Conditioned inhibition of conditioned suppression¹

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Conditioned inhibition of conditioned suppression was obtained. A food-reinforced response became suppressed during preshock CS, but not during the CS when paired with another stimulus (the conditioned inhibitor), with shock omitted. The conditioned inhibitor was shown to be a conditioned reinforcer.

In classical conditioning experiments, if the US is repeatedly omitted when the CS is paired with another stimulus, the CR fails to appear during the paired stimuli (Pavlov, 1927). Pavlov called the second stimulus a conditioned inhibitor (CI). He showed that the CI was not simply a neutral stimulus but exhibited motivational properties, from inhibition of CRs in new situations to the induction of sleep.

Behavioral suppression during a pre-aversive stimulus (Estes & Skinner, 1941) is widely interpreted as the result of classical conditioning of respondents whose elicitation reduces the probability of the operant. The present report extends the interpretation of conditioned suppression as a phenomenon of classical conditioning by demonstrating that conditioned suppression is susceptible to conditioned inhibition.

Method

In Phase 1 six male hooded rats, 22 h food deprived, were trained for 12 1 h sessions to press Bar 1 in an unlighted Grason-Stadler two bar box. Reinforcements were 45 mg food pellets, delivered on a 1 min variable interval schedule (VI 1). Twelve daily sessions of conditioned suppression training followed, superimposed upon the VI 1. Each session had 16 cycles. Each cycle consisted of 4 min of control period followed by either 2 min of intermittent white noise (the CS) or the white noise paired with a dim light (the CI) which preceded the white noise by 5 sec. The US was a 1.0 mA, 0.5 sec shock delivered to the grid floor at the end of the CS. No shock occurred when the CS was paired with the CI. Each session had four cycles with CS and 12 cycles with paired CS and CI.

In Phase 2, which directly followed Phase 1, the conditioned suppression procedure was discontinued and the VI 1 for food remained in effect. The rats were divided into two groups. Responding on Bar 2 was used to measure any reinforcing effect of CS and CI. For 10 1 h sessions responses on Bar 2 produced 5 sec stimulus presentations, the CS in one group and the CI in another, on a VI 1 schedule. For four more sessions, the stimulus was changed (from CS to CI for one group and from CI to CS for the other).

Results

Figure 1 shows the results of Phase 1 in the form of suppression ratios, calculated as $B/A + B$, where B

Fig. 1. Mean suppression ratios in Phase 1 (see text). The white noise (D for "danger") was terminated with shock, except when paired with the light (S for "safe").

is the response rate during a stimulus and A is the response rate during no stimulus (control) periods. Strong conditioned suppression developed during the CS when it occurred alone but not where it was paired

Fig. 2. Cumulative records of final performance in Phase 1. Durations of stimuli are indicated by displacements of the trace, with the pre-shock stimulus arrowed. The numbers 1-6 identify different rats.

Fig. 3. Results of tests for a conditioned reinforcing effect of CS and CI. Each point is the mean of the Bar 2 rates of three rats. The Bar 2 schedule in Phase 2 was VI 1.

with the CI. Individual records of performance on the last session of Phase 1 are shown in Fig. 2.

Figure 3 shows mean response rates on Bar 2. The rate on Bar 2 was near zero during Phase 1 when the responses had no programmed consequences (Sessions 8-12 in Fig. 3). In Phase 2 the rate greatly increased when the response produced the CI, but not when it produced the CS.² All the rats producing the CI had a higher rate on Bar 2 than the rats producing the CS, except in Session 13.

Discussion

The demonstration in Phase 1 of the existence of conditioned inhibition of suppression in accordance with the laws of classical conditioning supports the interpretation of conditioned suppression as a phenomenon of classical conditioning. This interpretation is consistent with previous studies which have shown appropriate effects of, for example, CS intensity (Kamin & Schaub, 1963), US intensity (e.g., Annau & Kamin, 1961), number of conditioning trials (e.g., Libby, 1951), and distance from the CS in tests of stimulus generalization (e.g., Ray & Stein, 1959).

In Pavlovian terms the CI is a "disinhibitor" since the CR is itself inhibitory. A positive motivational effect of the CI, rather than a neutral effect, is suggested by the many instances, seen in Fig. 2, of an increase in response rate during the paired CS and CI. The enhancement of response rate in the presence of the CI might be regarded as an example of "contrast," similar to the enhancement of rate of a reinforced response by the use of discriminated periods of punishment (Brethower & Reynolds, 1962) or low reinforcement rates (e.g., Reynolds, 1961). Certainly, it would be easy to state a general rule, not yet disproved, which would subsume all these phenomena.

A pre-aversive stimulus becomes an effective punisher, reducing the rate of responses which produce it (Hake & Azrin, 1965). Results of Phase 2 show a corresponding, opposite effect of the CI of a pre-aversive stimulus—the CI becomes a conditioned reinforcer.

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Notes

1. Supported by NIH grant No. GM 14221.
2. The fact that CI-producing responses declined after a few sessions is to be expected since the reinforcing effect of the CI was undergoing "extinction." The decline belies the interpretation that the apparent conditioned reinforcing effect was mainly due to the unconditioned reinforcing effect of dim illumination. However, another experiment which used auditory stimuli for CS and CI produced essentially the same results as reported here.