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Responses to snakes by surrogate- and mother-reared squirrel monkeys

DOUGLAS K. HUEBNER, JAMES L. LENTZ, MARILYN J. WOOLEY, and JAMES E. KING
University of Arizona, Tucson, Arizona 85721

Eight behaviors were observed in 1-year-old squirrel monkeys exposed to either a live boa constrictor or one of four inanimate objects with varying similarities to the live snake. The playpen group was exposed to these stimuli both in the presence of their feral mothers and after they had been permanently separated from their mothers. The surrogate group was similarly tested before and after separation from cloth mother surrogates. The principal finding was that the playpen group touched the box containing the stimulus objects for significantly shorter durations than did the surrogate group. The difference occurred both in the presence and in the absence of the mothers or the mother surrogates. This result indicated that the playpen infants had learned to avoid the stimulus box as a consequence of observing their mothers' marked affective responses to the snake.

An interesting and widespread phenomenon among many primates is their marked susceptibility to fear and avoidance responses in the presence of a live snake or even a snake model. The sensitivity of nonhuman primates to snakes has been known since the 19th century (e.g., Warwick, 1832) and has engendered several laboratory investigations on the form and generality of the fear response (e.g., Bernstien & Mason, 1962; Green, 1965; Schiller, 1952; Wolin, Ordy, & Dilliman, 1966). A useful technique for studying primates of avoidance of snakes and snake models in the laboratory is to measure the latency of the subject's food retrieval when the food is close to the snake stimulus. Research with this food retrieval technique has shown that feral squirrel monkeys (Murray & King, 1973), capuchin monkeys (King & Huber, Note 1), and rhesus monkeys (Joslin, Fletcher, & Emlen, 1964) manifest strong evidence of live snakes and discriminate among models of varying approximations to a live snake. Moreover, laboratory-born squirrel monkeys (Murray & King, 1973) and rhesus monkeys (Joslin et al., 1964) show no evidence of avoiding a live snake or any of the snake models.

One possible cause of the difference between feral and laboratory-born squirrel monkeys is that young feral squirrel monkeys may learn to avoid snakes as a result of observing the responses of their own mothers or other monkeys to snakes in the feral environment. Squirrel monkeys are preyed upon by boa constrictors in their natural habitat (Kauffeld, 1969). A question that we intended to answer with this experiment was whether juvenile squirrel monkeys housed with their feral-reared mothers would learn to emulate some responses made by the mothers in the presence of a live snake or inanimate models with varying degrees of similarity to the live snake. Specifically, we wished to determine if presentation of either a small live boa constrictor or one of various models of the live snake to juvenile squirrel monkeys housed with their mothers would result in juvenile behaviors predictably different, on the basis of observational learning, from those in a control group of juveniles housed with a cloth mother surrogate instead of a live mother.

The second question that we wished to answer was whether behaviors of laboratory-born squirrel monkeys without prior exposure to any snake would show significant variation dependent upon whether a live snake, a snake-like model, or a wooden block was present.

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METHOD

Subjects

The subjects were two groups of laboratory-born squirrel monkeys and a group of feral squirrel monkey mothers (*Saimiri sciureus*). The playpen group consisted of three monkeys reared in one of two playpen units. A unit contained two home cages measuring 39 x 61 x 58 cm, separated by a middle playpen cage of the same size, with openings leading into both adjoining home cages. Within 5 days of birth, mother/infant pairs were placed in each of the two home cages in both units. The playpen monkeys remained in the playpen units for a mean of 12 months, during which time they had access to their own mothers, the other mothers in the playpen units, and the infants of those mothers. At the end of 12 months, the mothers were removed from the playpen units; the playpen group remained in the units for the duration of the experiment. One mother died during the first 12 months. Her infant was left in the playpen unit and had access to the adjoining mother/infant pair but was not used as a subject for this experiment.

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Apparatus

Behaviors of the monkeys were tested in the presence of the following five stimuli, which were identical to those previously used by Murray and King (1973) and by King and Huber (Note 1) in their studies of snake avoidance in squirrel monkeys and capuchin monkeys, respectively: (1) a live boa constrictor (*Boa constrictor constrictor*), approximately 61 cm long (because of the relatively low temperature of the test room, the snake evidenced virtually no movement during the test periods); (2) a coiled rubber snake, 61 cm long, painted to resemble the live snake's pattern of coloration; (3) a coiled rubber snake, 61 cm long, painted a uniform gray; (4) a gray coiled rubber tube, 61 cm long, painted with red spots; (5) a wooden block, 3.8 x 3.8 x 5 cm, painted gray.

During testing the objects were contained in a transparent Plexiglas box (15 x 15 x 5 cm) with a closed top. The box was placed inside the subjects' cage and attached to the cage wall.

Behaviors were scored on a pushbutton-operated digital readout recording device that recorded total duration and frequency of each behavior observed. However, only total duration measures were used in the analysis of the data. A switch-operated timer was used to measure latency to touch the object box.

