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DIFFERENTIAL RESPONSE RATES CORRELATED WITH THE PRESENCE OF "NEUTRAL" STIMULI[1]

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Five out of six rats, pressing a lever for food reinforcement, showed differential rates of responding that were correlated with the presence of a buzzer, under conditions where the buzzer might have been assumed to be neutral. The effect was demonstrated when the presence versus absence of the buzzer distinguished the components of Mult FI 2 min FI 2 min, as well as when the buzzer was present throughout entire sessions of simple FI 2 min for n/2 of every n such sessions. The cause of the phenomenon was not determined.

When Ferster and Skinner (1957) first discussed multiple schedules, they emphasized the dependence of behavior in a given component on the contingencies of primary reinforcement in that component. More recent studies, such as those of Herrnstein and Brady (1958) and Reynolds (1961), have shown that the contingencies in one component can have significant second-order effects on performance in another component. The present paper considers a third source of control in multiple schedules, namely the effects of the discriminative stimuli *per se*.

Subjects

Six adult, male, brown rats of the Harvard Psychological Laboratory strain were maintained at approximately 80% of their free-feeding weights throughout the experiment. All were experimentally naive.

Apparatus

The experimental chamber was equipped with one response lever, a solenoid-operated milk dipper, a white house light, and a blue magazine light. An ac buzzer was mounted on the outside of the front wall of the chamber. The white light was on when and only when a reinforcement schedule was in effect, except that it was off during reinforcement. The blue light was on only during reinforcement. A separate counter recorded any responses made when neither light was on—*i.e.*, responses made before or after the session proper. The buzzer was always absent in these last mentioned periods, the durations of which varied from a few minutes to overnight. The operations of the magazine and the response clicker ("feedback relay") were clearly audible through the buzzer; no formal measurements of sound pressure levels were attempted, however.

Procedure

All the rats were magazine-trained, shaped to lever-press, and given one 60-reinforcement session of CRF with the buzzer absent, but with the white and blue lights operating as described above. Thus, light in the chamber was always paired with an opportunity for reinforcement, darkness with a complete lack of opportunity. After the CRF, the animals were introduced directly into one of the following three conditions: Phase I—Mult FI 2 FI 2 with the presence or absence of the buzzer distinguishing the components; Phase II—simple FI 2 with the buzzer either present throughout a session or absent throughout, each possibility being the case in half the number of sessions; Phase III—control sessions of simple FI 2 with the buzzer never present, but programmed and recorded with the same apparatus used in the multiple schedule of Phase I. Except for the brief preliminary

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training before the FI schedules, the total number of reinforcements in the presence of the buzzer was equated, for each animal, with the total number in the absence of the buzzer, until Phase III. All sessions comprised 60 reinforcements. In Phase I, the stimulus changed after every five reinforcements; and in Phase III the programming and recording equipment changed in exactly the same way except that the buzzer was not activated. Phase III thus constitutes a sort of "pseudo-multiple" schedule: there are "components" as far as the apparatus is concerned, but the schedule and the stimuli inside the chamber are constant. In Phase II, the order of the sessions was random with respect to the presence of the buzzer. Table 1 shows which of the rats participated in which phases of the experiment and for how many sessions.

Table 1

Numbers of Sessions Contributing Data for Each Animal in Each Phase

Rat No.	*Phase I*	*Phase II*		*Phase III*
		Buzzer Present	*Buzzer Absent*	
C-1	82	0	0	0
C-4	47	0	0	0
C-5	37	19	19	28
C-6	0	20	20	29
C-8	84	20	20	30
D-1	0	21	21	28

Results

Response rates averaged over all sessions of a given condition are shown in Tables 2, 3, and 4 for Phases I, II, and III, respectively. Tables 2 and 4 show, in addition, the percent of sessions in which the rate difference between the presence and absence of the buzzer occurs in the same direction for a single session as it does for the average of all sessions. (In Phase II, a comparison of single session rates would be vitiated by the lack of a multiple schedule to control for day-to-day variation.)

From Tables 2 and 3, it is apparent that all the rats except C-4 showed a clear difference in response rate between conditions identical with respect to food reinforcement. Table 4 reveals that no rat showed such a difference when conditions besides the food reinforcement were also equalized—*i.e.*, when the buzzer was always absent. Moreover, the effect is consistent in the sense that just when there is an average rate difference, there is a similar difference in the large majority of single sessions of that condition.

Two other features of the behavior should be noted: (1) When the effect occurred, its development was rapid. Thus, in Phase I, rats C-1, C-5, and C-8 exhibited single-session differences favoring the same stimulus condition favored by their overall rates in 100%, 80%, and 70%, respectively, of the first 10 sessions. By contrast, C-4, whose behavior was indifferent to the buzzer throughout, showed a 50%-50% division of single-session rates for these 10 sessions. (2) With occasional exceptions, responding before and after the session proper became insignificant after the first few sessions—*i.e.*, there was little responding in the darkened box.

DISCUSSION

The most obvious question about the effect presented above is its cause. There are two general classes of hypotheses that could apply: (1) The buzzer was not really neutral with respect to food reinforcement. (2) The buzzer

Table 2

Response Rates and Rate Differences in Phase I

Rat No.	*Responses/minute Buzzer Present*	*Responses/minute Buzzer Absent*	*Difference in Rates as % of Higher Rate*	*% of Sessions in which single-session rates differ in same direction as over all rates*
C-1	44.12	38.40	12.9%	90%
C-4	48.53	48.39	0.2%	51%
C-5	18.09	14.52	19.9%	92%
C-8	3.41	3.94	13.5%	81%

Table 3

Response Rates and Rate Differences in Phase II

Rat No.	Responses/minute Buzzer Present	Responses/minute Buzzer Absent	Difference in Rates as % of Higher Rate
C-5	21.39	17.08	20.1%
C-6	15.18	13.28	12.5%
C-8	7.19	4.30	40.2%
D-1	27.57	23.43	15.2%

Table 4

Response Rates and Rate Differences in Phase III

Rat No.	Responses/minute Equipment in "Buzzer" State	Responses/minute Equipment in "Buzzer-Absent" State	Difference in Rates as % of Higher Rate	% of Sessions in which single-session rates differ in same direction as over all rates
C-5	24.50	24.57	0.3%	54%
C-6	12.40	12.50	0.8%	55%
C-8	9.56	9.59	0.3%	43%
D-1	23.63	23.60	0.3%	50%

was neutral with respect to food reinforcement; its effect, therefore, either was direct or involved an experimental condition other than food. The first class would include the argument that the buzzer-absent reinforcements of the training previous to the FI schedules might have affected stimulus preference; such an argument would seem to predict the reverse of the preference actually found in the behavior of most of the animals. Less easily dismissed is the possibility that the periods before and after sessions constituted extinction in the absence of the buzzer. This possibility must be entertained, although the generally good stimulus control of the white house light would minimize this factor.

The second class of explanations would invoke such concepts as positive and negative reinforcing capacities of various intensities of the buzzer *per se*. (The simpler formulation of the buzzer as uniformly aversive gives no parsimonious explanation of the behaviors of rats C-4 and C-8.)

Clearly, only further experimental results will allow conclusive selection of any of the above, or other, explanations of the effect. The point brought out by the present study is really the existence of the effect under conditions commonly used in multiple schedules. Whatever the cause of the differential responding, it was not the programmed schedules of the sessions proper. Therefore, substantial caution is dictated in ascribing to the programmed primary reinforcement contingencies the whole of a rate difference in multiple schedules where the components are not identical.

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