THE ELIMINATION OF INTERFERING RESPONSE PATTERNS IN LEVER-PRESS AVOIDANCE SITUATIONS¹

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Lever holding into shock and short-latency responses to shock onset are two response patterns that interfere with avoidance acquisition in free-operant and discriminated avoidance situations. In an attempt to eliminate these patterns, an additional timer disabled the lever for a period slightly longer than shock duration. A free-operant avoidance schedule with a warning stimulus, but without the additional timer, constituted the control condition. The lever-disabling timer was turned on by different events in two experimental conditions: (a) release of the lever at the onset of shock, (b) shock onset. Interfering responses diminished most rapidly, and efficient avoidance behavior appeared earliest, when the lever-disabling timer was turned on by shock onset.

When a lever press is required as the avoidance operant in discriminated or free-operant avoidance procedures, two patterns of response that interfere with avoidance acquisition may appear (Meyer, Cho, and Wesemann, 1960; Ellen and Wilson, 1964; Sidman, 1966).

One pattern has been described by Sidman (1966, pp. 457-458) as the repeated termination of the shock-shock interval (S-S interval) by pressing the lever soon after receiving a shock, then waiting out the response-shock interval (R-S interval) until the next shock. Sidman's illustrative records appear identical to a sample designated by Ellen and Wilson (1964) as a "burst responding pattern". In both records, single responses soon after the delivery of shock appear to predominate. Sidman (1958) noted that the likelihood of a response immediately after shock is relatively high in some animals and that it has been generally observed that responses of this type tend to initiate bursts. A response that occurs very soon after the initiation of shock will be termed a short-latency-response-to-shock-onset.

The second pattern of response consists of repeatedly holding the lever in a depressed position throughout the R-S interval until shock onset (Hoffman, 1966; Keehn, 1967). It must be emphasized that lever holding is not intrin-

sically an interfering response pattern. For example, an animal might hold during the majority of an R-S interval but release and press the lever before shock onset. Past efforts to prevent or remove holding have met with little success (Feldman and Bremner, 1963; Hoffman, 1966).

An analysis of the contingencies in conventional schedules reveals the presence of a set of contingencies that increase the probability of response topographies that are incompatible with the emission of avoidance responses. When situated close to the lever, an animal may hit the lever in the course of the violent body contortions produced by shock. Almost all animals are "shocked into" lever presses at one time or another during early training. In time, some animals come to hover in the vicinity of the lever (Meyer *et al.*, 1960), place the forepaws on the wall above the lever, or maintain the lever in a depressed position. From these response topographies, single short-latency-responses-to-shock-onset tend to occur upon the first shock delivery after an R-S interval. By maintaining these response topographies, shocks tend to occur every R-S interval rather than every S-S interval (partial reduction of shock density). If short-latency-responses-to-shock-onset were rendered ineffective, behavior should come under control of the avoidance contingency more rapidly, because reduction of shock density would be associated only with emitting lever presses.

Since short-latency-responses-to-shock-onset may occur while an animal is hovering near

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the lever or holding the lever in a depressed position, a lever-disabling timer was scheduled to be turned on by a different event in each of two conditions. In one condition, the timer was turned on by shock onset (Shock-Timer-On). In this condition, short-latency-responses-to-shock-onset preceded by any behavior were rendered ineffective. In the second condition, the timer was turned on by release of the lever at shock onset (Release-Timer-On). This condition allowed recycling of the R-S interval by short-latency-responses-to-shock-onset not preceded by holds. Another alternative, rendering short-latency-responses-to-shock-onset not preceded by holds ineffective, but allowing those following holds to recycle the R-S interval, was not included in the experiment.

In order to insure the maximum opportunity for short-latency-responses-to-shock-onset to occur in all animals, the operant-conditioning chamber was modified to allow access only to the front of the lever. It was assumed that without this restriction, some animals might hold the lever so that contortions would not result in short-latency responses (animals that hold the lever with their body parallel to the wall on which the lever is situated tend to fall off the lever at shock onset).

METHOD

Subjects

Six male albino Sprague-Dawley rats (Charles River Breeding Laboratories) were experimentally naive and 90 days old at the beginning of the experiment. They were caged individually with free access to food and water throughout the experiment.

