The effect of two extinction procedures after acquisition on a Sidman avoidance contingency[1]

G. COULSON, V. COULSON, and L. GARDNER, York University, Downsview, Ont., Canada

Four white rats were conditioned to respond on a free-operant or Sidman avoidance schedule. After a stable level of responding had been reached, one of two extinction procedures was instated. The S received either no shock or the same number and pattern of shocks as in his last avoidance session. Response rates were very much higher under the latter extinction procedure, although they approached zero with continued extinction sessions with response-independent shocks.

Although extinction sometimes refers to a process, it usually denotes a procedure introduced after some reinforcement procedure has established a reliable baseline of responding. Of the several procedures called extinction, only two were used in the present experiment. While these procedures differ considerably from one another, their common feature is that responding has no effect on reinforcer delivery.

In one procedure, the one used most often, all conditions of acquisition and/or maintenance are maintained save that the reinforcer is never presented. In the other extinction procedure, all conditions of acquisition and/or maintenance, including frequency and pattern of reinforcer delivery, are maintained save that the occurrence of a response has no effect on reinforcer delivery.

Skinner (1938) and Rescorla & Skucy (1969) used the latter procedure after intermittent positive reinforcement and found that response decrement was less than if reinforcers were never delivered in extinction.

One of the best-known experiments in the extinction of avoidance behavior is that of Solomon, Kamin, & Wynne (1953). They found that removing shock after acquisition of signaled, discrete-trial avoidance behavior in dogs had little effect on percentage of avoidance responses. The probability of avoidance responses remained at almost 100% for all Ss for 200 trials.

Shnidman (1968) found that removal of shocks after conditioning rats in free-operant avoidance resulted in the emission of very few responses even after considerable warm-up with the regular avoidance procedure in the same session. Shnidman also trained free-operant avoidance with a signal presented shortly before impending shocks. Removal of the shocks but not the stimulus resulted in only a slight increase in responses during extinction compared with the number of responses during extinction of unsignaled shock.

The present experiment was designed to provide information on the effect of response-independent shocks during extinction of free-operant avoidance behavior. Presenting shocks during extinction preserves more aspects of acquisition and/or maintenance than totally withholding shocks. Will the shock-extinction procedure result in a higher rate of responding?

SUBJECTS AND APPARATUS

The Ss (S 1, S 2, S 3, and S 4) were male Sprague-Dawley rats from Holtzman Co., Madison, Wis. The Ss were about 90 days of age at the beginning of the experiment. They had previously been used briefly in a passive avoidance experiment and had received one 2-sec, .3-mA shock when they went from one side of a box to the other. They then received four retention trials without shock. The Ss were without other experimental experience.

The experimental space was a two-lever operant chamber (Grason-Stadler Model E3125D-100), with the right lever removed. The chamber was illuminated by light from a green bulb in the middle of the end wall containing the lever. Each lever press, which required a minimum of 13-g force, was accompanied by a brief flash from a red bulb mounted above the lever. The chamber was housed inside a Grason-Stadler sound-attenuating enclosure (Model E3125AA-3). Shocks were delivered from a Grason-Stadler Model E1064GS shock scrambler generator. Electromechanical control and recording equipment were housed in a room adjacent to the experimental space. The record-playback system consisted of a tape recorder and photoelectric relay as described by Adamson & McNab (1969).

PROCEDURE

During the first session, S was placed in the chamber without shock for 10 min. A Sidman, or free-operant, avoidance procedure was then instituted, in which the response-shock (RS) interval and shock-shock (SS) intervals were set at 30 and 1 sec, respectively, and S was shaped to press the lever, an outcome that took no more than 15 min for any S. The SS interval was then changed to 5 sec and the S was given 2 h of exposure to RS = 30 sec/SS = 5. All sessions thereafter were 2 h long, and during each avoidance session, SS was set equal to 5 sec and RS to 30 sec. Shock level was set at 1 mA and duration at .5 sec. Consecutive sessions were given on consecutive days for all Ss.

