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TRANSFER ACROSS DRIVES OF THE DISCRIMINATIVE EFFECT OF A PAVLOVIAN CONDITIONED STIMULUS[1]

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Previous results suggest that a stimulus paired in Pavlovian fashion with reward should exert some discriminative control over an unrelated operant response acquired under a different drive-reward system. In the following experiment, a stimulus was first paired with food reinforcement for a hungry rat. Subsequently, the animal learned to lever-press for water reinforcements when thirsty but not hungry. Finally, the control over lever-pressing of the food-paired stimulus was tested by presenting it at various times during extinction of the lever-pressing response. All animals in the experiment showed the expected effect; each emitted more lever-presses during periods of the food-paired stimulus than during alternate control periods.

The present experiment was designed to extend earlier work dealing with the relationship between discriminative stimuli (S^D) and conditioned reinforcing stimuli (S^r). Three previous results are relevant to the interpretation of this experiment. The first result, reported by Dinsmoor (1950), showed that a discriminative stimulus could be used in a secondary reinforcing capacity. The second result, reported by Estes (1948), demonstrated that a stimulus paired in Pavlovian fashion with food reinforcement acquired substantial discriminative control over an unrelated lever-pressing response that was trained with food reinforcement. The essentials of this result were replicated in an experiment by Morse and Skinner (1958). The third relevant result, again reported by Estes (1949), demonstrated that a stimulus paired with food reinforcement when the animal was hungry could serve subsequently as a conditioned reinforcer for lever pressing when the animal was tested thirsty but not hungry. An experiment by D'Amato (1955) replicated this result on the transfer of a secondary reinforcer across different drives.

The present experiment tests the following implication of these three results: if a stimulus has been paired with food reinforcement when the animal is hungry, then that stimulus should exert some control over an unrelated response that the animal acquires when it is thirsty and being reinforced with water. The reasoning here is direct: within the same drive-reward system a given stimulus can serve interchangeably as an S^r or an S^D; an S^r transfers across different drives; therefore, an S^r established under one drive-reward system should function as an S^D for an unrelated response established under a different drive-reward system.

METHOD

Subjects

Ten male albino rats, approximately 210 days old, were maintained in individual living cages. The feeding and watering regimens are described later.

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 response lever actuated a relay when it was depressed with a downward force of 5 g through a distance of .10 in. During the first part of the experiment, a food cup was located on the floor flush against the front wall, midway between the two sides. Single Noyes food pellets (45 mg) could be delivered into this food cup. For the second and third parts of the experiment, the food cup and pellet dis-

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penser were removed, the latter being replaced by a motor-driven dipper for delivering water reinforcements of .08 ml. When actuated, the cup of the dipper appeared for 3 sec in a hole in the floor near the front wall, immediately beneath the place where the food cup had been.

Procedure

Part I of the experiment consisted of pairing an external stimulus (tone or clicker) with food reinforcement. Prior to this training, the subjects (*S*s) had been placed on a reduced schedule of 20 min *ad lib.* feeding (lab checkers) each day for seven days. Water was continuously available in the home cages during this part of the experiment. The *S* was placed in the apparatus when 15-18 hr food-deprived. Each of the experimental sessions consisted of 15 alternating presentations of 30 sec of a continuous tone followed by 30 sec of a clicking noise. Five *S*s had food reinforcement paired with the tone and five had it paired with the clicker. During the 30-sec periods of the reinforced stimulus, two food pellets were delivered, one after 10 sec and one after 20 sec. Each *S* received eight 15-min sessions of this type; thus, each "tone-reinforced" animal received a combined total of 120 periods of tone with two food pellets per 30-sec period, and 120 periods of clicker, none of which was reinforced. The "clicker-reinforced" animals had the opposite pairing of stimuli and food reinforcement.

After Part I was completed, *S*s were permitted free access to dry food in their home cages, but were permitted to drink water for only 20 min each day. After four days on restricted watering, *S* began magazine and lever-pressing training for water reinforcements. Each *S* then received 30-min training sessions each day (for five days) on a VI 1 min schedule of water reinforcement for lever-pressing. Neither the tone nor the clicker was presented during these sessions.

On the day following the fifth day of VI 1 training, each rat was placed in the apparatus while 22 hr water-deprived. The first response was reinforced with water, and then lever pressing was extinguished for 1 hr. Throughout the hour of extinction, the tone and the clicker were presented separately in alternate periods of 30 sec. Responses during the tone and clicker were recorded separately on digital counters and on two cumulative recorders. One cumulative recorder ran during the clicker periods; the other recorded responses during the tone periods. Each *S* was returned to the apparatus the following day for a second period of extinction lasting 30 min. The first response was reinforced with water (with neither stimulus on) and then extinction began with tone and clicker periods alternating every 30 sec.

RESULTS

The comparison of interest is the number of responses emitted in extinction during the two stimuli, one of which had been paired previously with food reinforcement. The relevant results are displayed in Table 1, which gives the number of responses during the previously food-reinforced stimulus (S^D) and during the previously nonreinforced stimulus (S^{Δ}) for Extinction Day 1 and for Days 1 and 2 combined.