Apparatus

A Gerbrands Model C operant conditioning chamber, with a single lever centered on one of the metal end panels 3 in. (7.7 cm) above a floor of parallel steel rods, was enclosed in a sound-attenuated chamber. A blower fan produced an ambient noise level of 57 db. When the white noise warning stimulus was added (Grason-Stadler Model 901B Noise Generator), the noise level was 81 db. The floor, but not the lever, was wired to a Grason-Stadler Model E1064GS shock generator. A smooth hardwood block, 1.5625 by 2.5625 in. (4.0 by 6.5 cm) in cross-section, extended from the floor to the top of the chamber on each side of the lever. The blocks formed an alcove 4.0-

cm deep with the lever centered with one block covering the food opening. The chamber was illuminated by a 40-w bulb.

Procedure

Each lever press postponed for 20 sec (R-S interval) a 0.2-sec, 0.8-ma shock that otherwise occurred every 5 sec (S-S interval). Five seconds before a scheduled shock, a white noise warning signal began and continued until a lever press recycled the R-S interval (Shnidman, 1968). An electronic timer could disable the lever so that presses had no scheduled effect, but could still be recorded.

Rats were randomly assigned, two to each of three groups designated by the event initiating the lever-disabling timer.

No-Timer-On (NTO): A lever press at any time immediately recycled an R-S interval and terminated the warning signal, if present.

Release-Timer-On (RTO): A lever-disabling timer, set for 0.3 sec, was initiated by release of the lever if the lever was in a depressed position when shock started.

Shock-Timer-On (STO): A lever-disabling timer, set for 0.3 sec, was initiated by the onset of shock.

Animals were given ten 2-hr sessions with a two-day rest between each session. An animal was placed in the chamber facing the lever immediately after the start of an R-S interval.

In the initial session, orientation to the lever was shaped by administering 75 shocks (0.2 sec) by hand each time the rat turned from the lever during S-S intervals. As the rat moved farther from the lever, shocks were administered at increasingly higher frequencies. Animals responding with a lever press before delivery of all 75 shocks received the remainder upon successive moves away from the lever during subsequent S-S intervals.

In all conditions, the first lever press within 0.3 sec after the onset of shock was recorded as a short-latency-response-to-shock-onset. Responses emitted during R-S intervals were recorded as avoidance responses.

Although the opportunity existed for holds to be initiated and maintained through one or more S-S intervals when the lever-disabling timer was employed, only holds through R-S intervals are reported to allow comparison with the No-Timer-On condition. Similarly,

Fig. 1. Three types of non-avoidance responses. Total holds into shock, short-latency-responses-to-shock-onset (S.L.R.S.O.s), and short-latency-responses-to-shock-onset following holds for each rat for each of the ten 2-hr sessions. The plot of short-latency-responses-to-shock-onset does not include short-latency-responses-to-shock-onset following holds.

only the first short-latency-response-to-shock-onset after each R-S interval is reported.

RESULTS

Both animals in the Shock-Timer-On condition showed the lowest frequencies of the three types of non-avoidance responses analyzed in Fig. 1. All three non-avoidance responses diminished more gradually to a similar low level in the record of Rat NTO-1 in the No-Timer-On condition. The low frequency of non-avoidance responses, which occurred late in the record of RTO-2 in the Release-Timer-On condition, followed a shift in mode of response not shown by other animals in the experiment. Hovering over the lever and hitting it within 0.3 sec after shock onset was preponderant in Sessions 1 and 2. In Session 3, the following response pattern predominated: the lever was held through the R-S interval, released at shock onset, and not pressed again until the 0.3-sec period had elapsed. The shift was not detectable by examination of the cumulative response record. The greatest frequency of holds into shock was shown by Rat NTO-2 in the No-Timer-On condition.

There was at least one increase in holding into shock for each animal as sessions progressed (Fig. 1). The increases in the Shock-Timer-On condition were the smallest (STO-1, Session 4; STO-2, Session 9), with the majority of holds occurring in the first quarter of each of these sessions (Fig. 2). Two or more increases in holds into shock occurred in the records of all other animals (Fig. 1), with increases occurring within each session after the first quarter session (Fig. 2).

