THE EFFECT OF RESPONSE FORCE ON AVOIDANCE RATE¹

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In a Sidman-avoidance schedule of counter losses for two human subjects, the loss-to-loss and response-to-loss intervals were 20 sec. The avoidance response was a vocal response that was louder than a minimum vocal requirement. This requirement was set at 80 db, 95 db, or 110 db. In addition to vocal responses meeting the minimum requirement, all responses exceeding a threshold of 75 db or louder were recorded. The rate of both above-threshold and avoidance responses decreased as the response-force requirement increased. Thus, high response-force requirements produced an effect on avoidance responding similar to its effect on positively reinforced responding.

Several studies have shown that when a response on an operandum requires a high force, the rate of responding is reduced (Chung, 1965; Miller, 1968; Mintz and Notterman, 1965). In these studies the response was maintained by a schedule of positive reinforcement. If this effect is not peculiar to positive reinforcement, then a high force requirement should also reduce the rate of escape or avoidance responding. The present experiment examined the effect of different response-force requirements on the rate of a vocal avoidance response in human subjects.

METHOD

Subjects

Two normal males, 17- and 18-yr-old high school students, served.

Apparatus

The subject was seated within a sound-proofed experimental room, approximately 6 by 6 by 8 ft, in front of a console containing a stimulus light and an add-subtract counter. The experimental room also contained a concealed microphone. This equipment was con-

trolled by timers and relays located in an adjacent room.

Vocalizations were picked up by the microphone and used to operate a Gerbrands voice-operated relay (Model E7300-A-1). Every output of the relay was then converted to a standard pulse duration and used to operate other equipment. The shaped pulse was also used to provide response feedback to the subject in the form of a relay click and a brief light flash.

To prevent non-vocal sounds from operating the relay, several precautions were followed. First, the microphone was insulated from direct vibrations by suspending it in foam rubber. Second, to eliminate scraping sounds, plastic rubber was used to coat rough surfaces near the microphone. Third, the microphone was placed so that reaching it was inconvenient to the subject, thereby reducing direct blows. Fourth, sharp tapping sounds were prevented from operating the relay by the electronic requirement that sounds last 150 msec or longer. Fifth, the input to the microphone was monitored by the experimenter. If an alternative non-vocal behavior developed, the experimenter intervened and operated the feedback light with a hand-switch only when vocalizations occurred.

The vocal requirement corresponding to the sensitivity of the voice-operated relay was the major independent variable. Therefore, this sensitivity was calibrated in terms of the sound pressure level required to operate the relay. For the purposes of calibration, the

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sound was provided by a white-noise generator (Gerbrands Model 901A set at "speech") driving a 60-w multi-impedance speaker. The speaker was located 18 in. from the subject's microphone and the sound level increased until the voice operated relay was operated. The sound pressure level of this value was determined by a General Radio Co. sound survey meter (Type 1555A) placed 4 in. from the speaker. Sensitivity settings ranging from 75 db to 115 db were determined in this fashion and provided the basis for the values used in the experiment.

Procedure

A subject was brought into the experimental room, seated, shown the counter with a reading of 150, and told that he would be given a cash value equal to the number that was on the counter at the end of 1 hr. He was then told that the machine would be working when the white light was on. No further instructions were given and any questions were answered by repeating the relevant portion of the above instructions. The experimenter then left the subject alone in the room, closed the door, and started the experimental session.

Counter losses occurred according to a Sidman-avoidance schedule. If the subject failed to make a vocal response within 20 sec, the number on the counter decreased 1¢. After each additional 20-sec period another cent was subtracted from the counter unless the subject made a vocal response. Each response delayed the counter subtraction for 20 sec. Thus, continued vocal responding spaced at intervals of less than 20 sec avoided any losses on the counter. This schedule can be characterized as 20-sec R-L (response to loss) and 20-sec L-L (loss to loss) intervals.

The vocal requirement for both subjects was initially set at 80 db. This requirement was changed in 15-db steps until a level of 110 db was reached. After the 110-db sessions, the subject was returned to 80 db and stabilized. These changes were made only after the subject's average daily response rate had changed by less than 10% for three consecutive sessions and also had shown no consistent trend. The subjects were maintained an average of 13 sessions at each value. Throughout those sessions, those vocal responses that exceeded a threshold of 75 db were also recorded.

RESULTS AND CONCLUSIONS

Figure 1 shows the rate of avoidance responding at the different vocal requirements. Both the rate for responses above the recording threshold (75 db or higher) and the rate for avoidance responses (meeting the vocal requirement) are shown. The rate of avoidance responses decreased for each subject as the vocal requirement was increased. S-1 showed a decrease from about 13 responses per minute at 80 db to about five responses per minute at 110 db. The rates for S-2, while showing a smaller decrease, are similar. These results show that the rate of responding that successfully meets the vocal requirement decreases as the requirement increases.

One possible explanation for this reduction is that the responses at different vocal levels remain constant, but that fewer responses meet the avoidance requirement when the requirement is increased. The results of at least one study support this possibility (Elsmore and Brownstein, 1968). This possibility was evaluated in the present experiment by measuring all vocal responses above a recording threshold of 75 db or louder. Figure 1 shows that the rate of such responses decreased at each higher requirement for each subject. These findings indicate that the rates of all vocal responding decrease as the response-force requirement increases.

Neither the rate of above-threshold responses or the rate of avoidance responses fully describes avoidance responding. In particular, the use of an average rate implies a uniform spacing between responses. In fact, however, the spacing was not uniform; in general, an above-threshold response that failed to meet the requirement was quickly followed by additional responses. One way to measure this aspect of responding is to examine the rate of "response episodes". A response episode is a sequence of responses that is started by any above-threshold response and terminated by an avoidance response. If the length of time from the first above-threshold response to the final avoidance response is measured, then it is possible to estimate the rate at which response episodes are initiated by subtracting this interval from the overall session time. Figure 2 shows the rate of response episodes for each subject. The overall function for both subjects indicates that the rate of episodes de-

Fig. 1. Rate of avoidance responding during last three sessions at each vocal requirement. X's represent the rate of responses above the recording threshold (louder than 75 db); dots represent the rate of avoidance responses (meeting the vocal avoidance requirement). Unconnected points are redeterminations.

creases as a function of increasing the vocal requirement. These data provided additional confirmation of the existence of an inverse relationship between avoidance rate and response-force requirement.

Table 1 shows the mean number of counter losses incurred by the subjects at the different vocal requirements. There is only a slight indication that more losses occurred at the higher requirements. Further, the figures were highly variable from session to session. In general, the figures in Table 1 represent sev-

Fig. 2. Rate of avoidance response episodes (see text for definition) during last three sessions at each vocal requirement. Unconnected points are redeterminations.

eral occurring on one day and averaged over the three terminal days at the requirement. These data do little to suggest that the increased intensity of vocalizations required to meet the higher requirements represents an increase in response magnitude produced by aversive stimulation.

Table 1
Mean number of counter losses at each vocal requirement.

	80	95	110	80
S-1	0.6	0.3	2.0	0.3
S-2	0.0	2.7	1.3	0.0

This experiment showed that the rate of vocal avoidance responding is reduced proportional to the magnitude of the vocal requirement. This finding indicates that response-force produces an effect on avoidance responding similar to its effect on positively reinforced responding. Perhaps even more important, the present study also showed that the reduction is not an artifact of the changing response definition that results from varying force requirements.

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