Table 1

Total number of lever-presses in extinction during tone and clicker stimuli.

		Day 1		*Days 1 and 2 combined*	
Subject		S^D	S^{Δ}	S^D	S^{Δ}
Tone S^D	1	188	132	235	203
	2	144	165	242	238
	3	202	153	285	203
	4	110	79	166	132
	5	265	247	379	365
Clicker S^D	6	347	230	493	318
	7	187	137	271	171
	8	279	200	329	245
	9	368	334	501	474
	10	174	79	230	106
Mean		226.4	175.6	313.1	245.5

The results in Table 1 show directly the differential effect on lever pressing of the two stimuli. On Extinction Day 1, nine of the 10 rats emitted more responses in S^D than in S^{Δ}; considering response totals for Days 1 and 2 combined, all 10 of the rats emitted more responses in S^D than in S^{Δ}.

Figure 1 shows the Day 1 cumulative records for subjects 1 and 6, both showing the differential effect. Two curves are presented for each *S*, one for responses in the tone and one for responses in the clicker. Both *S*s show

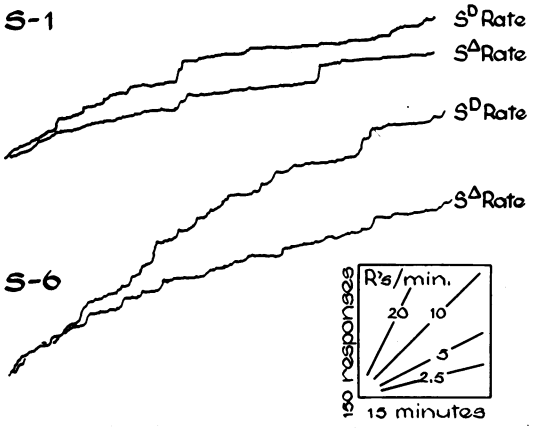

Fig. 1. Performance during extinction recorded separately according to the presence of tone or clicker, which alternated in 30 sec periods. The stimulus previously paired with food reinforcement was the tone for Rat #1, the clicker for Rat #6.

the gradual decline in response rate characteristic of VI extinction.

DISCUSSION

The results clearly show the intended effect: a stimulus paired with food reinforcement acquires some discriminative control over an unrelated response reinforced by water when the animal was thirsty but not hungry. The discriminative effect is relatively small, amounting to only 28 per cent more responses to the transferred S^D stimulus. However, one would reasonably expect the effect to be small because the presumed relationship is mediated through two steps: (1) the transfer of an S^r from hunger to thirst, and (2) the change in the functional role of the stimulus from an S^r to an S^D during the testing. Judging from the results of Estes (1948, 1949), one would expect each step to degrade in some degree the behavioral control exerted by the stimulus. One may note too, as have Morse and Skinner (1958), that the arrangement for testing for S^D properties of an S^r can mask the effect to the extent that superstitious behaviors incompatible with lever-pressing have been associated with the S^r during its initial pairing with reinforcement. In light of these various attenuating factors, it came as a mild surprise that the mediated discriminative control was actually as large and reliable as obtained in this experiment.

The effect obtained here is actually only one of several implications of the Dinsmoor and Estes results. A second implication is that a stimulus explicitly trained as an S^D for a response reinforced by food would be expected to serve as a conditioned reinforcer for a second, unrelated response when the animal is thirsty during testing. In both cases, the same presumed factors would be involved in mediating the effect. Cases of further interest arise when one inquires whether an S^r (or S^D) transfers only across appetitive drive-reward systems (hunger to thirst) where, at both ends, positive reinforcement is involved. Conceivably, a stimulus (S^r) paired with termination of an aversive stimulus (shock) transfers S^r or S^D properties when tested with an unrelated response trained with positive reinforcement when the animal is hungry or thirsty.

One can inquire whether there is some likely instrumental behavior connected to the "Pavlovian" stimulus which mediates the effect of that stimulus on lever-pressing. The probable candidates are orientation and approach to that area of the cage where the reinforcement magazine is located. This is suggested by the fact that, in both of Estes' experiments and the present one, the lever and magazine were located closer together on the same wall. The small excess of lever-presses during S^D periods of extinction could result from the fact that approach responses occurring to the S^D keep the animal in the vicinity of the lever. The transfer of the effect between hunger and thirst might then be accounted for in terms of the interactions between these deprivation conditions (cf. Verplanck and Hayes, 1953) and common interoceptive stimuli shared by the two deprivation conditions. Thus, the response of approaching the magazine location acquired to tone-plus-hunger stimuli would transfer in some degree to tone-plus-thirst stimuli. This analysis implies that the effect on lever-pressing of the Pavlovian stimulus would be negligible or even reversed if the magazine and lever were placed in different locations of the cage. This possibility remains to be tested.

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