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DRL responding under conditions of total darkness

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The effects of total darkness on DRL schedule control were studied with pigeons under two lighting conditions. Increased DRL schedule control is indicated by decreased response and response/reinforcer rates and by increased reinforcer rates. Four pigeons with prior training on DRL schedules were conditioned to keypeck in total darkness. There were five blocks of sessions. In Blocks 1-4, subjects were trained on four alternating blocks of sessions under dark and light conditions (ABAB design). Block 5 consisted of four alternating sessions of dark and light conditions (ABAB design). Comparison of the dark with the light condition showed 3 subjects with decreased response and response/reinforcer rates and increased reinforcer rates in the dark condition. The results indicate increased control with DRL schedules under conditions of total darkness and are in agreement with Robinson and Shelley's (1974) study in which increased control was demonstrated for FI, VI, FR, and VR schedules.

Schedule control of behavior has been studied extensively (e.g., Ferster & Skinner, 1957). One aspect that has been studied is whether pigeons' responding was differentially affected by dark and light conditions where reinforcement contingencies remained constant (Robinson & Shelley, 1974). In Robinson and Shelley's study, four groups of pigeons were trained in a light condition to respond to one of four schedules of reinforcement: a fixed-ratio schedule with 100 responses per reinforcer (FR-100); a variable-ratio schedule averaging 200 responses per reinforcer (VR-200); a fixed-interval schedule requiring 60 sec to elapse before a response was reinforced (FI-60); and a variable-interval schedule requiring an average of 60 sec between reinforcers (VI-60 sec). After the initial training with the houselight and keylight on, there were three other conditions. During the second condition, the lights were faded out until the subjects were responding in total darkness, with all subjects having a minimum of 10 sessions with no light. The third condition consisted of 10 sessions with the lights on, and the fourth condition consisted of an additional 10 sessions with no light (ABAB design). During all conditions, the schedule of reinforcement remained constant.

The results of Robinson and Shelley's (1974) study showed that the dark condition had a marked effect on pigeons' responding and that the direction of that change depended on the type of schedule. For the two ratio schedules, there was an increase in responding, resulting in a greater number of reinforcers being earned. There was a decrease in responding under the two interval schedules, with the number of reinforcers remaining relatively constant. The results were discussed in terms of increased schedule control which leads to different types of responding depending on the type of schedule. By schedule control, it is meant that the subject responds to the specific parameters of the schedule and does not engage in responding that is not reinforced. Thus, for ratio schedules, greater schedule control means more responses per unit time, resulting in a greater number of reinforcers. However, for interval schedules, quite the opposite indicates greater schedule control: since interval schedules reinforce the first response after a specified time, perfect schedule control is seen if the subject withholds responding until after the interval has passed and then makes one response. Increased schedule control results in decreased responding with no corresponding loss of reinforcers.

There is another type of schedule that requires that a specified interval of time pass before a response is reinforced: the differential-reinforcement-of-low-rates schedule, or DRL. The DRL schedule differs from an interval schedule in the requirement that no responses be made during the interreinforcer time; any responses made are programmed to reset the interval timer, thus delaying reinforcement. Response rates on a DRL schedule are usually

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lower than on the other intermittent schedule at similar reinforcement rates (Kramer & Rilling, 1970; Richardson, 1973). Increasing schedule control by a DRL schedule would be shown by a decrease in response rate and an increase in reinforcement rate to the maximum available on the particular schedule.

The present study was designed to determine whether ambient illumination would affect responding on a DRL schedule. Four subjects previously trained on a DRL schedule were exposed to two lighting conditions in the following order: four blocks of five sessions each with the houselight off in alternate *blocks* (ABAB design) and one block of four sessions with the houselight off in alternate *sessions* (an ABAB design in this one block).

METHOD

Subjects

Four adult racing homing pigeons were maintained at 75% of their free-feeding weights. All subjects had extensive training on DRL schedules of 20- and 30-sec values. Portions of the training were conducted with the subjects in a restrained condition with alternate sessions having a tone as a cue signaling availability of reinforcement. During the present experiment, the lighting condition in the colony room was a standard 12-h light/dark cycle.

Apparatus

Subjects were tested in four identical operant test chambers, with a single key on the response panel. This key remained dark during the experiment. Houselights were two 28-V bulbs behind a translucent screen across the top of the response panel. Houselight voltage could be varied from off to 28 V (full intensity). The reinforcer was one 45-mg Noyes

