Novelty and familiarity in discrimination learning by rhesus monkeys

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Four test-sophisticated rhesus monkeys were given a series of two-choice discrimination problems in which the discriminanda consisted of either two novel objects or two familiar objects. Familiar objects were selected in accordance with ecological variables that were apparent in the monkeys' laboratory environment. In addition to the usual "novelty effect," the experimental findings indicated an equally potent "familiarity effect." The results were interpreted within the framework of a simple memory model that embraced the principles of the Rescorla-Wagner model of associative learning.

Novel stimulation appears to have pronounced effects on several aspects of nonhuman primate behavior. Rhesus monkeys have learned to manipulate latches in order to view novel environments (Butler, 1954), and to solve novel puzzles in the absence of extrinsic reward (Harlow, Blazek, & McLearn, 1956). Chimpanzee play behavior has been shown to increase in the presence of novel stimuli (Welker, 1956) and, curiously, even memory for objects is improved when such objects are novel to the chimpanzee (Hayes & Thompson, 1953). Harlow (1944) similarly found nonspatial memory in rhesus monkeys to be enhanced through the utilization of novel trial-unique stimuli. More recently, Mishkin and Delacour (1975) demonstrated improved short-term memory (STM) in rhesus monkeys by requiring delayed responses to novel objects rather than to familiar objects.

In these and other studies (see Harlow, 1945a, 1945b; Mishkin, Prockop, & Rosvold, 1962), "novelty" has been defined within the context of the test situation, that is, a novel stimulus was one that had not been recently, if ever, presented in the test situation. Moreover, novel objects have generally been paired with other novel objects or with familiar objects in these tests of memory and discrimination learning. Alternative comparisons, such as pairing two familiar objects in contrast to two novel objects, have apparently not been explored within a discrimination learning paradigm because both novel and familiar stimuli have traditionally been defined by recent stimulus-event histories, as just described. It was therefore not clear that discrimination learning would progress in the same manner for problems in which the discriminanda were both novel or both familiar.

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In order to address this issue we defined the novelty-familiarity dimension in a slightly different manner. In the present experiment novel and familiar stimuli were objects that the monkeys had not previously encountered within the context of formal testing. However, familiar stimuli were those frequently present in the usual laboratory environment (e.g., wire mesh, latch, etc.). Novel stimuli consisted of objects that to our knowledge were unfamiliar ones to the monkeys (e.g., metal hasp, toy figure, etc.).

METHOD

Subjects

Four 6-year-old test-sophisticated rhesus monkeys (*Macaca mulatta*) that had not been tested within the previous 18 months were used as subjects. Each monkey received 24 daily pretraining trials on two-choice discrimination problems for 5 consecutive days in a standard WGTA. Neutral objects that differed in color, form, and size were employed in pretraining. Care was taken in the selection of pretraining stimuli so as to minimize dimensional similarities between them and objects later used as training stimuli.

Procedure

Two familiar (F) and two novel (N) six-trial two-choice discrimination problems were administered on each of 18 days in the WGTA. The 36 different F problems were generated by exhausting the number of possible pairs of nine different familiar objects; an equal number of N problems were generated in the same manner from nine different novel objects. The discriminanda for all problems therefore consisted of either F-object or N-object pairs. Appreciable color cues were absent in these problems. Problem order, both within and between test days, was randomized differently for each monkey.

Proportion correct responses for F and N problems were collapsed over two-problem blocks. The mean scores were then subjected to analysis of variance, with repeated measures on problems (F, N), blocks (Days 1-18), and trials (2-6).

RESULTS

Despite consistently high overall performance, the monkeys performed significantly more poorly when the discriminanda were F objects in contrast to N objects

Figure 1. Mean proportion correct responses ($\pm$ SD) on two-choice discrimination problems with novel, low-familiar, and high-familiar discriminanda.

($F = 437.0$, $df = 1/12$, $p < .001$). This effect was stable, as indicated by a statistically nonsignificant Problems by Blocks interaction ($F < 1.0$). Although performance improved significantly across trials, the rate of improvement did not differ between F and N problems ($F = 11.8$, $df = 4/12$, $p < .001$; $F < 1.0$). The lack of a significant Trials by Blocks interaction suggested that the monkeys had attained optimal levels of correct responding ($p > .05$).

Larger interproblem learning differences appeared to occur under Condition F than under Condition N. Cochran's test for homogeneity of variance (see Myers, 1966) confirmed this notion ($C = .54$, $p < .01$). Because F stimuli consisted of objects frequently experienced by the monkeys in, as well as outside, their home cages, it was thought that these experiential differences might account for the observed interproblem learning differences. Performance levels across subjects were therefore examined as a function of problems that involved high-familiar discriminanda (HF) (e.g., home cage objects such as home cage lock) and problems that involved low-familiar discriminanda (e.g., non-home-cage objects such as transport cage latch). Analysis by the t statistic revealed a significant difference between performance

levels under HF and LF conditions ($p < .05$). This finding is illustrated in Figure 1, which also shows average performance under Condition N for purposes of comparison.

