SHORT COMMUNICATION

Natural Conceptual Behavior in Squirrel Monkeys (*Saimiri sciureus*): An Experimental Investigation

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ABSTRACT. Natural conceptual discriminations have been tested in many different species, including pigeons and a variety of non-human primates. The ability of four male squirrel monkeys (*Saimiri sciureus*) to learn and use the natural concept 'squirrel monkey' was investigated in this study. After a training phase, subjects were presented with novel stimuli in transfer and test trials. All subjects performed at a rate significantly above chance on the first test trial ($p<.001$), indicating that squirrel monkeys can utilize natural concepts in the laboratory.

Key Words: *Saimiri*; Conceptual behavior; Squirrel monkeys; Natural concepts; Animal cognition.

OBSERVATION

Conceptual behavior constitutes the ability to recognize the common attributes among entities and classify new exemplars based on those attributes. In laboratory studies investigating conceptual behavior, the newness indicated is emphasized. Only from trials which use novel stimuli can one determine that evidence for conceptual behavior exists (THOMAS & CROSBY, 1977). Classifying new exemplars requires that one learns an attribute that is identified as belonging to a particular class, rather than memorizing specific objects or stimuli. Natural categories, categories of objects based on discriminanda encountered in nature (HERRNSTEIN et al., 1976), are open-ended, in that no specific feature must be present for the object to be identified as a member of the class. Categorization becomes a perceptual process where objects are seen as similar or dissimilar. Natural discrimination tasks test the ability of a subject to identify the similarity despite natural ranges in variability.

The ability of non-human primates to perform natural conceptual discriminations has been tested in many diverse laboratory studies (D'AMATO & VAN SANT, 1988; FUJITA & MATSUZAWA, 1986; LEHR, 1967; SCHRIER et al., 1984; SWARTZ, 1983; YOSHIKUBO, 1985). Surprisingly, the performance of many of these subjects is not as good as pigeons in comparable studies. That is, in the initial transfer tests, the performance of the pigeons continually is higher than the performance of the primates. Pigeons transfer immediately to new stimuli after training, with high rates of responding (HERRNSTEIN et al., 1976; CERELLA, 1979; HERRNSTEIN, 1979). While some primates have shown evidence of concept formation (e.g. SCHRIER & BRADY, 1987; YOSHIKUBO, 1985), these studies have pooled together data from several acquisition or test trials, leaving open the possibility that these primates are learning the correct responses rather than applying a concept on the first test trial. Further comparisons and conclusions are cautioned, however, as different testing techniques are routinely employed, and no study has directly compared the ability of pigeons and non-human primates on such tasks.

Squirrel monkeys' (*Saimiri sciureus*) cognitive abilities have been explored in studies ranging from conceptual numerousness judgements (THOMAS et al., 1980) to class conceptual behavior (THOMAS & CROSBY, 1977). Thus, they were deemed likely candidates to investigate natural conceptual discriminations. This study investigated the concept of 'squirrel monkey' in squirrel monkeys, and sought to determine whether squirrel monkeys, like rhesus macaques, can form a concept allowing visual recognition of the species. Based on the idea that the discrimination of squirrel monkeys is ecologically significant, it is hypothesized that squirrel monkeys can distinguish between squirrel monkeys and other similar entities in their habitats.

METHOD

Four wild born, experimentally naive male squirrel monkeys were tested. Subjects were individually housed at the University of Georgia, Department of Psychology. Estimated ages ranged from 2 to 11 years. The monkeys were maintained on a 12L:12D schedule with light onset at 07:00, and temperature and humidity levels were controlled. Testing occurred five times a week.

A modified Wisconsin General Testing Apparatus displayed the test stimuli, which consisted of 116 pictures presented in acrylic picture frames. Of the pictures, half were pictures of squirrel monkeys, and the remaining were of other mammals, such as capuchin monkeys, squirrels, ferrets, etc.

