Avoidance of a warning signal¹

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Rats were scheduled to receive electric shock every 20 sec, half under the typical nondiscriminated procedure where shock is scheduled from the last response, and half under a fixed-cycle procedure where shock is scheduled regularly by time. For half of each of these groups, a 4 sec CS preceded the shock. In the latter procedure, most avoidance responses occurred before (and hence also avoided) the CS. The difference was attributed to the relative efficiency of avoiding a warning signal.

Rats may learn to respond in order to avoid (postpone) an unsignalled shock that otherwise would occur at regular intervals; if a stimulus precedes the shock, rats typically wait until this warning signal occurs before responding (Sidman, 1958). Adaptive as this behavior may be, it appears somewhat paradoxical. A stimulus preceding a shock should become secondarily aversive. If the rat will avoid the primarily aversive stimulus (shock), why does he not also avoid the secondarily aversive stimulus (warning signal)?

One possible answer to this apparent dilemma is in terms of efficiency. In order to avoid both the signal and the shock, the rat must respond more often than to avoid only the shock. In effect, avoiding the signal may cost more in effort than it pays in minimizing aversive stimulation. This possibility can be evaluated by arranging conditions so that avoidance of the warning signal is equally efficient. In an attempt to accomplish this, the present study used a fixed-cycle procedure in which shock was regularly scheduled according to time. Any response occurring during the interval before a shock avoided that shock, and if it preceded the warning signal, also avoided that stimulus.

METHOD

Subjects

The Ss were 25 experimentally naive, hooded female rats, 90-120 days of age at the beginning of the study, bred in the colony of the Psychology Department of the University of New Mexico. They were housed individually in Wahmann suspended cages and maintained on ad lib Wayne Lab Blox and water.

Apparatus

The apparatus was a Gerbrands operant conditioning (bar-press) box with the factory-installed cue light as the CS and electric shock delivered via a Lehigh Valley scrambler set at 0.5 mA.

Procedure

Each of five groups of five rats was run for 24 daily 1-h sessions in one of the following conditions: (A) Discriminated avoidance with a 16-sec ITI and a 4-sec CS-US interval; for this group, responding before the CS had no effect. (B) Nondiscriminated avoidance (Sidman, 1955) with S-S and R-S intervals both set at 20 sec. (C) Same as Condition B except that a 4-sec CS preceded the shock; this CS was postponed by an anticipatory response or terminated by a response after it occurred. (D) Nondiscriminated avoidance with a 20-sec fixed-cycle (Sidman, 1962) shock schedule. (E) Same as Condition D except that a 4-sec CS preceded the scheduled shock; both CS and shock were avoided by a response during the 16 sec before the CS. In all conditions, a bar-press was required to terminate shocks that were not avoided.

RESULTS AND DISCUSSION

The groups were approximately equally successful in avoiding 50-60% of the scheduled shocks; in all procedures, a

maximum of 180 shocks could have been received, and daily counts at the end of training ranged between 75 and 90 shocks actually received. In the discriminated procedure, of course, all of these avoidance responses occurred to the CS. The effect of the CS in the nondiscriminated procedures is shown graphically in Fig. 1.

The right-hand panel replicates the findings of Sidman: when no CS was available, the S typically responded in less than 16 sec following the preceding response; when a CS was available, the S rarely responded until the signal occurred. Although both groups were equally successful in avoiding shocks, the temporal distributions of responding were quite different. They did not respond to avoid the warning signal.

As can be seen in the left-hand panel of Fig. 1, the reverse effect occurred for the fixed-cycle conditions. When no CS was available, the location of the avoidance responses was reasonably evenly distributed throughout the interval. When a CS was available, the majority of avoidance responses occurred early in the interval thus avoiding the scheduled CS as well as the shock. In fact, this group was no more likely to respond within the warning signal than the regular fixed-cycle group during that last 4 sec before shock but without the warning signal.

Accordingly, the effect of a warning signal is markedly different in the nondiscriminated and fixed-cycle procedures. In the former, although the warning signal can be avoided, very few short interresponse times occur and avoidance is channeled predominately into the CS interval. In the latter, the preponderance of avoidance responses antedate and hence avoid the warning signal. This difference is consistent with our initiating rationale: organisms will avoid a signal that regularly precedes an aversive event if doing so is equally as efficient as waiting for that signal before responding. However, the fixed-cycle procedure is a relatively complicated one in which the rat might easily "lose track of time." Indeed, our informal observations indicated that this group made most of its avoidance responses during the first cycle or two following a

Fig. 1. Distributions of the avoidance responses during the interval preceding shock during the last fifth of which a CS occurred for the groups shown by open forms. The right panel refers to typical nondiscriminated avoidance; the left panel refers to a fixed-cycle shock schedule.

shock, after which Ss were likely not only to wait for the signal but even to wait until the shock to respond and begin a new sequence. Accordingly, although the data clearly indicate that the role of a warning signal is quite different in the nondiscriminated and fixed-cycle procedures, even the latter may not be optimal for estimating an organism's tendency to avoid a warning signal.

REFERENCES

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NOTES

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2. Now at the University of Missouri.