

ERRATA

In Figure 1 and 2 "open circles" should refer to the discrimination-reversal group and "solid circles" should refer to the object-alternation group.

been demonstrated in nonprimate forms, the rate of learning and asymptotic levels of performance are generally inferior to those achieved by primates (1). The sources of these phylogenetic differences have not been established; one possibility is that the primates are more capable of developing "hypotheses" or "strategies" which facilitate problem solution. Most of the theoretical and experimental work on learning-set formation, however, has focused on changes in the relative strength of responses to the physical properties and spatial relations of the stimulus objects as a function of training (2).

Restle, however, has suggested that the cues common to the correct stimulus objects in a series of discrimination problems, regardless of the physical attributes of the stimuli, are the properties of having been rewarded on the previous trial. According to this interpretation animals achieving consistent one-trial discrimination learning "use an abstract understanding of an LS [learning set] experiment, transcending the 'stimulus-response' rubric familiar in most theories of learning" (3). The behavioral contingencies through which this abstract principle is expressed may be described as a "win-stay, lose-shift" strategy. Levine (4) has shown that various strategies operate during learning-set formation. Furthermore, he has suggested that the gradual strengthening of a win-stay, lose-shift strategy by means of 100 percent reinforcement is largely responsible for learning-set formation.

If such a strategy is responsible for one-trial discrimination learning it should be possible to establish the strategy under one set of circumstances and transfer it to another. Accordingly, the present experiment was designed to determine whether chimpanzees given successive discrimination-reversal training on a single pair of stimuli would develop this strategy and show immediate transfer to a series of simultaneous discrimination problems with multiple pairs of stimulus objects (like those used in conventional learning-set experiments). It was further hypothesized that a second group trained on object-alternation would develop a "win-shift, lose-stay" strategy which would retard the formation of a learning set for conventional discrimination problems.

Chimpanzees were trained to displace a single stimulus object covering a food well before testing was begun.

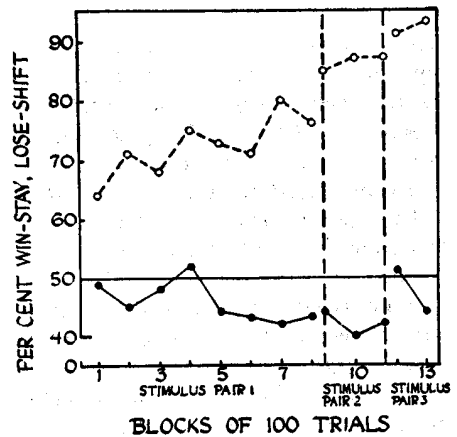


Fig. 1. Percentage of "win-stay, lose-shift" responses under two training conditions. Solid circles indicate progress of the discrimination-reversal group; open circles indicate lack of improvement for object-alternation group. Separation of data points indicates training on three different stimulus pairs.

Testing was conducted with a standard discrimination testing apparatus (5). The subject's task was to displace one of two stimuli (differing from each other in several dimensions) in order to obtain a food reward. The interval between stimulus presentations was 5 seconds. If the animal's initial choice was incorrect, it was allowed to displace the correct object after a 5-second delay.

The investigation consisted of two experiments. In the first experiment, seven experimentally naive adult chimpanzees were randomly assigned to two groups. One group (N = 4) received successive discrimination-reversal training on three stimulus pairs and the other group (N = 3) received alternation training on the same three stimulus pairs. The number of trials per stimulus pair for both training conditions is

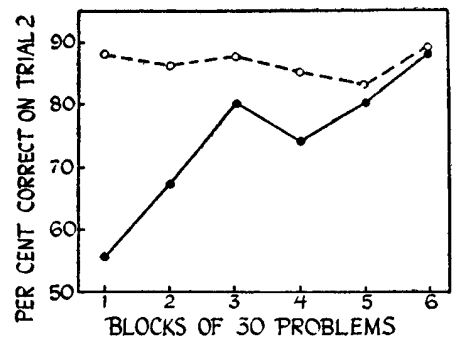


Fig. 2. Trial 2 performance on a learning set series of 180 discrimination problems after successive discrimination-reversal training (solid circles) and object-alternation training (open circles) on three stimulus pairs.

**Transfer Effects of Successive Discrimination-Reversal Training in Chimpanzees**

*Abstract.* Chimpanzees receiving successive discrimination-reversal training on a single pair of stimuli transferred almost perfectly to two additional reversal tasks and to a "learning-set" series of 180 discrimination problems. A "win-stay, lose-shift" strategy, however it is acquired, seems to be a sufficient basis for one-trial discrimination learning.

Training on multiple discrimination problems results in progressive improvement in performance culminating in one-trial learning of single problems. This effect has been described as the formation of a learning set, and it has been studied most intensively in the primates. Although learning set has

shown in Fig. 1. Prior to their training on each stimulus pair all animals were given a single discrimination-reversal test. The stimulus pairs used for the three discrimination-reversal tests were also used for the training phases. The criterion for discrimination-reversal learning was 12 consecutive correct responses.

The results of the training phases are shown in Fig. 1, which plots the mean percentage of win-stay, lose-shift responses for both groups as a function of 100-trial blocks. These curves reflect the number of correct responses. Improvement is indicated by a rising curve for the discrimination-reversal group and a falling curve for the alternation group. The discrimination-reversal group did show progressive improvement with extremely efficient transfer from one training phase to another, whereas the alternation group showed no such improvement. The latter group failed to solve the object-alternation task. The differential effects of training were further demonstrated by performance on the test series. Mean numbers of errors to criterion for tests 1, 2, and 3 were 57.8, 6.5, and 3.5 for the discrimination-reversal group, and 44.3, 38.7, and 45.0 for the alternation group. Matched *t* tests between tests 1 and 2 and tests 2 and 3 revealed significant positive transfer effects for the

discrimination-reversal group ( $p$ 's  $< .05$ ) and no transfer for the alternation group. The differences between the groups on tests 2 and 3 were also significant ( $p$ 's  $< .02$ ). These results show clearly that chimpanzees positively transfer the effects of successive discrimination-reversal training on a single stimulus pair to a new stimulus pair.

The second experiment was undertaken to test the transfer effects of successive discrimination-reversal training to a learning-set series of 180 discrimination problems. Upon completion of experiment 1 all subjects received a series of ten, 6-trial discrimination problems each day for 18 days. Figure 2 presents the percentage of correct responses on trial 2 for each group as a function of problem blocks. Throughout testing the discrimination-reversal group appeared to obtain all the information necessary for problem solutions on the first trial. The effect was immediate and persistent. The alternation group showed progressive improvement, attaining consistent one-trial learning only after 90 problems. In spite of extensive alternation training the learning-set function produced by this group was similar to those functions obtained by Hayes *et al.* (5) on naive chimpanzees. On the basis of the results obtained in these two experiments we may conclude that a win-shift, lose-

stay strategy was not established in the alternation group.

A study by Riopelle (6) indicated that relatively naive rhesus monkeys who were trained on a series of 216 discrimination problems, constructed from all possible combinations of four stimulus objects, showed a consistently high efficiency of learning when shifted to an ordinary learning-set series. In view of my results and those of Riopelle, it is suggested that the learning-set phenomena may arise from any training technique producing a win-stay, lose-shift strategy which transcends the physical properties of the stimulus objects (7).

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#### References and Notes

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  7. I was a National Science Foundation post-doctoral fellow at the time this research was done.
- 2 April 1962