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EFFECT OF PRIOR PAVLOVIAN DISCRIMINATION TRAINING UPON LEARNING AN OPERANT DISCRIMINATION[1]

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The effect of Pavlovian discrimination training with two stimuli upon subsequent learning of an operant discrimination involving those stimuli was studied. After preliminary lever press training, the lever was removed and thirsty rats received noncontingent pairings between S_1 (a tone or a clicker) and water reinforcements, whereas S_2 (a clicker or a tone) occurred always without reinforcement. This procedure presumably established S_1 as a positive CS for respondent behavior, whereas S_2 was established as an inhibitory CS. Following this training, the lever was reintroduced and the rats were trained on an operant (lever pressing) discrimination involving S_1 and S_2. For the Consistent *Ss*, S_1 was the S^D and S_2 the S^Δ in the operant discrimination; for the Reversed *Ss*, S_2 served as S^D and S_1 as S^Δ. The Consistent *Ss* learned the operant discrimination significantly faster than did the Reversed *Ss*. The result emphasizes the importance of respondents, conditioned to S^D and S^Δ, which modulate operant performance to these stimuli.

In an operant discrimination, *S* receives reinforcement contingent upon responding (*e.g.*, lever pressing) in the presence of S^D but not in the presence of S^Δ. It has been widely recognized that this procedure should also result in a concomitant respondent discrimination; that is, the respondent elicited by the reinforcing stimulus should become conditioned in Pavlovian fashion to S^D but not to S^Δ. Despite the wide assumption to this effect, there has been very little research designed to assess the contribution of the respondent discrimination to performance of the operant discrimination. The work by Shapiro (1961, 1962) and Williams (1963) has shown some parallels between the temporal course of lever pressing and salivation in dogs working for food reinforcement. Although these data give credit to the assumption that differential respondents may be involved in operant discriminations, they provide no assessment of the relative importance of this factor. For example, available evidence would not contradict the flat assertion that the conditioned respondent is an interesting, but nonetheless inconsequential, concomitant of operant conditioning.

The present experiment examined the effect of prior respondent discrimination training upon rate of learning an operant (lever pressing) discrimination involving the same stimuli. After some preliminary bar press training, the lever was removed and the rats received noncontingent pairings between one stimulus, S_1 and water reinforcements, whereas a second stimulus, S_2, was frequently presented always without reinforcement. In later sessions, the lever was reintroduced and water reinforcements were made contingent upon lever presses in S_1 (for four *Ss*) or in S_2 (for four other *Ss*), whereas lever presses in the alternate stimulus (S_2 or S_1, respectively) were not reinforced. It was expected that the operant discrimination would be learned faster by those *Ss* for which the S^D-to-be was S_1 (called Consistent *Ss*) than for those *Ss* for which the S^D-to-be was S_2 (called Reversed *Ss*).

METHOD

Subjects

Eight male Wistar rats from the same litter, 90 days old, were kept in individual living cages with *ad lib* food (lab checkers). They had access to restricted watering of 30 min after their daily experimental session.

[1]The idea for this experiment developed from a conversation between the first author and Dr. M. A. Trapold. The research was supported by a research grant, HD00954, to the first author from the National Institute of Child Health and Human Development. Reprints may be obtained from Gordon Bower, Dept. of Psychology, Stanford University, Stanford, California.

Apparatus

A standard rat operant conditioning chamber manufactured by Foringer and Co. was used. Associated programming and recording equipment was located in an adjoining room. The modified response lever closed a Microswitch when it was depressed with a downward force of 10 g through a distance of .50 in. A motor-driven dipper delivered water reinforcements of .08 ml. When activated, the cup of the dipper appeared for 3 sec in a hole in the floor near the front wall where the lever was mounted. During phase II of the experiment, the lever was removed from the chamber and the lever-hole was covered by a metal shield. Auditory stimuli were delivered via a 4 in. speaker mounted above the rear wall of the chamber.