The majority of holds into shock began to occur in the first quarter of each session early in training for the Shock-Timer-On animals (Fig. 2). A similar distribution appeared in Session 5, and later, in the record of one No-Timer-On animal (NTO-1). The reduction of holds into shock within each session was less consistent over sessions for all other animals.

A more accurate comparison of avoidance behavior during the major portion of each session was afforded by eliminating the first quarter of each session (Fig. 3). The most rapid decrease in shocks delivered and increase in avoidance responses occurred in the Shock-Timer-On condition. The low frequency of shocks remained relatively constant in this

Fig. 2. Quarter-session analysis of the distribution of holds into shock.

condition, even though the number of avoidance responses diminished after Session 5. With the exception of RTO-1, all animals showed a more gradual increase in avoidance responses over sessions. Of these, one rat in the No-Timer-On condition (NTO-1) approached the efficient avoidance performance of the Shock-Timer-On animals. Total shocks exceeded avoidance responses in all but one session for Rat RTO-1 in the Release-Timer-On condition.

The shift in mode of response, already mentioned, in the record of Rat RTO-2 (Fig. 1, Session 3) occurred with only a small change in the number of shocks delivered and avoidance responses in Sessions 2 through 4.

Fig. 3. Total responses during R-S intervals and total shocks delivered for each rat during the last 90 min of each of the ten 2-hr sessions.

DISCUSSION

When the set of contingencies for increasing the probability of response topographies incompatible with the emission of avoidance responses was removed from the schedule, behavior rapidly came under the control of the avoidance contingency. Although holding into shock occurred in each session of the Shock-Timer-On condition, it consistently tended to decrease after its appearance early within each session.

The presence of the contingency that allowed short-latency-responses-to-shock-onset (not preceded by holds) to recycle the R-S interval was associated with the delayed appearance of efficient avoidance behavior and either the increase or gradual decrease of non-avoidance responses (Release-Timer-On and No-Timer-On conditions).

Included in the No-Timer-On condition is the additional contingency that allowed short-

latency - responses - to - shock - onset following holds to recycle the R-S interval. The differences in the behavior of rats in this condition are representative of the variability in behavior among animals exposed to conventional schedules. At comparable periods in training, the behavior of each rat can be under the control of any of the contingencies in the schedule. This condition does not allow an assessment of the contribution of any of these contingencies to the persistence or increase of holding into shock.

In the Release-Timer-On condition, only short-latency-responses-to-shock-onset not preceded by holds were allowed to recycle the R-S interval. If the increase or persistence of holding were related only to the intermittent recycling of the R-S interval following holds into shock, a low frequency or rapid decrease of these responses would be expected in this condition. The low frequency of short-latency-responses-to-shock-onset after holds indicates

that RTO-2 was only rarely exposed to the Release-Timer-On contingency. Notwithstanding the Release-Timer-On condition, holds into shock were frequently followed by an R-S interval. In the second and third sessions, hovering over the lever was almost totally replaced by holding into shock and emitting another hold after 0.3 sec. The number of avoidance responses and shocks delivered did not appreciably change in these sessions. The frequency of short-latency-responses-to-shock-onset after holds for Rat RTO-1, on the other hand, indicates that this animal was frequently exposed to the release-Timer-On contingency. Nevertheless, holding into shock did not show the expected decrease over sessions. A further analysis revealed that this persistence of holding into shock may be related to the fine response differentiation demanded by the Release-Timer-On contingency: hovering over or lightly resting on the lever was often followed by a single shock every R-S interval, whereas maintaining a lever press was not. Considering this possibility, future research to isolate the factors contributing to the increase of holding into shock should include the one alternative not included in this experiment (allowing only short-latency-responses-to-shock-onset following holds to recycle the R-S interval).

Restricting approach to only the front of the lever was an experimental measure to provide the maximum opportunity for interfering responses to occur in all animals. The elimination of interfering response patterns would appear to be best accomplished by adding a lever-disabling timer, turned on by shock onset, to conventional schedules and presenting the schedules in an unmodified operant conditioning chamber.

Had shaping not been employed, it is unknown whether lever presses would have increased in frequency in the Shock-Timer-On condition. It may be that short-latency-responses-to-shock-onset must recycle the R-S interval for animals to orient to the lever. If this be the case, animals could be exposed to a conventional schedule until lever presses of any type occurred. The Shock-Timer-On condition could then be imposed.

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