

Effects of duration of DRL correlated stimuli on timing and collateral responding

TORÉ LYDERSEN and DAVID PERKINS
California State University, Fullerton, Calif. 92631

Three pigeons were trained to respond under a two-key discrete trial multiple DRL 4:DRL 8 procedure in which the exteroceptive cues specifying the scheduled components were presented either throughout each trial or only at the start of each trial. Under continuous cue conditions, the IRT distributions for DRL 4 and DRL 8 components showed little overlap; modal IRT values for each component were slightly higher than the minimum reinforced value. Under brief cue conditions, all IRT distributions were similar, with modal values between 4 and 8 sec for both components. No clear relationship was found between noncontingent collateral responding and DRL value.

Under differential reinforcement of low-rate (DRL) schedules, a response is reinforced only if it follows the preceding response by a minimum interresponse time (IRT). One frequently observed characteristic of DRL responding has been that, during the IRT, Ss develop stereotyped response chains, or collateral behavior. Examples of such noncontingent responding include ambulatory activity by pigeons (Holz et al, 1963), wood gnawing or tail nibbling by rats (Laties et al, 1969), and drinking behavior (Segal & Holloway, 1963). The development of collateral behavior has typically been accompanied by an increase in the frequency of reinforced responses, while the disruption of such behavior has led to decreases in reinforcement frequency (e.g., Laties et al, 1969). These relationships have frequently been interpreted as being consistent with a response mediation hypothesis which assumes that collateral behavior produces cues which mediate the temporal discrimination required under DRL schedules.

Indirect support for the behavioral mediation of temporal discrimination has come from an experiment by Nevin & Berryman (1963) in which pigeons were reinforced for a response on a right key which followed an initial left-key response by more than 2 sec. Under these conditions, a strong positive correlation was found between the number of noncontingent left-key responses following the initial response and the IRT of the initial left-key/right-key sequence. More recently, however, the significance of the correlation between collateral behavior and IRT has been questioned. Zuriff (1969), for example, reported that collateral key responding was not only more variable, but also a less accurate indicator of the scheduled DRL values than were the mean IRTs on the DRL key. This suggested that collateral key responding alone was

not sufficient to function as a "clock" for DRL key responding.

The present experiment further examined the relationship between collateral key and DRL responding in a two-key discrete trial multiple (mult) DRL:DRL design. This procedure permitted an assessment of the effects of collateral key responding upon DRL accuracy when the exteroceptive stimuli specifying the scheduled DRL components were presented either throughout each trial or only at the start of each trial. If the exteroceptive stimuli functioned only to cue the S to initiate a chain of collateral responses, then the continued presence or absence of DRL-correlated exteroceptive stimuli beyond the start of each collateral chain should not differentially affect either DRL or collateral key behavior.

SUBJECTS

Three experimentally naive homing pigeons maintained at 80% of their free-feeding weight served as Ss.

APPARATUS

A sound-attenuated two-key Grason-Stadler conditioning chamber was used. Both keys could be transilluminated by white, red, or green light. Experimental contingencies were programmed by standard relay equipment, and data was recorded by electromechanical counters.

PROCEDURE

Following shaping, Ss were reinforced on a FR 16 schedule for responding to a white left key for five sessions. The procedure was then changed to the following two-key mult DRL:DRL schedule: After the onset of red on the left key, an initiating response (Ri) to that key (1) changed the color to white, (2) transilluminated a previously dark right (DRL) key with red, and (3) started a DRL 4-sec interval. A response to the right DRL key extinguished both keys. This right-key response was designated as the terminating response (Rt). If the

Rt followed the Ri by 4 sec or more, reinforcement was made available for 3 sec; if the Ri-Rt interval was less than 4 sec, a 3-sec blackout occurred. Responses which occurred during the Ri-Rt interval on the left key were designated as collateral responses (Rc). Rcs were recorded, but had no scheduled consequences. The preceding trials were alternated with trials in which all red-key transillumination was replaced with green. The red and green trials were presented 16 times each in a mixed order which repeated every 32 trials. Training continued under these conditions for a total of 20 sessions. Next, green trials were changed to DRL 6 (23 sessions) and then to DRL 8 (23 sessions), while the red component remained DRL 4. This last procedure will be referred to as Condition 1. Condition 2 consisted of 9 sessions during which the Ri response to the red (or green) left key (1) changed the color to white, (2) transilluminated the previously dark DRL key with white, and (3) started a DRL 4 (or DRL 8) interval. Finally, Condition 1 was reinstated for 9 sessions. Each session was terminated after 50 reinforcements.

