as the constellation of behaviors characteristic of a single social group, behaviors which are transgenerational and socially learned by individuals as members of the group. The present report describes an attempt to apply controlled laboratory methods to a social learning situation suggested by the above field and

laboratory observations. My particular interest was whether the learned avoidance behavior of a conditioned monkey toward a conditioning object could induce a lasting effect on the behavior of a second monkey toward that same object.

My warmest thanks go to Professor John T. EMLEN for discussion and guidance which led to posing the question, to Professor Harry F. HARLOW, Dr. Bruce K. ALEXAN-DER and personnel of the Primate Laboratory, Department of Psychology, University of Wisconsin, for guidance in expediting the study, and to my wife, Gayle, for assistance in gathering the data and patience during their analysis.

B. Method

1. Subjects

Eight lab-reared rhesus monkeys (4 males and 4 females, *Macaca mulatta*) about three years of age served as subjects. They had been raised with their mothers and had had much play experience with each other during their first 2½ years of life. Primate Laboratory personnel regarded them as socially normal. No conditioning experiments had been performed on these subjects prior to the study reported here.

2. Apparatus

Subjects were taken by transport cage from their separate home cages in colony rooms to the apparatus (Fig. 1) in the testing room. White noise masked most of the extraneous noises in the test environment. Observations of each subject's behavior in the presence of an object were made through a one-way window and recorded continuously with a keyboard activating nine channels of an Esterline-Angus recorder. Data recorded were location of the subject and the object in the apparatus, incidence of vocalization, and incidence and duration of visual exploration, ambulation, stereotypic movements, and manipulation of the object. When two subjects were observed at once, a trained assistant simultaneously recorded the second subject's behavior with similar keyboard. General comments and impressions were noted at the end of each session.

Only the data for manipulation of objects are considered in this report. Manipulation ranged from apparently passive contact of the subject's hand with the object, to active investigation, including mouthing and chewing. Objects were plastic kitchen utensils (seive, cup, mustard jar, etc.) of different sizes and colors; all elicit similar responses from the subjects under similar circumstances.

3. Procedure

Subjects were assigned to unisexual pairs. Each subject, either alone with an object, or together with its partner and an object, was observed in sessions of 15 minutes duration. A total of 45 test and control sessions was conducted with each subject. The critical test sequences were towards the end of this series and contained four sessions as follows:
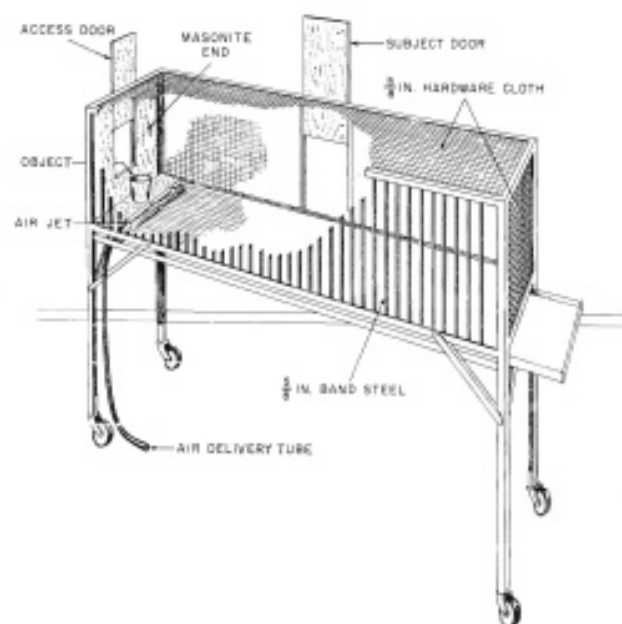
Fig. 1: Steel cage in which all sessions were conducted. The 7 × 2 × 2 ft. angle-iron frame was covered with heavy duty hardware cloth except for one side of steel slats. Prior to a subject's entry into the test room and apparatus, one object was placed on the board at the masonite end.