Each S was run until it had five consecutive sessions in which the response rate varied by no more than .5 responses per minute (stability criterion). The pattern of shocks for the last session of the stability run was recorded and used in the shock-extinction session.

After the first stability run, each S received two sessions without shock and four sessions of played-back shock. During played-back shock sessions, each S received shocks at the same points in time as it had received them on the last stability session. During the shock-extinction sessions, responding had no effect on shock delivery. S 1 and S 3 were given the shock-extinction sessions first and the no-shock extinction sessions second. The order was reversed for S 2 and S 4. Each S was then exposed to the same free-operant avoidance schedule as before until the stability criterion was met again and the pattern of shocks he received during the last session of the second stability run was played back on his subsequent shock-extinction session. After meeting the stability criterion the second time, each S received a slightly different sequence of extinction sessions. The details may be found in Fig. 1. The experiment was terminated by giving each S 15 sessions of shock-extinction.

RESULTS

As Fig. 1 indicates, the main result is clear for all four Ss. Response rates are much higher under the shock-extinction procedure than under the no-shock-extinction procedure. For S 1, S 2, and S 4, there is some indication that response decrement is slower during the second sequence of shock-extinction than during the first. This is most evident in the data of S 4. S 1 received 173 shocks on the last session of the first set of stability criterion sessions and 224 shocks during the last session of the second set. Comparable numbers of shocks for S 2, S 3, and S 4 were 63 and 71, 94 and 138, and 66 and 123. The greater number of shocks during the second shock-extinction series might account for the slower response decrement during these sessions.

DISCUSSION

The present data bear some resemblance to those of Kelleher, Riddle, & Cook (1963), who found that lever pressing in monkeys who had an avoidance history was maintained by the presentation of