RESULTS

Throughout exposure to the mult DRL:DRL procedures, an Ri response to red or green on the left key was immediately followed by a run of Rc responses on the white left key and then by a Rt response on the DRL key. An infrequent exception occurred when only the required Ri response was emitted prior to the Rt response.

Of primary interest was an examination of Rc and DRL responding during the two conditions of mult DRL 4:DRL 8. Figure 1 shows the relative frequency of Ri-Rt response IRTs, computed by dividing the number of IRTs in each 1-sec interval by the total number of IRTs across the last 5 days for both Conditions 1 and 2. For each S, the IRT distributions of DRL 4 and DRL 8 during Condition 1 peak approximately 1 sec longer than the minimum reinforced IRT. The mean accuracy (number of reinforced trials/total number of trials) during mult DRL 4:DRL 8 was 73%:53%, 59%:41%, and 85%:57% for Ss 1, 2, and 3, respectively. Thus, during Condition 1, each S acquired a relatively accurate discrimination between the two DRL values, as evidenced by IRT distributions.

Exposure to Condition 2 produced a shift in each DRL 4 distribution toward the DRL 8 distribution, while the DRL 8 distribution shifted toward that obtained under DRL 4 for Ss 1 and 3, but not for S 2. The mean

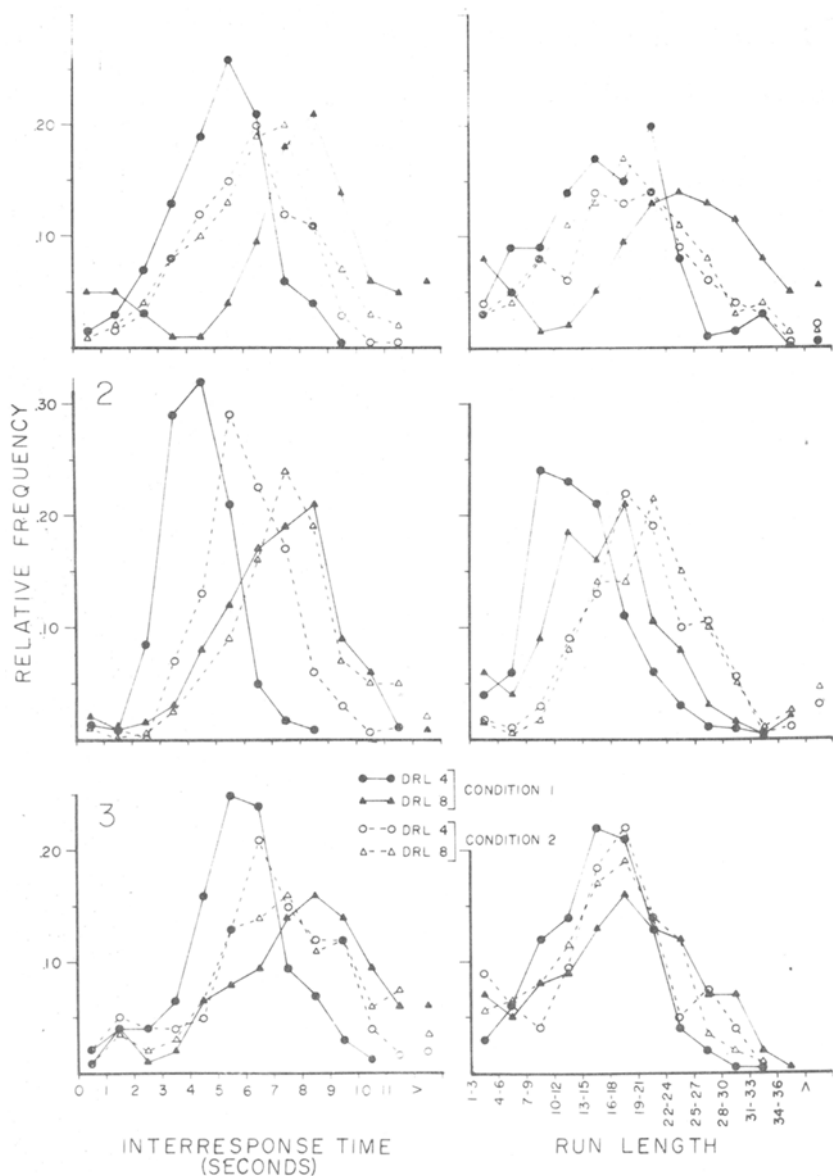


Fig. 1. Left column: Relative frequency of DRL interresponse times in 1-sec intervals. Right column: Relative frequency of collateral response run lengths in groups of three responses. Data points not connected by lines represent IRTs ≥ 12 sec (left column) and run lengths ≥ 37 responses (right column).