Procedure

Prior to initiation of testing, the subjects were adapted to the presence of the empty object-presentation box described above. Identical empty Plexiglas boxes were placed in the home cages of each mother/infant pair of the playpen group and each infant/surrogate mother pair in the surrogate group for a period of 72 continuous hours. Observations of the monkeys indicated that well before the end of the 72-h period, their behaviors had returned to the levels that prevailed before introduction of the boxes.

Phase 1. During this phase the playpen group remained in their home cages with their mothers, however, visual and physical contact with peers and other mothers was prevented by insertion of opaque wood panels between the home cages and the center cages of the units. The surrogate group remained in their home cages with their cloth mother surrogates.

The procedure for object presentation was as follows. The stimulus to be presented was placed in the Plexiglas object box outside the test room and the box was covered with a brown cloth. The box was then brought to the test room and placed inside the cage with the cloth still covering the box and its contents. The cover was removed and both the latency timer and test timer started. During the subsequent 3-min period, latency to touch the object box and total durations of the other seven behaviors described in Table 1 were recorded. At the end of the test period, the subject's cage was opened, the cloth cover was placed on the box, and the box was removed from the room for insertion of the next test stimulus.

Two observers were present for the scoring of the playpen group, one to score the infant's behavior and other to score the mother's behavior. Only one observer was present for the scoring of the surrogate group.

All five test stimuli were presented to each subject once on each of 5 consecutive days for a total of 25 test sessions. Latin squares were used to determine the order of stimulus presentation over the 5 test days, with a separate randomly selected Latin square used for each subject.

Phase 2. At the completion of Phase 1, the mothers and mother surrogates were removed from the home cages of the subjects and they were observed over a 10-day period as part of a different mother-separation study. At the end of this time, the monkey's behaviors had returned to preseparation levels and Phase 2 was initiated.

During Phase 2, the subjects were again presented all five stimuli each day for 5 consecutive days. The procedures were identical to those in Phase 1 except that only one observer

Table 1
Description of Behavioral Categories

Locomotion	Movement of entire body between two locations separated by at least one body length.
Vocalization	Any type of screech or other type of vocalization.
Self-Motion Activity	Movement involving rapid expenditure of energy.
Approach Object	Any direct movement toward the object box.
Proximity Object	Positioning of body within approximately 2.5 cm of object box, but not touching box.
Touch Object	Subject in physical contact with object box.
Latency to Touch	Length of time from beginning of trial to first physical contact with object box.
Visual Orientation	Visual contact with object box. May involve simultaneous bodily orientation toward object box.

scored the test sessions of the playpen group. A total of 30 days after separation of the mothers from the playpen group, the mothers were returned to the playpen units and infants were removed to separate cages. After a 5-day adaptation period, the mothers' behaviors in the presence of the five test stimuli were scored over a 5-day period with the same procedures as used before.

RESULTS

Of the eight behaviors that were scored, visual orientation toward the stimulus object showed the most clear-cut differences among the five types of stimuli presented. Figure 1 depicts the mean proportion of time that visual orientation occurred as a function of stimulus object, group, and testing phase. Application of analysis of variance to Phase 1 data from the playpen and surrogate groups revealed a significant Groups by Objects interaction [$F(4,20) = 4.56$, $p < .01$]. This interaction apparently occurred because the surrogate group was discriminating between some pairs of objects, while the playpen group was not. To support this interpretation, a further analysis of the interaction was conducted. This analysis showed a significant variation

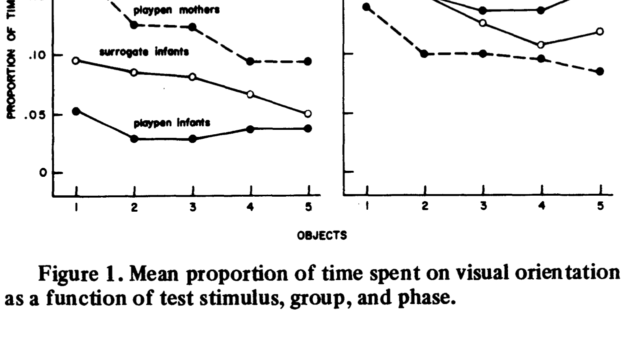

Figure 1. Mean proportion of time spent on visual orientation as a function of test stimulus, group, and phase.

in visual orientation across objects for the surrogate group [$F(4,20) = 6.79$, $p < .01$], but not for the playpen group. A Newman-Keuls multiple-comparisons test showed that the surrogate group visually oriented to the live snake significantly longer than to the block ($p < .01$). In addition, significantly more visual orientation was directed toward the snake painted with snake coloration than toward the gray block ($p < .05$).