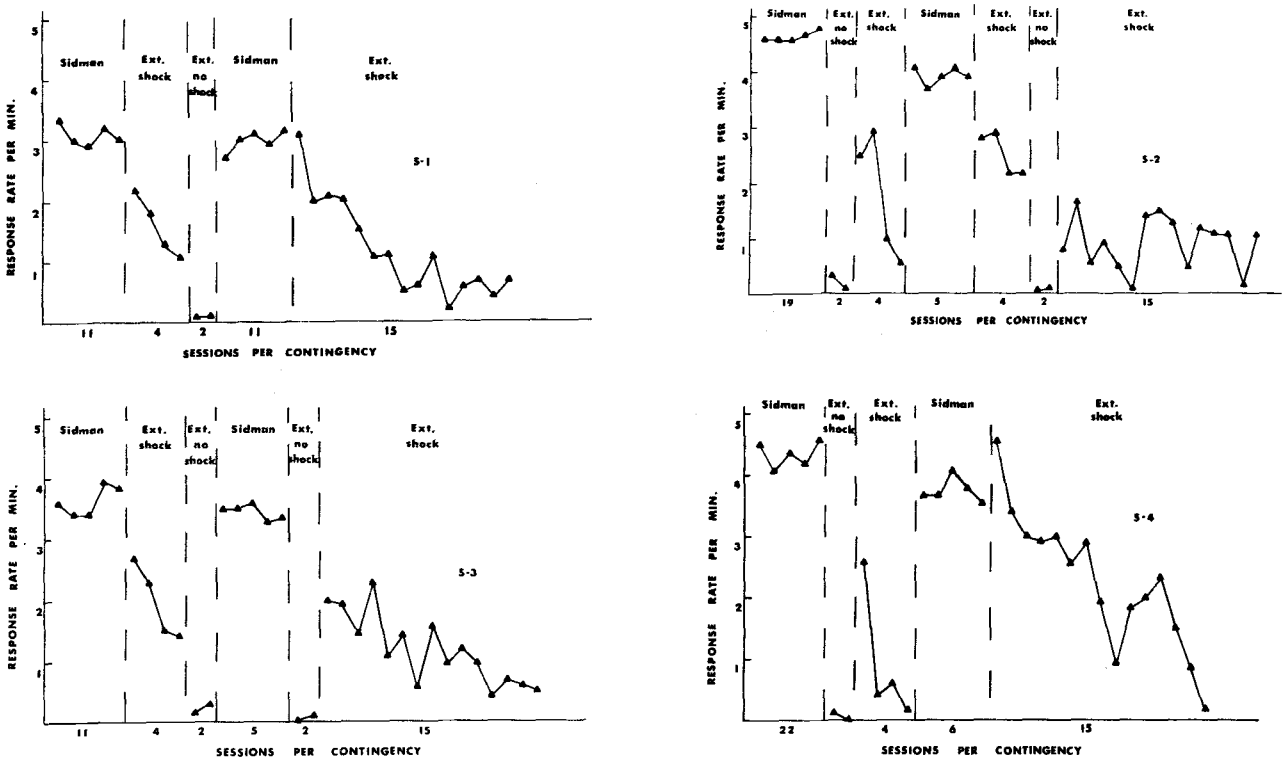

Fig. 1. Response rates per minute for individual Ss as a function of contingency and trial number. Numbers on the abscissa refer to the number of sessions in a contingency. Only the five criterion sessions are shown for the Sidman contingency each of the two times it was in effect.

unavoidable, inescapable, and noncontingent shock presented at a fixed interval. Stretch, Orloff, & Dalrymple (1968) report similar findings with response-contingent shock available on a fixed-interval 5-min schedule after free-operant avoidance training. The present data are also similar to those of Stretch et al in that response rate declined over sessions of the shock extinction.

In any case, since the present authors have found, in the absence of a history of avoidance behavior, that operant level of lever pressing in the presence of randomly presented shocks is close to zero, the shock-extinction procedure potentiates greater-than-operant-level responding for at least 30 h.

The procedure of extinguishing free-operant avoidance behavior by presenting noncontingent shock provides more similarity to the avoidance procedure than extinction by removing the shock completely. As Sidman (1966) says, "... shocks ... tell the animal that it is in an avoidance situation [p. 485]." Rescorla & Skucy (1969) make a similar point in discussing extinction of positively reinforced behavior. They point out that delivering the positive reinforcer independent of responding maintains more aspects of acquisition and/or maintenance than does removing the reinforcer completely. Placed in this context, the present experiment makes contact with procedures and results of other experiments that have removed the response-reinforcer contingency while maintaining reinforcer delivery.

REFERENCES

ADAMSON, R., & McNab, L. A photoelectric sound-activated relay. Behavior Research Methods & Instrumentation, 1969, 1, 147.

KELLEHER, R. T., RIDDLE, W. C., & COOK, L. Persistent behavior maintained by unavoidable shocks. Journal of the Experimental Analysis of Behavior, 1963, 6, 507-517.

RESCORLA, R. A., & SKUCY, J. C. Effect of response-independent reinforcers during extinction. Journal of Comparative & Physiological Psychology, 1969, 67, 381-389.

SHNIDMAN, S. R. Extinction of Sidman avoidance behavior. Journal of the Experimental Analysis of Behavior, 1968, 11, 153-156.

SIDMAN, M. Avoidance behavior. In W. K. Honig (Ed.), *Operant behavior: Areas of research and application.* New York: Appleton-Century-Crofts, 1966. Pp. 448-498.

SKINNER, B. F. *The behavior of organisms.* New York: Appleton-Century-Crofts, 1938.

SOLOMON, R. L., KAMIN, L. J., & WYNNE, L. C. Traumatic avoidance learning: The outcomes of several extinction procedures with dogs. Journal of Abnormal & Social Psychology, 1953, 48, 291-302.

STRETCH, R., ORLOFF, E. R., & DALRYMPLE, S. D. Maintenance of responding by fixed-interval schedule of electric shock presentation in squirrel monkeys. Science, 1968, 162, 583-586.

NOTE

1. This research was carried out while the first author held a predoctoral fellowship from the Alcohol and Drug Addiction Research Foundation of Ontario.