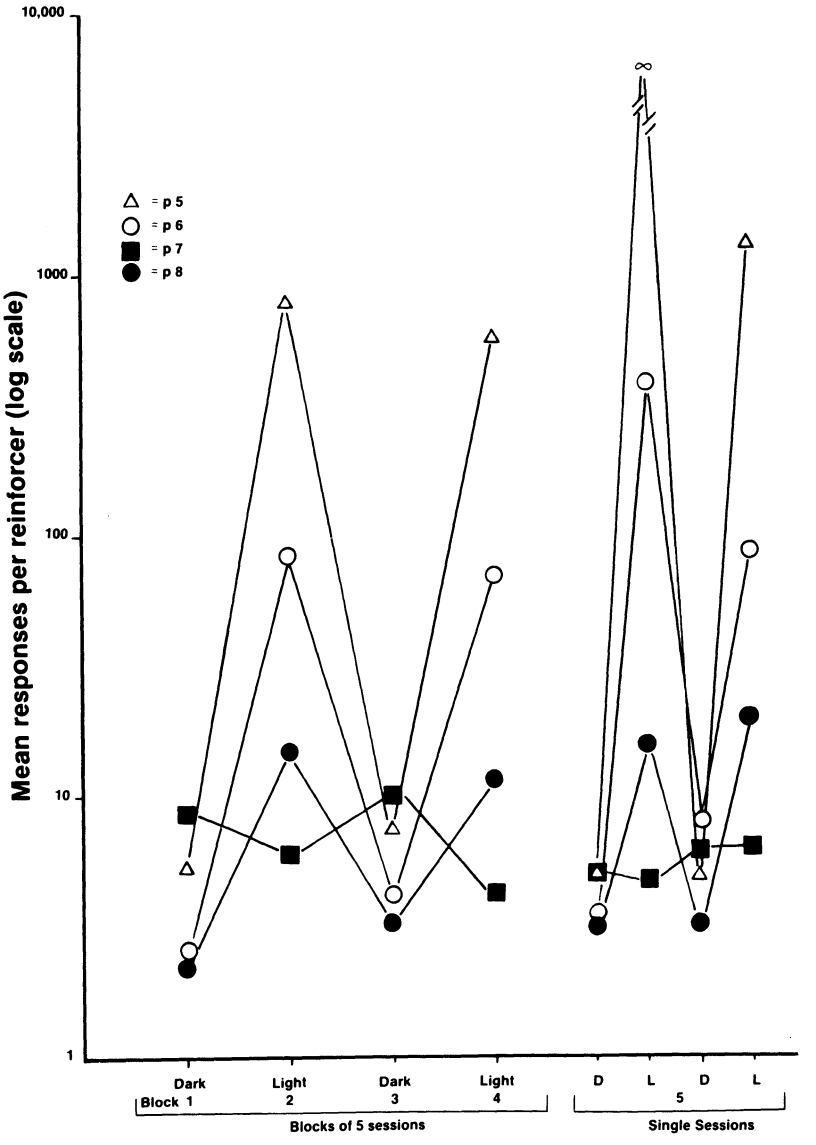

Figure 1. Mean responses per reinforcer for individual subjects for each block condition. (Note that the y-axis is a logarithmic scale.)

pigeon pellet. Ventilation provided by a fan and white noise were available throughout the experiment.

Procedure

The subjects had been conditioned to peck a dark response key with the houselight at full intensity in a previous experiment using a DRL schedule. To train subjects to respond in total darkness, we gradually decreased houselight intensity over 12 sessions by lowering the voltage 2-3 V between each session until the houselights were completely off for an entire session. The first session during which the houselights were off for the entire session marked the beginning of this experiment. Session length was 1 h, and the DRL schedule value was 15 sec.

There were two lighting conditions. In Blocks 1-4, the light was alternatively off and on over the blocks (ABAB design). To determine whether the effect was one that was immediate or that developed over sessions, Block 5 consisted of four sessions during which the light was alternated every session (also an ABAB design).

RESULTS

All results are reported as responses per reinforcer, as this measure reflects most clearly the relevant dimension of the DRL schedule. The ratio would be one to one if schedule control were perfect. As the number of responses increases, the ratio increases. Figure 1 shows the results for each subject for each block condition. Blocks 1-4 are means of five sessions, where Blocks 1 and 3 are dark conditions and Blocks 2 and 4 are light conditions. For Subjects P5, P6, and P8, there is an effect of the dark condition, with these subjects showing a decreased response per reinforcer ratio in the dark condition relative to the light condition. Subject P7 showed little change in responding from dark to light conditions.

Block 5 consisted of alternating sessions of the dark and light conditions (ABAB) and was used to determine whether the effect was immediate. For Subjects P5, P6, and P8, the effect was immediate, as seen in Block 5 of Figure 1. Subject P7 again showed no effect of the conditions.

