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A comparison of *Cebus albifrons* and *Saimiri sciureus* on oddity performance

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Four squirrel and four Cebus monkeys were trained on five-trial oddity problems. Two of each species were then given problems where the odd object was reversed randomly on Trials 2, 3, or 4. They were then given one-trial oddity problems. All reached criterion in initial training. One Cebus reached criterion in reversal training, but the others showed significant improvement. All monkeys receiving one-trial oddity training responded correctly on 80% of 40 consecutive problems within 80 problems. No reliable differences were seen between the species. Discussion concerned the measures required to conclude that an animal has the oddity principle, and it was suggested that no nonprimate has been shown to master oddity.

Despite frequent warnings that many so-called oddity studies may be using inconclusive methods for determining whether an animal is using oddity as its cue (French, 1965; Strong & Hedges, 1966; Noble & Thomas, 1970), some sources continue to report such experiments as evidence for oddity performance in various species (Denny & Ratner, 1970; Maier & Maier, 1970). Two frequently used types of oddity problems are the one-odd and the two-odd. The one-odd involves repeated presentations of three stimuli, two of which are alike. The animal might learn it on the basis of oddity or as a simple object quality discrimination; if the researcher went no further, he would be unable to state conclusively that the animal had used oddity. The two-odd problem is derived from a pool of two pairs of identical objects, three of which are chosen at random and presented in random positions on a given trial. French (1965) suggested that such a problem could be learned as specific stimulus configurations (e.g., the animal might learn two triangles vs a circle or two circles vs a triangle as separate object quality discriminations, even though these two stimulus configurations were presented randomly to the animal).

Noble and Thomas (1970) reported evidence which suggested that squirrel monkeys learned the stimulus configurations of a two-odd problem separately. Fortunately, the rates of learning of the two configurations were notably different, and it was evident that the configurations had been learned separately. But as the authors noted, had the monkeys not shown different rates of learning for the two configurations, one would still be unable to conclude that the animals had used oddity as their cues since they might have learned the separate configurations with equal facility. As French (1965), Strong and Hedges (1966), and Noble and Thomas (1970) have said, perhaps the only conclusive measure of the use of oddity is with learning sets where the animal can show on the first trials of oddity problems that he is using oddity as his cue.

Strong and Hedges (1966) further noted that unless one examines first trial performances, improvement over problems may merely indicate learning set for object quality discriminations. This possibility would appear to apply, for example, to the study by Warren (1960) which is often cited to suggest that cats can master the oddity principle. It is not contended that Warren's successful cat did not use oddity as his cue, but that one cannot state conclusively that he did.

Davis et al (1967) reported oddity data for seven species of monkeys and one prosimian. Davis et al used three versions of oddity training. While two of the versions are strongly suggestive that the animals might have performed successfully by using oddity, certain ambiguities in describing their procedures, the nature of certain procedures, and the incompleteness of the report of the results raise the possibility that the problems were performed by the animals by means other than oddity. In any event, the results pertinent to the present work suggested that Cebus monkeys (*Cebus apella*) were superior to squirrel monkeys (*Saimiri sciureus*).

Cebus superiority to squirrel monkeys has also been described for successive discrimination reversals (Gossette & Slonim, 1969) and object quality learning sets (Shell & Riopelle, 1958). The present work attempts a conclusive determination of oddity performance in the Cebus monkey as well as a comparison of Cebus and squirrel monkeys on several stringent measures of oddity.

METHOD

Subjects

Four wildborn adult male squirrel monkeys (*Saimiri sciureus*) and four wildborn adult male Cebus monkeys (*Cebus albifrons*) purchased from commercial suppliers were Ss. Two of the Cebus monkeys had limited experience in the Wisconsin General Test Apparatus (WGTA) and the others were experimentally naive.