Procedure

During phase I, the *Ss* were trained to lever press for water rewards, receiving five daily 30-min sessions on a variable interval (VI) 30-sec schedule of reinforcement. During this phase, neither S_1 nor S_2 was presented. In phase II which followed, the lever was removed from the chamber and *Ss* received pairings between one stimulus, S_1, and water reinforcement. A second stimulus, S_2, was presented always without reinforcement. For four *Ss*, the reinforced stimulus was a continuous tone and the nonreinforced stimulus was a 3 per sec clicker; for the other four *Ss*, the reverse pairings obtained. There were 10 sessions of 30 min each in phase II. Stimuli S_1 and S_2 occurred in alternate 30-sec periods throughout each session. During each 30-sec presentation of S_1, either one, two, or three (mean of two) water reinforcements were delivered at irregular times; during presentations of S_2, no reinforcements were delivered. Thus, over the 10 sessions, *Ss* received a total of 300 presentations of S_1 along with 600 reinforcements in S_1, and 300 presentations of S_2 without any reinforcements.

In phase III which followed, the lever was reintroduced and *Ss* were trained on an operant discrimination. S_1 or S_2 occurred in alternate 1-min periods over 27 daily 1-hr sessions. Lever pressing was reinforced on V130 sec in the presence of one of these stimuli and was nonreinforced in the other stimulus. For four *Ss* (two from each subgroup of phase II), lever pressing was reinforced in S_1, the stimulus paired with reinforcement in phase II, whereas lever pressing was not reinforced in the presence of S_2. This is referred to as the "Consistent" condition. The remaining four *Ss* constituted a "Reversed" condition. For these *Ss*, lever pressing was reinforced in S_2, the nonreinforced stimulus in phase II, whereas lever pressing was not reinforced in S_1, the stimulus paired with reinforcement during phase II. The notation S^D and S^Δ are henceforth used to refer to the reinforced and nonreinforced stimuli in the operant discrimination, while S_1 and S_2 refers to the pairings in phase II. One *S* in the Consistent condition died after its 15th day on the operant discrimination procedure.

RESULTS

The result of interest is the comparative rates of learning the operant discrimination for *Ss* in the Consistent and Reversed conditions. As an index of discriminative performance, the percentage is taken of all daily responses emitted in S^D. The group average of these daily percentages is shown in Fig. 1.

There is a clear and uniform advantage for the Consistent *Ss*. This is as true of individual *Ss*' results as of the mean curve; the score for the best Reversed *S* did not exceed that of the

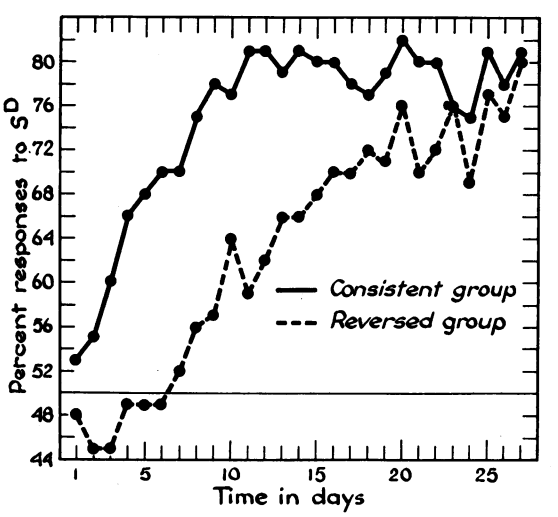

Fig. 1. Group average discrimination scores plotted against successive days of training. The index is a percentage score obtained by dividing responses to S^D by total responses to S^D and S^Δ combined. The horizontal line at .50 represents nondifferential performance.

worst Consistent *S* until Day 16 (*i.e.*, the distributions of percentage scores did not overlap until late in training). It is noteworthy that all Reversed *Ss* went through an initial period, lasting from three to seven days, when they responded more to S^{Δ} than they did to S^{D} (percentage index less than .50). The asymptotic differential performance in this situation is approximately a 4:1 ratio of S^{D} to S^{Δ} responses. The Reversed *Ss* attained this level only after extensive training.

Figure 2 shows the absolute response rates for the two groups over the course of training. In both conditions, differentiation is accomplished by increasing rates in S^{D} and decreasing rates in S^{Δ}. For the Reversed *Ss*, the mean response rate is higher in S^{Δ} than in S^{D} during the first six days. The eventual rates attained in S^{D} and S^{Δ} are similar for the two groups.