Figure 2 shows more clearly the effect of the dark conditions. Each point is the mean for a subject for either all light conditions or all dark conditions. All subjects except P7 showed a significant decrease in responses per reinforcer in dark condition [P5: $t(9) = -5.54$; P6: $t(11) = -10.60$; P8: $t(11) = -10.81$; $p < .05$, two-tailed test

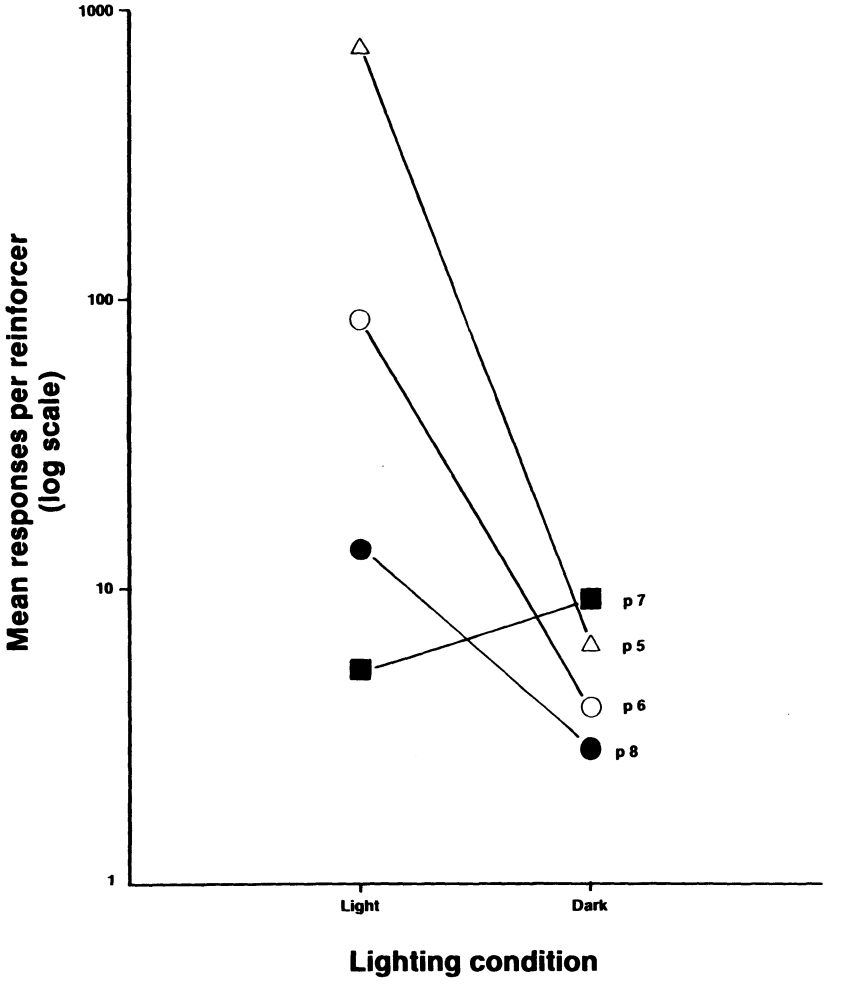

Figure 2. Mean responses per reinforcer for individual subjects, collapsed across light and dark conditions. (Note that the y-axis is a logarithmic scale.)

for all three]. Subject P7 showed the opposite, with significantly fewer responses per reinforcer in the light condition (5.13) than in the dark condition (8.91) [$t(11) = 4.40$, $p < .05$, two-tailed test].

DISCUSSION

The finding of Robinson and Shelley (1974) that schedule control of responding was increased in a dark condition has been shown to hold in a situation using a DRL schedule of reinforcement. The same problem cited by Robinson and Shelley exists in this study as to determining the possible explanation of the increased control. Explanations of stimulus control generally fall into one of three categories: (1) nonresponse pretraining; (2) innate prepotencies; and (3) differential reinforcement (Robinson & Shelley, 1974). The present results are not explicable in terms of any of these explanations. There is no apparent adaptive value for pigeons to peck in the dark, and there was no pretraining of the pigeons in the dark. Finally, since there was no change in the reinforcement contingencies, the explanation due to differential reinforcement is also invalid.

Robinson and Shelley (1984) offered an explanation in terms of indirect differential reinforcement in that the dark condition could include a change in the competing or concurrent reinforcement contingencies: "The increased schedule control arising in the dark condition may be due to the removal of these competing contingencies and any discriminative stimuli associated with them" (p. 399). Although it is possible that this could explain the increased schedule control under the DRL schedule, it is noted that a direct manipulation of competing contingencies (Richardson & Loughead, 1974) resulted in decreased DRL schedule control.

REFERENCES

FERSTER, C. B., & SKINNER, B. F. (1957). *Schedules of reinforcement*. New York: Appleton-Century-Crofts.

KRAMER, T. J., & RILLING, M. (1970). Differential reinforcement of low rates: A selective critique. *Psychological Bulletin*, **74**, 225-254.

RICHARDSON, W. K. (1973). A test of the effectiveness of the differential-reinforcement-of-low-rates schedule. *Journal of the Experimental Analysis of Behavior*, **20**, 385-391.

RICHARDSON, W. K., & LOUGHEAD, T. (1974). The effect of physical restraint on behavior under the differential-reinforcement-of-low-rates schedule. *Journal of The Experimental Analysis of Behavior*, **21**, 455-461.

ROBINSON, P. W., & SHELLEY, M. F. (1974). The effects of total darkness on schedule control. *Journal of the Experimental Analysis of Behavior*, **22**, 391-400.

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