Free-operant avoidance performance as a function of shock, signal, and shaping parameters

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Free-operant avoidance was studied as a function of parametric manipulation of several likely variables in a factorial study. The implications of the present findings for recent studies using free-operant avoidance as a dependent variable are discussed.

Sidman's (1953) free-operant avoidance procedure had been intensively studied for approximately a 12-year period. Various manipulations had been attempted to examine the methodological soundness and theoretical importance of that procedure. More recently, studies challenging the legitimacy of the procedure as a distinct learning type have lessened, and the procedure continues to be used as a tool in various experimental contexts (i.e., Capobianco, MacDougall, & Foster, 1977; Gaebelein & Howard, 1979; Mason & Fibiger, 1979; McCord, Hamlin, Pool, & Milner, 1979; Savaki & Lewis, 1977; Young & Black, 1979). It is not clear from a survey of the literature whether sufficient control in free-operant avoidance exists in the simple parametric sense aside from issues relating to the theoretical significance of such behavior.

This experiment was performed to delineate the effects of three salient factors on free-operant avoidance: shock intensity, the use of a warning stimulus, and the preshaping of subjects to a barpress escape response.

METHOD

Subjects

Twenty-four experimentally naive 120-day-old Wistar rats, maintained at their free-feeding weights, were used in this experiment.

Apparatus

Two single-bar stations (Grason-Stadler Model E31256-100) were housed in sound-attenuating animal chests (Grason-Stadler Model 1101) with a BRS/LVE audio generator AU-902/112-05 providing white masking noise and a (340-cps) warning tone of 90 dB. Shock was delivered from a BRS/LVE shock generator (Model SG-903) and shock scrambler (Model SC-922) through floor grids.

Procedure

All subjects were trained in free-operant avoidance (Sidman, 1953) in which the shock-shock interval was 5 sec and the response-shock interval was 20 sec. Responses in the presence of

shock did not terminate the shock. Each subject was tested for 12 2-h sessions, and total responses and shocks per session were recorded. Cumulative records of each session were maintained. Subjects were tested under three conditions. Half the subjects were trained under a shock intensity of 1.2 mA (high shock), and half the subjects served under a shock intensity of .8 mA. A 2 by 2 by 2 factorial design was used, with shock intensity, warning stimulus (tone vs. no stimulus), and preshaping of barpress response vs. no shaping as factors. The shaping procedure consisted of training escape from shock by reinforcing successive approximations to the operant when necessary prior to the session. Shaping terminated when 10 barpresses were emitted.

RESULTS AND DISCUSSION

Statistical assessment of the dependent variables of shock rate, response rate, and efficiency (McIntire, Davis, Cohen, & Branch, 1968) were performed for the tone, shock, and shaping factors. No interactions were found for any combination of the independent variables for 12 2-h sessions. An analysis of variance (between-subjects design) yielded a significant triple interaction in the efficiency scale [$F(1,16) = 6.9, p < .025$]. A significant sessions effect was found [$F(1,80) = 5.15, p < .001$], but all other split-plot analyses failed to show significant values.

No evidence of reliable behavior change was demonstrated by the independent manipulations performed, although a trend toward avoidance was demonstrated by the increased response rate accompanied by the decrease in shocks received by the 12th session, consistent with Roberts, Porter, and Porter (1974).

When shock intensity served as independent variable, the mean sessional shock rates were consistently lower for the high-shock group for both tone and no-tone subjects. Powell (1970) found similar learning trends with shock values of 2.0 mA and 1.0 mA. A *t* test of the difference was not significant, however, even with nonlearners excluded from the data. A ratio of shocks received to the maximum number possible was calculated for each subject in the last session; no significant difference in the trend was found.

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Consistent with previous findings, postshock response bursts, as well as bar holding, were common response styles (Bolles, 1967; Sidman, 1958, 1966). Evidence of temporal discrimination was not found. Previous reports of nonacquisition were also supported; 5 of 24 subjects could be classified as nonlearners (Weissman, 1962). Sidman's (1966) explanation that the failure of some subjects to learn is determined by decreased attentional factors was not supported here, because some nonlearners were previously shaped in the operant and their attention had been drawn to the leverpress as a terminator of shock.

Inter- and intrasubject variation within different conditions has been found to alter asymptotic performance (Hurwitz, Harzem, & Kulig, 1972; Sidman, 1966); attempts to standardize the criteria were made by McIntire et al. (1968) with their "index of efficiency" and by Hurwitz and Bounds (1968) with their "proficiency of avoidance" (AVPRO). These measures were intended to supplement the use of response rate and/or shock rate as measures of avoidance proficiency. An "efficiency scale" value was calculated for each subject but an analysis of variance using the dependent variable yielded no significant main effect or interactions. In fact, the appropriateness of this efficiency scale for early avoidance acquisition is questionable. Subjects classified as nonlearners were found to have more efficiency through nonresponse than subjects in the process of acquisition, that is, with initial shock rates reduced and response rates elevated toward approximately equal proportions.

Choice of dependent variable is obviously important in free-operant situations. However, the expected control of behavior by the independent variables used did not manifest itself within the present acquisition phase. Much of the behavior observed was both irrelevant and counterproductive to the learning situation; when a discriminative stimulus signaled "safe" periods, it was not used.

Despite a long history of partially successful investigations involving a search for the most appropriate parameters to maximize performance in free-operant avoidance, as well as studies challenging the legitimacy of the procedure itself (Anger, 1963), researchers still use free-operant avoidance in lesion and drug studies across a number of species and experimental contexts (Capobianco et al., 1977; McCord et al., 1979; Savaki & Lewis, 1977; Young & Black, 1979).

When one considers the difficulties encountered in the acquisition phase of free-operant avoidance and its insensitivity to parametric manipulations found to aid learning in other avoidance situations, can it reasonably

be used as an assessment device in situations in which subjects have undergone neurophysiological interventions? Manipulations using free-operant avoidance as a dependent variable may be not of unequivocal utility, and their inclusion in the literature may have to be reassessed.

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