1. One subject of a pair, while alone in the apparatus, was punished with an air blast each time it started to manipulate an object. Two or three air blasts generally sufficed to terminate all manipulation tendencies toward this object.

2. This subject was again observed alone with the object to test for retention of the learned response.

3. The subject, now a «demonstrator,» was observed with its naive partner in the presence of the conditioning object. No air blasting was done.

4. The naive subject was observed while alone with its partner's conditioning object. The remaining sessions were conducted to gather control data.

An initial block of 16 sessions served to habituate subjects to the test apparatus and procedure, to determine the manipulation tendency of each individual, and to determine the effect of social interaction on an individual's manipulation tendency. Subjects were exposed to either Object 1 or to Object 2 in these sessions. A subject was exposed to Object 1 only when alone in the apparatus and was exposed to Object 2 both alone and when together with its partner. Each subject had four sessions with Object 1, six sessions alone with Object 2, and six sessions together with its partner and Object 2.

To control for the possibility of daily variation in a subject's tendency to manipulate an object, and for any changes in this tendency during the three months of study, each subject was observed while alone with Object 1 in 13 sessions systematically scheduled through the entire period of study, both before and after the critical test sessions. Eight of these sessions were scheduled so that each subject was in a single session and all of the subjects had their session on the same day. To control for changes in the effect of the presence of a second subject on a subject's manipulation tendency, additional control data about each subject were gathered in two sessions alone with Object 2 and four sessions together with its partner and Object 2 scheduled over the remainder of the study.

To determine the effect of novelty *per se* on a subject's manipulation tendency and the possible effects of its reactions to novelty on a second subject's manipulation tendency, the sequence of four sessions listed above as the critical test sequence was first run without reinforcement as a control series. This was followed within two weeks by the test series in which the novel object was reinforced for the demonstrator subject with a blast of air as described above.

To increase the number of tests of transfer of information, the respective roles of subject A and B of a pair were assigned and conducted in one way and then reversed (Sets I and II in Fig. 2a). This procedure was followed for both the novelty (non-reinforced control series) and the reinforced object tests series (Fig. 2b).

Fig. 2: Sequence of Sessions with Novel Objects

a) Control: Response to a Novel Object

	Set I				Set II		
A	A	A + B	B		B	B	B + A	A
alone	alone	together	alone		alone	alone	together	alone

Object 3   Object 4

b) Test: Transmission of a Learned Response Toward a Novel Object

	Set I				Set II		
A	A	A + B	B		B	B	B + A	A
alone*	alone	together	alone		alone*	alone	together	alone

Object 5   Object 6

* — air blast when the subject attempts to manipulate the object.

Fig. 2: Format of sequences of sessions with novel objects for all pairs of subjects. (a) In the control sequence, subjects were put with non-reinforced novel objects. (b) In the test sequence, the demonstrator subject was punished with air blasts at the moment it was about to touch the object. Since the demonstrator did not attempt to manipulate the object during its second session with it, no further air blasts were administered, and the demonstrator was considered successfully conditioned to avoid this specific object

C. Results

1. Control data

In the initial block of 16 sessions, males manipulated 8.5% and females manipulated 35.4% of the total time available. Averages over this block for individual males ranged from 2.5% to 12.9% and for individual females from 22.4% to 58.1%. This sex difference in manipulation tendencies was maintained throughout the study.

A subject's manipulation tendency, relative to the tendencies of the other subjects, remained similar, session to session, throughout the study. Subjects were ranked for their amount of manipulation in each of the ten sessions in the initial block while alone with either Object 1 or Object 2. Concordance of these rankings was tested by the Kendall method (Siegel, 1956) and was found significant (p < 0.01). Rankings of subjects in each of eight of the remaining 13 sessions alone with Object 1 also showed concordance (p < 0.01).