As subjects were experimentally naive, a pretraining phase (following THOMAS et al., 1980) was necessary to familiarize the animals with the testing apparatus and environment. In this pretraining phase, the stimuli were presented in the left picture frame. The right frame always displayed a plain white card. In presenting the stimuli, a picture of a squirrel monkey (S+) was alternated in a quasi-random fashion following GELLERMAN (1933) and FELLOWS (1967) with a picture from the non-squirrel monkey class (S−). When the S+ picture was displayed, the correct response was to displace the frame showing the S+ picture. On S− trials, the correct response was to displace the white card. Correct responses were reinforced with a currant. Subjects were required to score a minimum of 16 out of 20 trials correct in two consecutive sessions before proceeding to the next phase. This criterion for successful performance, 80% correct on two consecutive sessions, was employed throughout.

After the successful completion of the pretraining phase, a training phase, consisting of squirrel monkey (S+) and other stimuli (not a white card) (S−), was carried out. After 49−60 sessions (depending upon the subject), and an average performance ranging from 78 to 82% correct, the subjects moved onto a final training stimuli set and subsequent transfer test.

RESULTS AND DISCUSSION

For the final training and transfer phase, background cues were controlled by size of subject and background, using brown capuchin (*Cebus apella*) and squirrel monkey stimuli.

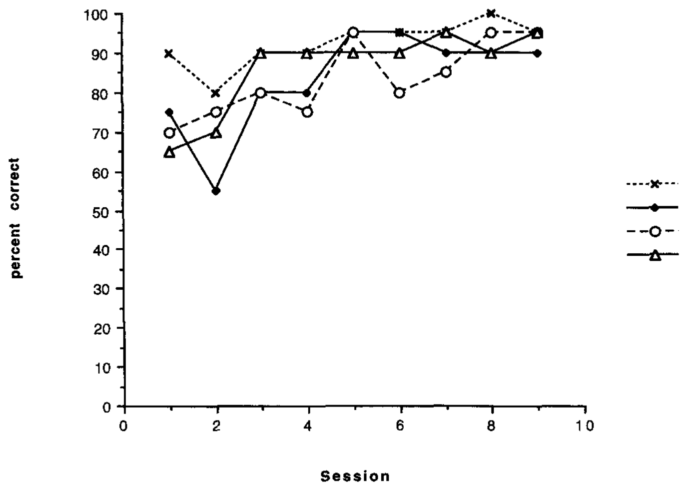

Fig. 1. Performance curves for final training phase.

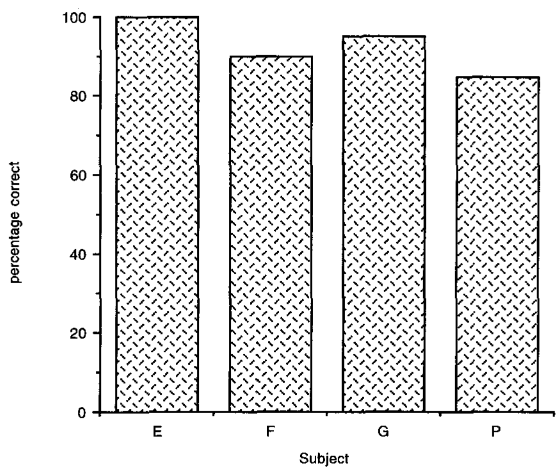

Fig. 2. First trial performance on final training set.

A planimeter was used to measure perceived size of figure of pictures. The differences in area between the S+ and S− classes were not significantly different, as measured by a two-tailed *t*-test [t $(38)=1.27$, $p=.105$]. One subject performed 90% correct on the first training day ($p<.001$). All other subjects reached criterion on the third day of training. Figure 1 illustrates the performance curves of all subjects on this final training set. A final transfer set of 20 novel stimuli, consisting of 10 squirrel monkey and 10 capuchin pictures, was presented to the subjects. First-trial performance on this set was used as an indicator of conceptual behavior. All subjects demonstrated performance significantly above chance on this test using binomial probabilities ($p<.001$). Figure 2 displays each subject's performance on the transfer test. These data support the hypothesis that squirrel monkeys utilize natural categories, as demonstrated by categorizing novel pictures of squirrel monkeys as distinct from other classes of animals. Additionally, their performance was as well as that reported for pigeons on the first transfer trial.