DISCUSSION

The results show a powerful effect of noncontingent pairings between stimuli and reinforcement (and nonreinforcement) upon subsequent learning of an operant contingency involving those stimuli as S^{D} and S^{Δ}. Since neither S_1 nor S_2 was associated with lever pressing during phase II, their later effect on this response must be mediated through some other process, normally concomitant with acquisition of an operant discrimination, which modulates the operant output. This other process may be labelled variously as conditioned incentive motivation, hope or joy (in S^{D}) and depression or frustration (in S^{Δ}). The assumption of such a modulating process figures prominently in the writings of many psychologists (*e.g.*, Keller and Schoenfeld, 1950; Mowrer, 1960; Seward, 1950; Sheffield, 1954; Spence, 1956). It is further supposed that this modulating process is based upon the classical conditioning of respondents (and attendant emotions) to S^{D} and S^{Δ}. In these terms, the Consistent condition is favored because the appropriate respondent has been conditioned to S^{D} and extinguished to S^{Δ}. The Reversed condition is unfavorable because the *S* must extinguish the respondent to S_1 (now S^{Δ}) and associate it with the formerly extinguished stimulus, S_2 (now S^{D}). In brief, the emotions conditioned are appropriate in the former case and inappropriate in the latter. Presumably, a control condition with phase II omitted would yield an intermediate rate of differentiation.

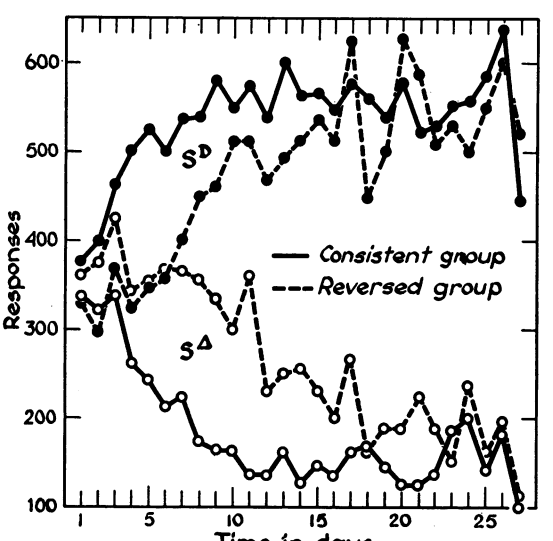

Fig. 2. Group average responses per session to S^{D} and to S^{Δ}. Solid lines show results for Consistent *Ss*; dashed lines for Reversed *Ss*. Responses per minute may be calculated by dividing the values plotted by 30.

Previous attempts by Walker (1942), Estes (1948), Morse and Skinner (1958), and Bower and Kaufman (1963) to show the effect on an operant of a Pavlovian CS may be aptly summarized by saying that the effect was usually small and short lived. The present experiment differs in showing a large effect which persisted throughout 25 hr of discrimination testing. It may be significant that the former studies assessed the influence of the CS in the course of extinguishing the operant response.

With these results at hand, it is apposite to interpret a result by Trapold and Odom (1964) which suggested this experiment. Trapold and Odom first trained rats to operate two different levers, one requiring a vertical push, the other a horizontal push. After the rats were taught an S^{D}-S^{Δ} discrimination with one of these responses, there was substantial transfer of this discrimination when the alternate response was tested. Such transfer might be interpreted in terms of the obscure notion of "response generalization". The present results indicate an alternate interpretation in terms of respondents, classically conditioned to S^{D} and S^{Δ}, which modulate the output rate of relevant operant responses. This interpretation was suggested by Trapold and Odom, and the present results enhance its credibility.

For the present experiment, the existence of a respondent discrimination to S_1 and S_2 remains only a plausible inference since no measures of respondent behavior were actually taken. Considering the entire complex of behaviors differentiated in the "Pavlovian" *vs.* the "operant" phases of this experiment, one may recognize the likelihood of a number of common elements besides the common respondent (and emotions) alluded to, *e.g.*, differential orientation and approach to the water-dipper hole in S_1 and S_2. Until a functional analysis is pursued in sufficient depth, the contribution of these various common elements to the ultimate induction observed cannot be gainsaid. In this regard, it may be reported that gross observations of *S*'s bodily orientation during S_1 and S_2 in the "Pavlovian" phase proved to be not particularly informative. Most of the time, *S*s maintained relatively fixed orientations, hovering over the water-dipper hole. They were somewhat more likely to move away during the nonreinforced stimulus, S_2—a fact simply explained by the drinking time in S_1.

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