While there was daily variation in a subject's manipulation tendency, each subject tended to have its high and low amounts of manipulation on the same days that the other subjects had their respective highs and lows. Ten sessions of each subject when alone with Object 1 were ranked for amount of manipulation. Concordance of these rankings for all of the subjects was found significant (p < 0.01).

The manipulation tendency of a subject was affected by the presence of a second subject. Females manipulated Object 2 about twice as much when together (62.7%) as when alone (30.1%). Individually, every female manipulated Object 2 more when with its partner than when alone. Males manipulated Object 2 more when together with another subject (11.4%) than when alone (7.6%). As individuals, two males increased and two males decreased their amount of manipulation when with their partners from the amount when they were alone.

The relative manipulation tendency of the subjects when with their partners did not differ from that when alone. The rankings of subjects for total manipulation of Object 2 while alone and while together were very similar (Spearman Rank Correlation Coefficient $r_s = 0.95$, p < 0.01).

Subjects manipulated novel objects more than familiar objects. When all sessions for each subject while alone with an object were ranked for amount of manipulation, the four sessions when a subject was alone with an object for the first time were not uniformly destributed over the ranking, but tended to be in the high part of it ($X^2 = 10.75$, p < 0.02). When together-sessions were ranked for amount of manipulation, the distribution of sessions with novel objects was more uniform over the ranking.

Subjects manipulated novel objects more of the available time when together with their partners than when alone. Females manipulated such objects 65.7% when together and 38.8% while alone. Males manipulated such objects 38.7% when together and 32.9% when alone.

Novelty had more effect on males than on females in the together-sessions. Among females, the percent of available time spent manipulating was about the same for novel objects (65.7%) as for familiar objects (67.4%). Among males, novel objects were manipulated more (39.2%) than familiar objects (13.1%).

2. Tests for transfer of information

Comparison of the time course of manipulation of an object during the four sessions of the critical test sequence with a reinforced novel object and the four sessions of the control sequence with a non-reinforced novel object is presented for the males in figures 3 and 4 and for the females in figures 5 and 6. In the critical test sequence, designed to test for transfer of a learned response, the learned response toward the reinforced object was transferred with lasting consequences from the demonstrator subject to the naive partner in three cases; all of them involved males (Fig. 3, Sets I and II; Fig. 4, Set I). In three other cases, all females, the information was not transferred, but instead, the avoidance response of the demonstrator was gradually extinguished as the non-conditioned naive partner proceeded to manipulate the object (Fig. 3, Set I, Fig. 6, Sets I and II). Data for the remaining two sequences were inconclusive.

All subjects appeared to have been successfully conditioned to avoid the reinforced object during their first session as demonstrator in the critical test sequences; no air blasts were required to prevent manipulation by the demonstrator in the second session while it was alone with the object. Behavior in the third session, while the conditioned demonstrators were paired with their naive partners, varied according to the sex of the subjects as noted above. In two of the male sequences, the demonstrator exhibited what was interpreted as a threat facial expression while in a fear posture. As the naive partner (Subject A_1) approached the conditioning object in the third sequence with males (Fig. 3, Set II), the behavoir of the demonstrator (Subject B_1) was more definite as described below:

The demonstrator subject, upon being placed in the apparatus, retired to the end furthest from his conditioning object. The naive subject, when placed into the apparatus ten seconds later, first went to and mounted the demonstrator subject, then proceeded to the object without hesitation, looked at it and slowly reached out towards it. At this moment, the demonstrator subject came from the far end of the apparatus, grabbed the naive subject by the flanks and pulled him away. The object remained in place on the board. The demonstrator then turned and sexually presented to the naive partner. The naive partner, although it subsequently approached the object several times, did not touch the object in the remaining 14 minutes of the session.

In the three cases involving females, the demonstrator subject remained away from the object, but made no overt moves to interfere.

D. Discussion

Data from six of eight critical test sequences designed to test for transfer of information between socially normal lab-reared monkeys demonstrate that behavior of one member of a pair toward a novel object can alter the behavior of its partner toward that object with lasting consequences.