All Ss were housed in individual cages in the University of Georgia primate colony in a temperature- and humidity-controlled area. Daily light-dark cycles of approximately 12 h light and 12 h dark were maintained. Testing was conducted during the light cycle. Feeding took place immediately after test sessions. The standard diet of Purina Monkey Chow was supplemented with fresh fruits.

Apparatus and General Procedures

The animals were trained and tested in a modified WGTA. The apparatus was fitted with a gray stimulus tray containing three foodwells (16 mm in diam, 6 mm deep, 153 mm apart). Discriminanda were selected from brightly colored plastic toys. General procedures for all problems were: (a) Currants were used for reinforcement except on a few occasions when apple or banana pieces were required to maintain responding by the Cebus monkeys, (b) the intertrial intervals were 30 sec, (c) response intervals were 10 sec, and (d) 40 trials were presented per day in all phases of pretraining and testing. Training was done in a relatively quiet air-conditioned room (23.6°C), illuminated only by a 25-W bulb mounted in the top center of the WGTA.

Pretraining

Five stages of training were used prior to the introduction of the oddity learning-set problems. A detailed description of these preoddity training measures may be found in the article by Noble and Thomas (1970).

Oddity Learning Set

Discriminanda were selected from brightly colored plastic toys varying in hue, brightness, size, and form. An object was randomly selected and matched with an identical object, and then an odd item was randomly selected. Each new oddity problem was drawn from a stimulus pool of 96 objects. The only restriction was that no object was allowed to serve as the odd or paired item more than twice in a single session. The odd item could differ on one or more of the hue, brightness, size, and form properties. Training was to a criterion of 80% correct on the first trials of a series of 40 consecutive problems. Eight five-trial oddity problems were presented each day, 5 days each week.

Oddity Reversal

After reaching criterion on the five-trial oddity problems, C1 and C4 and two of the squirrel monkeys (S1 and S2) were given five-trial reversal problems where one of the paired objects became the odd object on the second, third, or fourth trial (randomly chosen) of the reversal problem. Training was continued until a criterion of 80% correct in 40 successive reversals was met or until a total of 200 reversals had been given. They received eight reversal problems per day, 5 days per week.

One-Trial Oddity Problems

The four animals trained in oddity reversals were then given 20 one-trial oddity problems per day until a criterion of 80% correct responses in 40 consecutive problems was met.

RESULTS

Evidence that all eight animals have mastered the concept of oddity is offered by the results on five-trial oddity problems. The two Cebus and two squirrel monkeys run on one-trial oddity problems offered additional evidence that choices were made on the basis of oddity, although three of these four animals were disrupted in their behavior on midproblem reversals.

All Ss reached the criterion of 80% correct of first-trial responses on the five-trial oddity problems. The mean number of problems to criterion for the squirrel monkeys was 180, with individual scores ranging from 80 to 232 problems. The Cebus monkeys ranged from 48 to 224 problems in reaching the 80% criterion, with a mean score of 132 problems to criterion. There was considerable overlap of individual scores within the groups, and no significant differences were seen between the species on this phase of oddity acquisition (Mann-Whitney, $U = 6.5$).

Three of the Ss trained on midproblem reversals failed to reach the 80% criterion during the series of 200 problems. The exception (C4) required 72 problems to reach criterion. Because C2 and both squirrel monkeys failed to reach the 80% criterion, a comparison of the first and last 40 problems was done. These animals had a mean of 32% correct on the first 40 problems and a mean of 65% correct on the last 40 problems, and there was no overlap in scores on the first and last 40 problems ($U = 0$, $p < .05$).

In one-trial oddity, all four animals reached criterion of 80% correct on 40 consecutive problems within 80 problems. C1 took only 40 problems and achieved a score 92.5% correct.

DISCUSSION

The results of the present work show that the Cebus monkey can perform successfully on several stringent measures of oddity. The study also confirms earlier work with the squirrel monkey showing successful oddity learning (Noble & Thomas, 1970) and extends that work to one-trial oddity problems. Finally, the present work suggests that there are no reliable differences between Cebus monkeys and squirrel monkeys on the measures of oddity that were used.

