Conditioned punishment and conditioned negative reinforcement on a multiple schedule

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Two rats, earlier trained on Mult VI 1 VI 1 (clicker plus reinforced response shock), were exposed to increasing intensity shock until their punished rates were 1/3 or less of their unpunished rates. At this point, the clicker (discriminative stimulus for shock) was made to sound for 2 sec following each response in the shock-free components. This condition resulted in conditioned punishment (suppression of nonshock response rate). The contingency was then reversed, such that the clicker sounded in the absence of responding and each response terminated the clicker for 2 sec. This resulted in increased response rates (conditioned negative reinforcement). Control rates were recovered through a final reversal to the training condition.

A neutral stimulus, after pairing with electric shock, will frequently suppress the rate of an operant behavior when made contingent on that behavior. Several studies have demonstrated the temporary maintenance of such a "conditioned punisher" (Barlow, 1952; Evans, 1962; Mowrer & Aiken, 1954; Mowrer & Solomon, 1954). The conditioned punishment effect (suppression) was not long enduring in these studies, since the stimulus-shock pairing was discontinued prior to the contingency on operant behavior. Hake & Azrin (1965) have developed a procedure in which this stimulus-shock pairing is maintained concurrent with the contingent delivery of the stimulus alone. Thus, conditioned suppression was maintained with stimulus-shock pairs (Estes-Skinner procedure) while investigating conditioned punishment with the same stimulus delivered at other times in the session. This procedure effectively reduced response rate as long as the pairing continued.

In the current experiment, the discriminative stimulus for suppressive shock punishment in one component of a multiple schedule was presented contingent on barpresses in a shock-free leg of the multiple. Thus, the stimulus-shock association was maintained in one portion of the schedule while the stimulus was

made to follow responses in another portion.

Several studies have also paired a stimulus with shock but then presented the stimulus in the absence of operant responding, allowing the organism the opportunity to remove or escape from the stimulus by a response. This phenomenon (conditioned negative reinforcement) was demonstrated by early fear conditioners (Miller, 1948, 1951; May, 1948; Mowrer & Lamoreaux, 1942), is a part of standard signal avoidance, and was obtained by

Dinsmoor (1962) on a variable interval escape schedule. In the current study, a stimulus signaling suppressive shock in one component of a multiple schedule was also made to occur in the absence of barpresses in the other, shock-free component. Responses in the latter component removed the stimulus.

SUBJECTS

The Ss participating in this experiment survived an earlier study (Davidson, 1970) described in the procedure section. They were two male Sprague-Dawley rats maintained on dry Purina Rat Chow and water at 80% of their free-feeding weights. They also received dietary supplements of Sustagen (Mead Johnson) and antibiotic (Terramycin, Pfizer).

APPARATUS

Standard operant apparatus (see Davidson, 1970), including a rat chamber equipped with a single lever, a motor-driven dipper, and grid floor, were used. An 800-V ac shock source remotely introduced current through series resistors and a high-speed scrambler to the floor grids. Shock intensities were read off a milliammeter in series with the animal. Relay equipment automatically programmed the schedules, and cumulative recorders and counters supplied the data.

RESPONSES PER MINUTE ON MULTIPLE VI₁ VI₁ (REINFORCED RESPONSE-CONTINGENT SHOCK)

Fig. 1. Mean response rates on Mult VI 1 VI 1 (clicker plus reinforced response-contingent shock) for R1. As indicated by the legend, the solid lines plot response rates in nonshock components, while broken lines graph rates in shock components. Responding in conditioned punishment produced a clicker for 2 sec in nonshock components, while responding in conditioned negative reinforcement removed the clicker for 2 sec in nonshock components. Shock intensity was 1.40 mA through all depicted conditions.

RESPONSES PER MINUTE ON MULTIPLE VI₁ VI₁ (REINFORCED RESPONSE-CONTINGENT SHOCK)

PROCEDURE

The first phase of this experiment (described earlier, see Davidson, 1970) consisted of training the animals to respond on a VI 1 schedule of reinforcement (.2 cc of 12% sucrose solution delivered contingent on the first response after 1 min, on the average). One of the Ss (R1) received VR training, which elevated his terminal rates above those of the other (R9). The terminal schedule was Mult VI 1 VI 1 (reinforced response-contingent shock). On this schedule, a clicker sounded throughout every other period during which 13 reinforcements were dispensed (averaging about 13 min). The clicker signaled the availability of shock contingent on each reinforced response in the clicker component. Shock intensity was increased until each S showed suppression in the shock components to 33% or less of nonshock rates.

Following this history, the animals were maintained on the same basic multiple schedule at the same shock intensity, but two additional manipulations of the clicker (discriminative stimulus for shock) were now introduced. First, the clicker was made to sound for 2 sec contingent on each response in the nonshock component until response rates appeared to stabilize (a limited number of sessions was run, instead, with R9, who had begun to show some signs of physical debilitation).

Next, the clicker contingency was reversed so that the clicker sounded in the absence of responding in the nonshock component, and each response terminated the clicker for 2 sec. This new contingency was again maintained until the rates

appeared to stabilize at a new value. Since R1 tended not to respond in the third (nonshock) component during this phase, timeouts (removal of all contingencies and disconnecting the houselights) were programmed for 1-10 min. This usually reinstated responding.