In the three female sequences, the influence of the naive subject on its demonstrator partner appeared to be through simple observational learning (c.f. HALL, 1963) in which the demonstrator, known to have been successfully conditioned to avoid a specific object, observed its partner manipulating that object, and subsequently, also manipulated the object. ITANI's (1958, p. 86) original referent for culture in monkeys
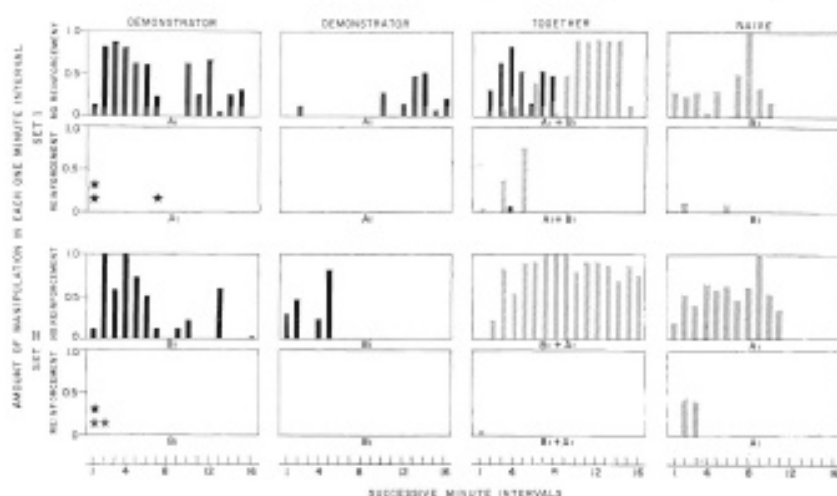
Fig. 3: Manipulation of novel objects by male subjects A_1 and B_1. Histograms represent amount of manipulation in each one-minute interval of the session. Time available for manipulation in the first and sixteenth intervals of the session totals one minute. Stars indicate blasts of air to punish attempts to manipulate a specific object
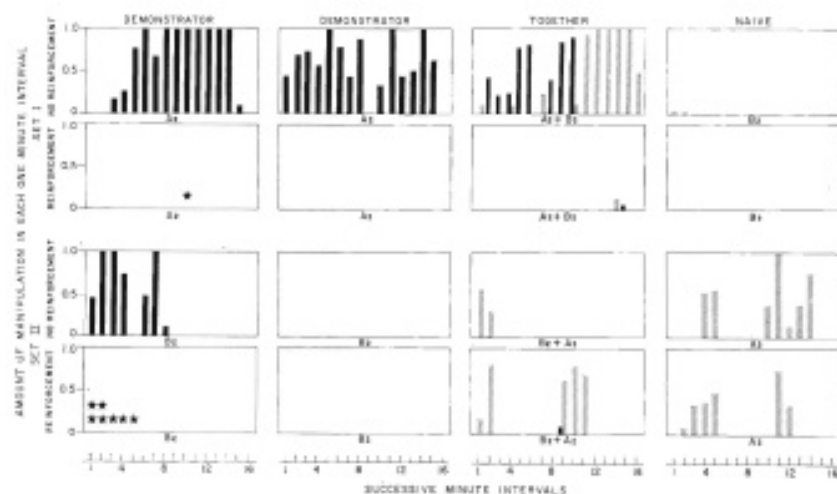