DISCUSSION

The results indicate that HF and N objects are more easily discriminated by monkeys than are LF objects. It seems paradoxical that monkeys should discriminate highly familiar objects as well as they discriminate completely unfamiliar objects; that discriminations are performed most poorly with relatively unfamiliar objects is also a curious effect. An explanatory account of these findings is formulated here, but first a discussion of the novelty principle seems appropriate.

The novelty principle holds that novel stimuli are easily discriminated because they elicit orienting responses that somehow increase attention to relevant cues (see Maltzman, 1967; Zeaman & House, 1963). In rhesus monkey learning this phenomenon has been termed "immediate discrimination" by Harlow (1945a, 1945b). While the superior performance of monkeys under Condition N relative to Condition LF might be attributed to the novelty effect, the equally pronounced performance difference between Conditions HF and LF is difficult to explain in terms of the novelty principle.

Neither HF nor LF stimuli were novel to the monkeys. In regard to newness of the test situation, HF stimuli might be considered more novel than LF stimuli, that is, the expectancy of experiencing home-cage objects outside of the home cage could be low relative to the expectancy of experiencing non-home-cage objects outside of the home cage. Such an account, however, is based on the tenuous assumption that laboratory monkeys define such stimulation only in terms of home-cage experience. Under that assumption one should expect to find some evidence of competing response tendencies for problems involving HF stimuli (see Lubow & Moore, 1959). The present findings suggest that such an assumption is false since HF performance was clearly superior to LF performance. Hence, the novelty principle cannot adequately account for the learning differences between Conditions HF and LF.

A more appropriate theoretical framework might be derived from associative learning models such as those provided by Rescorla and Wagner (1972; Wagner & Rescorla, 1972). In those models learning is manifested by incremental increases in associative strength that are determined in part by the saliency of stimulus elements (α), the strength of reinforcers (λ), and the frequency of stimulus-reinforcer pairings. In the present experiment both HF and LF stimuli constituted preexposed stimuli, though neither of them was systematically paired with biological reinforcers prior to testing. However, if the satiation of "manipulatory drive" in rhesus monkeys constitutes reinforcement (Harlow, Harlow, & Meyer, 1950), then home cage objects (HF) which were frequently manipulated by the monkeys in the course of a usual laboratory day may have been preexposed for n reinforced "trials." By contrast, non-home-cage objects (LF) which were rarely, if ever, manipulated by the monkeys prior to testing may have been preexposed for n nonreinforced "trials." Hence the Rescorla-Wagner model predicts that learning with LF objects should be attenuated relative to that with HF objects because of the different number of previous pairings of those objects with reinforcement. This effect was clearly demonstrated in the present experiment.

It therefore appears that the equal facility with which monkeys perform N and HF discrimination problems cannot be explicated solely in terms of the novelty principle. Although the novelty effect might account for the prepotency of N cues over LF cues, it cannot account for the salience of immediately discriminable HF cues. While the Rescorla-Wagner model can adequately handle the HF vs. LF contrast, it can only account for

the N vs. HF comparison if an additional assumption is made, that is, the associative strength of N stimuli reaches asymptotic levels comparable to the associative strength of HF stimuli because α_N initially takes on higher levels than α_{HF} .

A simple memory model could also provide an appropriate framework for the present experimental findings. Highly familiar objects may provide monkeys with salient discriminable cues because long-term memory (LTM) mnemonics are utilized in making such discriminations. These LTM mnemonics could presumably be formed through the monkeys' repeated encounters with like objects that are paired with reinforcing events. Furthermore, there exists evidence that STM mnemonics for novel stimuli develop rapidly in monkeys, an effect that has been termed "immediate recognition" by Mishkin and Delacour (1975).

Consequently, we hypothesize that with continued and repeated exposures to initially novel stimuli, monkeys first exhibit n levels of learning (Condition N), followed by $n - k$ levels of learning (Condition LF), followed still later by n levels of learning (Condition HF). The factor K in this model represents some performance decrement that is associated with intermediate degrees of learning which follow the emergence of STM mnemonics (the novelty effect) but which precede the development of LTM mnemonics (the familiarity effect). Associative learning in this memory model provides a vehicle for the encoding of STM mnemonics into LTM. The intermediate levels of learning that are associated with low-familiar discriminanda are assumed to reflect the incremental nature of associative learning processes that are prerequisite to LTM consolidation.

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