The effect of different operants on spaced responding

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Rats were trained to emit two operants, either touching a bar or licking an empty water tube, for water reinforcement on a reinforcement schedule which reinforced responses spaced at least 10 sec from the previous response. The results indicated that the efficiency of responding, in terms of the number of responses made for each reinforcement, was reduced for the response which was similar to the consummatory response involved in reinforcement (licking) compared to the efficiency with the other response (touching). The results indicate that the operant is an important variable, particularly where temporally delayed responding is involved.

Under a schedule of reinforcement which differentially reinforces low rates of responding (DRL schedule), the responses of Ss are reinforced when they are spaced a certain minimum time (specified by the E) from the previous response. It has been commonly observed that rats, monkeys, and humans perform at very efficient levels on this schedule of reinforcement; in other words, a large proportion of the responses are reinforced (see Kramer & Rilling, 1970, for a review). Pigeons, on the other hand, perform poorly on DRL schedules of 20 sec or more (Kramer & Rilling, 1969; Staddon, 1965). An implicit assumption has been that pigeons are inferior in their ability to delay responding under a DRL schedule (Kramer & Rilling, 1970), since it has been shown that they are able to make accurate temporal discriminations (Stubbs, 1968; Reynolds & Catania, 1962). More recently, Hemmes (1970) obtained data which suggest that pigeons are much more efficient in delaying responding if the operant involved is treadle pressing rather than the typical response of keypecking. This suggests that the operant is an important variable in a S's ability to delay or inhibit responding. More specifically, the tendency to respond may be stronger or more probable in time if the operant is more similar to the actual consummatory response (pecking a key, pecking at food) than when the operant is of a different class (pressing a treadle, pecking at food). This tendency would work counter to efficient DRL performance which requires a delay in responding.

The purpose of the present study was to investigate the efficiency of performance of rats where two different operants were reinforced for each individual on different days, one operant being very similar to and the other being very different from the consummatory response.

SUBJECTS

The Ss were three female albino rats, approximately 100 days of age at the start of the experiment.

APPARATUS AND PROCEDURE

The experimental chamber was a Scientific Prototype Model 25 operant conditioning chamber. This chamber contained a T-bar and a manually operated water dipper which was 3½ in. from the bar. The chamber was modified so that an empty water bottle could be mounted on the Plexiglas wall 3½ in. from the dipper, with the tube of the water bottle projecting into the chamber. Responses were reinforced by an approximately 1-sec presentation of water from the manually operated dipper. External programming equipment was used to determine when the minimum amount of time had elapsed from the last response so that the E knew when to reinforce the next response. Responses and reinforcements were detected by an E and recorded on electromechanical counters through hand microswitches.

The Ss were run under 23-h water deprivation. The Ss were each trained on separate days to touch the bar and to lick the empty water tube. Both responses were reinforced with water. On the day that each response was shaped, the Ss were given 25 reinforcements on FRI after the response had been shaped. During sessions when touching the bar was reinforced, the water bottle was absent, and vice versa, for the entire experiment.

Once both responses had been trained, the Ss were required to emit one or the other of the operants on alternate days. For Ss 1 and 2, touching the bar was first, and for S3, licking the tube was first. Responses were reinforced on a DRL 10-sec schedule of reinforcement. The Ss were run for 18 to 20 days.

RESULTS

In recording the data, "bursts" of

responding were not recorded as separate responses, but as one response. Although there were virtually no instances of this with the touching response, the Ss frequently made several consecutive licks without interruption. This behavior was recorded as one response.

The basic results are presented in Fig. 1 in the form of efficiency ratios: the number of responses divided by the number of reinforcements for each session with the two different operants. Maximum efficiency in responding would be indicated by a ratio of 1, which would mean that each response was reinforced. As responding becomes less efficient (as more responses are not reinforced), the ratio becomes larger. The general trend for all animals is that the efficiency ratios for the two operants were similar early in training and then diverged later in training where behavior was less efficient with the licking response, reflected in a higher ratio. During the last 4 days of training for each operant for each S, there was no overlap in the ratios. These efficiency ratios reliably reflected the response rates and the reinforcement rates. For example, considering comparable days of training for each operant (the fifth day of bar touching with the fifth day of licking, etc.), the response rate was higher for the licking response for each animal over the last

Fig. 1. The number of responses divided by the number of reinforcements for all Ss with two different operants.

7 days shown in Fig. 1. When the efficiency ratios were high, the response rates tended to be high and the reinforcement rates tended to be low, and vice versa.

For statistical purposes, the data for each animal were divided into two blocks of training, the first half and the second half of training, for each operant. A two-way repeated measures analysis of variance (Operant Response by Blocks of Training) indicated that there was a significant effect due to the operant ($F = 20.13$, $df = 1/2$, $p < .05$), but no significant effect due to blocks of training ($F < 1$) and no significant interaction ($F = 12.58$, $df = 1/2$, $p > .05$).

DISCUSSION

The results of this experiment indicate that the operant affects the efficiency of performance when the reinforcement contingencies require some delay between responses. The difference found in the present experiment can not be attributed to differences in bursts of responding, since bursts were not counted as individual responses. It may be that the amount of effort required in making the two responses is a factor, since one could argue that the total act

of touching the bar requires more effort than licking. If this were the case, then you might expect that the efficiency ratios would have been different from the very first day. Such was not the case, at least for Ss 1 and 2, where there was a good deal of overlap in the data during the first half of training.

The results suggest that an operant which is reinforced by a similar consummatory response has a higher response probability than does a response which is dissimilar. A similar observation was made by Staddon & Simmelhag (1971) in their analysis of behavior under response-independent reinforcement schedules. They found that when pigeons were given food periodically but independent of responding, the pecking response came to be emitted with a very high probability just prior to the delivery of food.

At the factual level, these results suggest that the operant, and its similarity to the consummatory response involved in reinforcement, is an important experimental variable. Note, for example, that most research with pigeons involves the pecking operant which is similar to pecking at

food reinforcement, while most research with rats involves pressing a bar for food or liquid reinforcement, two dissimilar behaviors. At the theoretical level, these results support Staddon & Simmelhag's (1971) theoretical analysis of behavior from an evolutionary point of view.

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