During Phase 2, when all infants had been separated from their mothers or mother surrogates, visual orientation did not differ significantly as a function of objects for either the surrogate or the playpen group. The surrogate group manifested longer approach-object durations in Phase 2 than in Phase 1 ($t = 3.552$, $p < .05$, two-tailed test), but all other overall comparisons between Phases 1 and 2 were not significant.

Visual orientation by the mothers toward the real snake and the various snake models was ordered the same as that observed in the surrogate group and remained relatively constant from Phase 1 to Phase 2. Combined data for the mothers from both phases contained a significant stimulus object difference [$F(4,8) = 4.40$, $p < .05$]. A Newman-Keuls test showed significantly more visual orientation toward the real snake than toward any of the other stimulus objects ($p < .05$). No other differences were significant.

Figure 2 shows the total time spent touching the stimulus object box by all three groups of subjects during Phase 1 and Phase 2. Because of the extreme heterogeneity of variance between the playpen and surrogate group data, a square-root transformation was applied to the scores before calculation of the t scores. The playpen group spent significantly less time touching the stimulus object box than did the surrogate group during Phase 1 [$t(5) = 2.356$, $p < .05$, one-tailed test], as well as during Phase 2 [$t(5) = 2.640$, $p < .025$, one-tailed test]. The mothers avoided touching the stimulus box virtually all of the time during Phase 1, as well as during Phase 2. The uniformity of the mothers' scores necessitated use of the Mann-Whitney U test for the

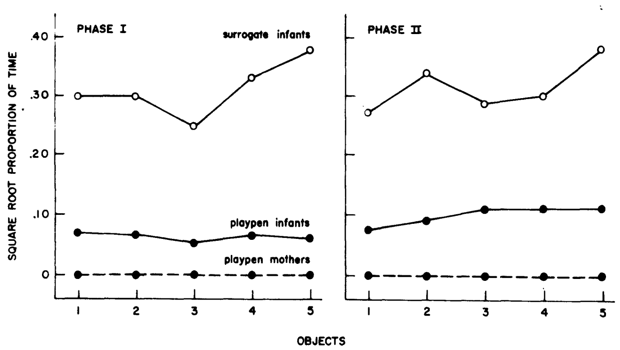

Figure 2. Square root of mean proportion of time spent touching stimulus box as a function of test stimulus, group, and phase.

comparison of the mothers' scores with those from the surrogate and playpen groups. These comparisons showed significantly more object touching by the surrogate group than by the mothers during both phases ($p < .05$). The difference between the playpen group and the mothers was not significant during either phase. No significant differences in object touching as a function of the type of stimulus in the object box were observed.

DISCUSSION

The behaviors observed during Phases 1 and 2 demonstrated two basic results. First, the duration of touching the Plexiglas stimulus box indicated that the playpen monkeys learned to avoid the stimulus box as a result of observing their mothers' total avoidance of the box accompanied by pronounced affective responses, including vocalizations and positioning in the corner of the test cage opposite the stimulus box. The low durations of stimulus box touching by the playpen monkeys in Phase 1 may have been partly influenced by the constraining effect of the mother's presence. However, the playpen monkeys continued to touch the stimulus box less than did the surrogate monkeys during Phase 2, in which neither mothers nor mother surrogates were present. The latter result, therefore, supports the conclusion that the box avoidance was acquired by the playpen infants through observing the mothers' responses to the box in Phase 1.

The amount of box touching by the mothers and the playpen infants was virtually independent of the stimulus object contained in the box. After the initial presentation of the live snake in the box, the snake, the wood block, and the intermediate stimuli all evoked about the same amount of box touching. Clearly, the initial responses of the mothers to the live snake and box combination had generalized to the box with nonanimate contents, and the generalized response was apparently learned by the playpen infants through observational learning. This widely generalized response across a wide variety of test stimuli contrasts with findings in prior experiments (Murray & King, 1973; King & Huber, Note 1) showing a sharp discrimination by squirrel and capuchin monkeys between snakes and snake models as measured by food retrieval latencies in the presence of those stimuli. The shape of the stimuli was an important variable in these studies. In the study described here, the particularly strong affective responses caused by the live snake in the home cages may have resulted in wider generalization of those responses than in the previously cited studies.

The second principal finding was that the surrogate monkeys directed significantly more visual orientation toward the live snake and the rubber snake painted with snake-like colorations than toward the gray block. Furthermore, the amounts of visual orientation to all five stimuli were ordered in the same way as the similarity of the objects to the live snake. These differences in visual orientation were possibly caused by differences in the complexity of the stimuli: The live and the painted rubber snakes were visually more complex than the other three stimuli. However, another enticing possibility is that live snakes and inanimate objects shaped and painted like snakes are particularly effective elicitors of visual orientation in laboratory-reared squirrel monkeys who have not previously encountered any snake or snake-like object. The possibility that such effectiveness is enhanced by an innate or unlearned factor requires much further investigation, but it is hoped that additional information on this interesting phenomenon will be forthcoming.

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