Gossette and Slonim (1969) noted that the genera *Cebus* and *Saimiri* have been placed traditionally by taxonomists in the same subfamily Cebinae, while the owl monkey (genus *Aotes*) has been placed in the subfamily Aotinae. Gossette and Slonim also noted that Hill (1960) argued that *Saimiri* and *Aotes* may be more closely related behaviorally and morphologically than are *Saimiri* and *Cebus*. Gossette and Slonim compared Cebus, owl, and squirrel monkeys on successive discrimination reversal and found comparable performances by the owls and squirrels, while Cebus performance was superior. Gossette and Slonim suggested that these data may support Hill's argument that *Saimiri* and *Aotes* should be in the same subfamily rather than *Saimiri* and *Cebus*. On the other hand, the similar performances of *Cebus* and *Saimiri* seen in the present work indicate that caution must be used in suggesting taxonomic classification on the basis of behaviors studied in the laboratory.

Harlow (1958) and Strong and Hedges (1966) have suggested that mastery of the oddity principle may be beyond the capacity of nonprimates. Considering their conclusions and the design problems discussed earlier in this paper, it is suggested that no nonprimate has been shown to master oddity. In view of this, it might be useful to consider what this capacity may represent in the animal in the natural habitat. It is not suggested that the use of the oddity principle per se plays an essential role in the primate's ability to cope with his environment, but rather that the capacity to perform oddity is related to a more general ability.

One ability that the oddity problem samples is that of responding to the same physical stimulus differently when that stimulus occurs in different contexts. However, this ability as described here would not seem to preclude certain behaviors seen in nonprimates. For example, it is well known that animals change their responses to another member of the species depending on whether the other member has invaded its territory. Similarly, a female hamster will respond aggressively or receptively to male hamsters depending on whether she is in estrus (Kislak & Beach, 1955). Thus, if oddity performance samples the ability to respond to the same stimulus differently in different contexts, it is evident that a more precise definition of this ability is needed.

Another experimental procedure that samples the ability to respond differently to the same stimulus in changing contexts is conditional discrimination (as this term has been used by students of primate behavior; see French, 1965, p. 174). There have been reports to suggest that nonprimates can perform such tasks. However, this task is susceptible to the same methodological criticisms raised for the oddity problem. For example, Barge and Thomas (1969) showed that squirrel monkeys committed significantly more errors on a black tray/cross association than on a white tray/parallelogram association even though the cross and parallelogram were presented on every trial while the trays were changed randomly. These data suggest that the animals responded to the different stimulus configurations rather than that they had acquired the unifying concept associated with this task. Incidentally, it would be difficult to administer the conditional discrimination task in a way that both tests whether the animal had acquired the hoped-for concept and precludes the possibility that successful performance was based on the formation of object quality learning sets. A possible solution might be to train animals to respond to oddity then have tray quality signal whether to respond to the odd or to either of the alike stimuli (e.g., black tray/odd and white tray/either of the alike). Following this procedure, a new set of oddity stimuli might be given on each trial, with the changing context provided by the tray being the only reliable cue for the response.

As with the oddity problem then, it is suggested that perhaps the only designs which will permit one to state conclusively that an animal has formed concepts useful to perform conditional discrimination are those which permit first trial assessments when new stimuli are given. Otherwise, the animal may perform successfully on the basis of its ability to master rapidly the specific stimulus configurations.

While the detailed analyses of the conditional discrimination literature have not been done, it is suggested that few, if any, studies will meet the stringent conditions necessary to conclude that an animal has the ability to respond differently to the same stimulus in different contexts as measured by these tasks. Should the weight of evidence eventually suggest that this ability is unique to primates, it may be useful to seek data pertinent to the origin and role of this ability in the natural habitat.

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