Fig. 4: Manipulation of novel objects by male subjects A_2 and B_2. While subject B did not manipulate the non-reinforced novel object much as naive subject in Set I, he would not touch his demonstrator partner's conditioning object
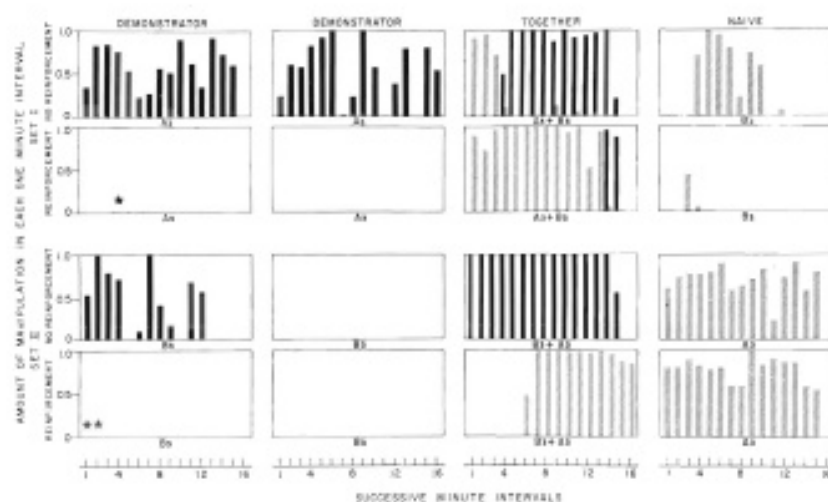
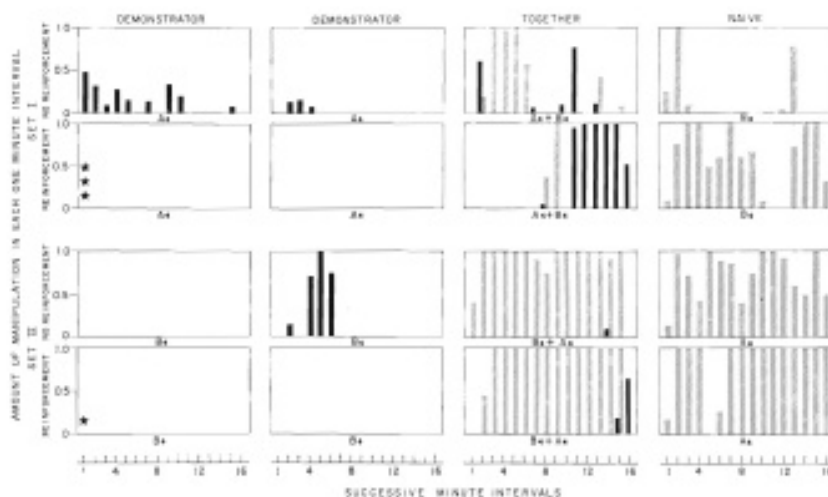Fig. 5: Manipulation of novel objects by female subjects A_3 and B_3

Fig. 6: Manipulation of novel objects by female subjects A_4 and B_4

was the constellation of food habits acquired by Japanese macaques through a social learning process closely similar to this. New foods (FRISCH, 1959) as well as new objects (MENZEL, 1966) appear to have some negative valence for these feral monkeys. Through observational learning, some negative valences associated with specific objects (edible as well as others) can be overcome.

In the three male sequences, the demonstrator subject altered the naive subject's behavior toward a novel object which had previously been negatively reinforced for the demonstrator. Control data indicated that each subject had a characteristic level of manipulation which persisted with little variation throughout the study, that the tendency to manipulate was enhanced by novelty of the object, and that, for two of these subjects, presence of a second subject further enhanced the tendency of each subject to manipulate. In view of this control data, the observed alteration of the naive's behavior was unexpected. I consider transfer of information in these instances different from the observational learning described above for females, and homologous with admonition in the acquisition of culture by humans as discussed by E. T. HALL (1959). A demonstrator subject pulling his naive partner away from the demonstrator's conditioning object is admonition. Similarly, I regard the interactions between feral Japanese macaques in response to novel objects described by MENZEL (1966, p. 134) as admonition: «On more than 6 occasions, females with infants showed clearly that some caution underlies their indifference [to objects] when they pulled their offspring away from an approach to an object.»