That squirrel monkeys (as demonstrated by this study) and macaques (YOSHIKUBO, 1985; SCHRIER & BRADY, 1987) have demonstrated natural conceptual behavior in laboratory testing is not surprising. Natural conceptual behavior has been reported in free-ranging vervet monkeys (*Cercopithecus aethiops*) of Kenya (SEYFARTH et al., 1980a, b) and in prairie dogs (*Cynomys gunnisoni*: SLOBODCHIKOFF et al., 1986). SEYFARTH et al. suggest that vervets classify predators into at least three categories: snake, raptor, and mammalian predator. Each class of predator is assigned an acoustically distinct alarm call, which elicits a distinct set of responses that are appropriate to the type of threat received. Additionally, vervets recognize differences among calls given by different individuals, but categorize them as same by producing the appropriate escape response.

Various theories have been proposed to explain the process used to categorize natural concepts. HERRNSTEIN (1979) proposed that pigeons were attending to a set of common elements which members of a class tended to share. This notion of a 'family resemblance' (WITTGENSTEIN, 1953) emphasizes a set of features: no one feature is enough to determine that the exemplar is a member of the class.

While this theory of family resemblance has support, there are at least two opposing views. GREENE (1983) investigated concept formation in pigeons, and concluded that the pigeons were not responding necessarily to the target feature, but rather to irrelevant features associated with the stimuli. On transfer tests, the stimuli would often be misclassified if the irrelevant feature was present on the opposite stimulus class. GREENE suggested that one of the initial mechanisms for learning a particular category may be memorization of features common to all in a set. Then one is able to apply those defining features to new exemplars, and thus, a class is created. PREMACK (1983) also argued that in many instances of concept learning the class being learned could be defined by a small set of simple features. By simply memorizing the set of simple features, one could show conceptual behavior. PREMACK also criticized the work on natural concepts because, he felt, all members of a class looked alike.

GREENE's and PREMACK's criticisms bring up two important points for discussion: the idea of memorizing a set of features to define a class, and all members of a class looking alike. In any class of objects, all members will have similar features in common; that is how, perceptually, like and non-like objects are categorized. I propose that when initially defining a class, one does mentally note or memorize the similar features of all in a class. The attributes that characterize a particular class are identified. When one begins to notice the differences as well as the similarities, and can still class the two together on certain features, then one is utilizing a concept. In this sense, then, the process of incorporating new experiences into one's existing knowledge is initially based on recognizing inherent similarities and differences between two objects, and classifying them as such.

PREMACK's second criticism, that all members of a class look alike, is true to a certain extent. Various entities are categorized together because they do look alike, even though some differences may exist. Initially, one may generalize from one object to another similar object; as the objects in the category become more individually recognizable, one may form a concept of these objects. Therefore, familiarity with the subject class allows for more detailed observations and distinctions. Once such discriminations are made, continuing to classify a set of objects as similar indicates the existence of a concept which associates readily discriminable objects with one another.

What this discussion suggests is that members of a natural class can be identified through the possession of certain features, and thus perhaps are not as open-ended and variable as initially proposed. However, is it necessary to attempt to identify those features which might be necessary for an object to belong to a certain class? Some investigators, such as D'AMATO and VAN SANT (1988), feel that such research is likely to be unproductive because of the subject's tendency to focus on irrelevant features. Trying to identify which features would be considered irrelevant for a particular category, and then controlling for these features, might be one way to begin investigation into this area.

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