Last, the clicker contingency was removed from the nonshock components, thus reinstating the original Mult VI 1 VI 1 (reinforced response-contingent shock) with the same intensity of shock in an attempt to recapture the earlier base rates during control (punishment) conditions.

RESULTS

Both animals demonstrated dramatic effects of introducing clicker contingencies in nonshock components. These effects were most often observed as changes in nonshock response rates. However, there were also occasional changes in shock rates. These results are depicted in graphs which analyze the effects on overall (component) rates.

Figure 1 is a summary graph for R1, showing shock and nonshock rates as broken and continuous lines, respectively. It should be noted that this animal responded at higher rates than the other rat, due to a short exposure to variable-ratio schedules of reinforcement. Shock intensity remained at 1.40 mA throughout the experiment and maintained rates at lower than 5 rpm, as illustrated by the broken line across the lower portion of the graph.

Under the initial punishment condition (left panel), average rates in the nonshock legs were about 25 rpm, but when the 2-sec clicker sounded following each response in the nonshock components, conditioned

Fig. 2. Mean response rates on Mult VI 1 VI 1 (clicker plus reinforced response-contingent shock) for R9. Solid lines plot response rates in nonshock components, while broken lines graph rates in shock components. Responding in conditioned punishment produced a clicker for 2 sec in nonshock components, while responding in conditioned negative reinforcement removed the clicker for 2 sec in nonshock components. Shock intensity was 1.47 mA throughout, with the exception of the second panel, which depicts one day on which no shock was delivered.

punishment was observed as suppression of nonshock rates to about one-third the previous rate (second panel).

When, on the other hand, the contingency was reversed such that responding in nonshock legs now terminated the clicker (conditioned negative reinforcement, third panel), the S's rates increased to the highest observed in his history, with the exception of the VR history. As mentioned in the procedure section, R1 tended not to respond in the second nonshock component unless a timeout was programmed. Because of this variability, the data in the third panel (Fig. 1) are taken from only the first two components each day.

The last panel represents a reversal to the original punishment condition, with no extraneous stimulus in the nonshock components. The data in this panel demonstrate recapture of the initial base rates under the same conditions.

Similar data for R9 appear in Fig. 2, with shock and nonshock rates again appearing as broken and continuous lines, respectively. As illustrated in the left panel of this figure, this animal showed stable responding under punishment of 1.45 mA, with an average rate of response in nonshock components that was seven times that of shock-suppressed rates.

The second, unlabelled panel in Fig. 2 indicates rates during one session during which shock was accidentally deleted.

Under the conditioned punishment contingency (third panel), rates in both shock and nonshock components rose to high levels (about 8 rpm); then the rates in nonshock components decreased first, followed by recovery of suppressive levels of shock-suppressed rates. Thus, on 3 of the initial days of exposure to this schedule, shock rates were higher than nonshock rates. Though the difference in mean rates between the two components was much smaller than in the punishment condition, the overall downward trend in both components was the only real indication of increasing suppression in both

components. Similarly, the downward trend in nonshock rates is the best substantiation of conditioned punishment effect (suppression by clicker alone).

By contrast, the initial exposure to the conditioned negative reinforcement contingency (each response in the nonshock component now terminated the clicker for 2 sec. fourth panel) sent the nonshock rates to higher levels than had ever been previously observed in this S. Shock rates also increased during early exposure to this contingency, but then fell again to low rates.

Control (punishment) rates were recaptured when the stimulus (clicker) was removed from nonshock components, as shown by the last panel of Fig. 2. The animal again appeared ill at this point, and died, despite ad lib feeding, increased dietary supplements, and administration of antibiotics, about a month later.

DISCUSSION

With one exception (conditioned punishment in R9), these data clearly indicate the powerful effects on behavior by a stimulus which has been a discriminative stimulus (signal) for shock. Introducing the discriminative stimulus for suppressive shock contingent on unpunished behavior resulted in stable suppression of that behavior in R1 (this might have been also produced in R9, had the contingency been maintained for a longer period).

By contrast, when the same stimulus was made contingent upon pausing in shock-free components and responding removed it, response rates increased to

higher values than ever before observed in both Ss.

Reversals to control conditions demonstrated the recoverability of stimulus-free response rates. In fact, recovery of control rates in the same range indicated the power of this particular paradigm.

A short reference might be made again to the increase in shock rates that occurred at the beginning of the conditioned punishment and conditioned negative reinforcement conditions in the behavior of R9 (Fig. 2). Similar, but smaller, increases were exhibited by R1, although they do not appear in Fig. 1. Some of this increase might indicate indiscriminability between the two components of the schedule, since the transition point between components was not marked by a detectable stimulus change. Thus, if the animal happened to be responding at the transition between conditioned punishment and clicker-signaled punishment components, no stimulus change would mark the transition. A changeover delay between components might have eliminated these increases.

Increases in shock rates were again observed in both Ss when first exposed to the conditioned negative reinforcement contingency, although the increase was more marked and longer lasting in R9. These increases might have reflected superstitious attempts to escape shock and the discriminative stimulus for shock, as was programmed in the nonshock components of the schedule. Again, a changeover delay might have eliminated such increases by making the change

between schedule components more clearly distinguishable.

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