The case is more difficult to interpret when no physical contact is observed. No vocalization was heard in the together-sessions with novel objects. Experimental studies (MILLER et al; 1959, 1966) suggest that communication of affect can be mediated in rhesus monkeys through facial expression and posture alone. With respect to the novel object in my studies, however, the referent of communication was nonsocial and specific, and remained specific in subsequent test sessions when the subject was alone. Less overt behaviors appear to have been operating and resulted in a more subtle form of admonition.

Recognition of admonition as a form of communication extends the modes of acquisition of culture which heretofore have been considered available to species of Macaca and Papio. Admonition can operate between individuals, and could conceivably operate between a single individual and the rest of the group, particularly from a dominant individual to subordinates.

Admonition could be operating complementarily with observational learning in Imanishi's (1957, p. 2) notion of «enculturation.» For example, IMINISHI (1960) and MIYADI (1964) conclude that the status of a given individual in the social hierarchy of a Japanese monkey troop is at least partially dependent on and learned by other monkeys in the troop in relation to the social status of that individual's mother. HALL and GOSWELL (1964) discuss such acquisition in terms of social learning. The acquisition of fear responses within feral troops, as well as to stimuli external to the troops, could be mediated through observational learning in combination with admonition.

Admonition in the tests described in this report was observed only in males; observational learning, only in females. The sample size is small and no sharp sex difference should be inferred. It may be pertinent to note that, in the sample, females had a greater tendency to manipulate than did males. From rank correlation, the tendencies of individuals to manipulate objects appeared to be relatively constant throughout the study. Manipulation of the conditioning object by the naive partner in the critical test sequence while alone subsequent to the together-session was highly correlated with its tendency to manipulate objects in the control sessions. Perhaps punishment during conditioning was not severe enough to prevent observational learning by or to educe admonition from females in this study.

E. Summary

The social learning situation suggested by field and laboratory observations to be involved in the acquisition of culture by individuals in groups of macaque monkeys was studied by controlled laboratory methods. In six of eight critical tests sequences with pairs of socially normal lab-reared rhesus monkeys, behavior of one subject toward an object altered, with lasting consequences, the independent behavior of a second subject toward that same object. Observational learning and admonition are distinguished as two types of information transfer between subjects which mediate the acquisition of culture in monkeys.

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The Learning Skills of Primates: a Comparative Study of Apes and Monkeys

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The purpose of this paper is to assess the learning abilities of groups of great apes, gibbons, macaques, and squirrel monkeys on a variety of visual discrimination tasks which range in difficulty from simple discrimination learning through object-quality learning set (LS; HARLOW, 1949), discrimination reversal (DR), and oddity concept (OC). Though there exists a vast literature on the subject of primate phylogeny as it relates to capacity for learning a wide variety of complex tasks, there has been no study in which the genera represented by the above listed groups have been directly compared within a single experimental program. The major barriers to such an experiment have been access to the animals in numbers and access to appropriate test facilities. Through the cooperation of the San Diego Zoological Society, it has been possible for the authors to overcome these barriers and to collect an extensive body of comparative primate data, major portions of which constitute material for the present paper.

Method

Subjects (Ss)

All ape and macaque Ss are identified and coded in Table 1, which also includes summary data of adaptation and simple discrimination learning data collected in Experiment I described below. All apes, except two chimpanzees (C-6 and C-11) and one orangutan (O-11), either had been on exhibit at the Children's Zoo, for various periods of time prior to serving in the experiment, or had been raised as pets, the latter being true of all gibbons. None of the macaques had this kind of history, which provided for close and sustained contact with people at an early time in life, but without exception they were well-adapted to being maintained at the Zoo before serving in the program. Squirrel monkeys Ss *(Saimiri sciureus)*, data from which are reported in Phase 3 of Experiment II described below, were the only Ss not tested at the Zoo. They were tested in the laboratory at San Diego State College where they had been maintained several weeks prior to experimentation. All *Saimiri* Ss were adult males (captured near Leticia, Colombia) estimated to be about three years old.