AVOIDANCE RESPONDING AS A FUNCTION OF SIMULTANEOUS AND EQUAL CHANGES IN TWO TEMPORAL PARAMETERS

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In 1953, Sidman published a short paper describing a technique for conditioning and maintaining avoidance behavior without the use of an exteroceptive warning stimulus (Sidman, 1953a). Sidman subsequently reported on the effect of varying two temporal parameters in maintaining the rate of responding (Sidman, 1953b).

Although many other investigators have since used this schedule of negative reinforcement to generate stable rates of avoidance responding, no further data have been reported concerning the effects of varying the shock-shock (SS) and response-shock (RS) intervals. Sidman's original study was a parametric one: each of three animals was run through a series of combinations of SS and RS intervals (Sidman, 1953b). Throughout the experiment the SS interval was kept equal to, and always changed simultaneously with, the RS interval. The general nature of the function relating the duration of the SS and RS intervals, when SS is equal to RS, to the rate of responding is reported here.

METHOD

The subject was a male hooded rat (Long Evans strain), approximately 6 months old at the start of the experiment. Food and water were always available in the living cage.

The apparatus consisted of an experimental cage 10 inches long, 4.5 inches wide, and 7 inches high. The lever, described elsewhere (Verhave, 1958), was center-mounted 2.5 inches above the grid floor of the experimental cage. During the 8-hour experimental sessions, a No. 313 G.E. light bulb was lit. This light was mounted 0.5 inch above the lever behind a 1-inch-diameter, opaque plastic window mounted flush with one end wall of the

Figure 1. Cumulative record of avoidance responding during the first session of training. The vertical marks on the record indicate the occurrence of shocks.

cage. The cage was enclosed in a light-proof and sound-resistant box. A sound mask of white noise (75 decibels) was continuously fed into the experimental cubicle in which the cage was located.

The avoidance schedule has been described elsewhere (Sidman, 1953b). The animal was trained initially at SS equal to RS and equal to 30 seconds (Sidman, 1953b), and subsequently run at various other intervals in which SS is equal to RS. Table 1 shows the order in which the various SS-equal-to-RS intervals were programmed, as well as the number of sessions the animal was run at a particular value.

The shock was provided by a constant-current generator passing half-wave, 60-cycle current at 1.5 milliamperes. The shock duration was 0.2 second.

Each session was preceded by a 15-minute time out (TO), indicated by the switching on of a No. 313 G.E. bulb mounted outside the cage behind the end wall opposite to the lever. The bottom two inches of this end wall are perforated with a series of holes below the level of the grid floor permitting the TO light to shine dimly into the animal's compartment through the grid floor. During the TO the light above the lever was switched off. After the 8-hour session, programmed every other night (from 3:30 P.M. to 11:30 P.M.), was terminated, the animal was put in TO again; it was removed from the experimental cage the next morning at 7:45 A.M.

Figure 2. Rate of responding as a function of the SS-equal-to-RS interval.

Figure 3. Shock rate as a function of the SS-equal-to-RS interval.

RESULTS AND DISCUSSIONS

The subject was quickly trained, and rapidly reached a stable rate of responding. The cumulative record of Session 1 is shown in Fig. 1.

Figure 2 shows the rate of responding at various SS-equal-to-RS values. Table 1 gives the same data and the standard deviations. The rate values of Fig. 2 represent the mean

Table 1

Order of Presentation of, and Number of Sessions and Rate of Responding at, Various SS = RS Values

Session	No. of Sessions	SS = RS Interval (Seconds)	Rate (Response per Minute)	SD
1-7	7	30	5.93*	0.54
8-11	4	20	10.98*	1.73
12	1	50	3.81	----
13-15	3	20	9.89	1.08
16-18	3	15	13.29	0.76
19	1	20	10.38	----
20-22	3	50	3.63	0.39

*During the last 3 sessions

rate of responding during the last 4 hours of three successive sessions. Since counter readings of the number of responses emitted were taken at 2-hour intervals, the standard deviations shown in Table 1 are based on six separate determinations of the rate of responding. The SD varies between 6 and 17% of the rate values. The rates obtained during Sessions 12 and 19 show that the rate adjusts itself to a new SS-equal-to-RS value within one session. The data obtained during these sessions were not used in constructing Fig. 2.

Figure 4. IRT distributions obtained with various SS-equal-to-RS intervals. The location of one of the modes in these distributions, as plotted against the SS-equal-to-RS interval, is shown at the top of this figure.

Figure 5. Location of mode in IRT distribution in seconds plotted against the SS-equal-to-RS-interval.

The curve drawn through the data of Fig. 2 was fitted by eye. The data can be described by the simple logarithmic equation

$$Y = 274.3 X - 1.1104$$

in which Y represents the rate of responding in responses per minutes and X the duration of the SS-equal-to-RS values in seconds. This equation was fitted by the method of least squares. The fact that the present data can be described by a logarithmic equation is not surprising considering previous findings (Sidman, 1953b; Verhave, 1959; Herrnstein, 1959).

Figure 3 shows the shock rate at various values of SS equal to RS values. These data were obtained simultaneously with the rate data of Fig. 2. A maximum in this relationship occurs at 20 seconds.

Figure 4 shows inter-response-time (IRT) distribution data obtained at the various SS-equal-to-RS intervals.¹ Each point of an IRT distribution is again an average of six separate determinations obtained during the last 4 hours of three successive sessions.

¹IRT's of different lengths were recorded on separate electrical impulse counters. The IRT's counted by a single counter will be called a bin. Thus, the 2-to 4-second bin refers to IRT's between 2 and 4 seconds long.

The general nature of these distributions is similar to that reported by Sidman (1956). The lower relative frequency of responses in the first bins at the longer SS-equal-to-RS intervals is probably due to the fact that the IRT frequencies were determined in terms of bins, the duration of which was always 0.10 of the SS-equal-to-RS period.

Each of the IRT distributions shows a mode in addition to the usual high frequency of the first bin. When the location of this mode is plotted against the SS-equal-to-RS interval, the relationship shown at the upper right in Fig. 4 is obtained. Between 15 and 30 seconds the animal "waits out" a larger percentage of the SS-equal-to-RS interval. When the actual time waited most frequently (the mid-point of the bin in which the highest frequency occurs) is plotted against the SS-equal-to-RS interval, a different picture emerges, as shown in Fig. 5. This function has a minimum at 20 seconds. (The location of these modes is independent whether actual or relative frequencies are plotted.)

SUMMARY

The nature of the relationship between rate of responding and the interval by which each response postpones an electric shock is reported. Throughout the experiment the shock-shock interval was varied simultaneously and kept equal to the response-shock interval. Certain features of the inter-response-time distributions were also reported.

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Received June 17, 1959