accuracy during DRL 4 and DRL 8 components under Condition 2 was 85%:27%, 92%:44%, and 85%:46%, respectively, for Ss 1, 2, and 3. No systematic changes in daily IRT distributions were noted across the nine sessions.

When Condition 1 was reinstated, the IRT distributions returned to essentially the same form as the initial Condition 1 distributions shown in Fig. 1. The mean accuracy across the first five sessions of DRL 4:DRL 8 was 82%:66%, 73%:34%, and 84%:64%, respectively, for Ss 1, 2, and 3.

The number of Rc responses per trial (run length) was compiled into

groups of three (i.e., Group 1 represents run lengths of 1, 2, or 3 responses; Group 2 represents run lengths of 4, 5, or 6 responses; etc.) across the last five sessions for Conditions 1 and 2. The relative frequency of run lengths in any given group, computed by dividing the number of run lengths in that group by the total number of run lengths, appears in Fig. 1. There was an overall tendency for longer run lengths to be emitted during DRL 8 than during DRL 4 trials of Condition 1. During Condition 2, the DRL 4 and DRL 8 run length distributions became essentially identical for all Ss.

Following the return to Condition 1, no marked changes in run length distributions were found for Ss 2 and 3; S 1 run lengths, however, returned partly toward initial Condition 1 forms.

DISCUSSION

In the present experiment, the schedule control obtained when DRL-correlated stimuli were presented continuously throughout each trial was reduced when the procedure was changed so that DRL-correlated stimuli were presented only at the start of each trial. The apparent reliance upon the continued presence of DRL-correlated stimuli was further supported by a rapid recovery of the discrimination following reinstatement of the continuous cue condition. Although discrimination between DRL components did not sharpen during the nine sessions of Condition 2, it is not known if prolonged training would have eventually resulted in IRT distributions which would be similar to those obtained during Condition 1.

These findings may be considered in terms of the previously discussed mediation account of temporal discrimination. Under the present two-key mult DRL:DRL procedure, the hypothesis would likely assert that the IRT on each trial should be a function of the time to complete either of two chains of collateral (mediating) responses, the length of which would be determined by whether red (DRL 4) or green (DRL 8) was presented at the start of the trial. Given this interpretation, the chain of mediating responses, once started, should control the IRT independently of the continued presence or absence of DRL-correlated stimuli. Because IRTs were not independent of the DRL-correlated stimuli, it would therefore appear that collateral key responding did not mediate DRL responding by serving a timing function. This interpretation is based on the assumption that noncontingent keypecking, which continued throughout the experiment, could have served as an effective mediator. This conclusion remains tentative, however, since several alternative interpretations of the present results are possible. It may be, for example, that collateral key responding functions as effective mediating behavior only when DRL-correlated stimuli are continuously presented throughout trials, as in Condition 1. The fact that both spaced responding and collateral key responding continued during Condition 2, but not differentially with respect to the two DRL values, could be interpreted as supporting this view. A related possibility might be that the brief presentation of

DRL-correlated stimuli during Condition 2 was not of sufficient duration to permit the initiation of appropriate timing chains.

REFERENCES

HOLZ, W. C., AZRIN, N. H., & ULRICH, R. E. Punishment of temporally spaced

responding. *Journal of the Experimental Analysis of Behavior*, 1963, 6, 115-122.
LATIES, V. G., WEISS, B., & WEISS, A. B. Further observations on overt "mediating" behavior and the discrimination of time. *Journal of the Experimental Analysis of Behavior*, 1969, 12, 43-57.
NEVIN, J. A., & BERRYMAN, R. A note on chaining and temporal discrimination.

Journal of the Experimental Analysis of Behavior, 1963, 6, 109-113.
SEGAL, E. F., & HOLLOWAY, S. M. Timing behavior in rats with water drinking as a mediator. *Science*, 1963, 140, 888-889.
ZURIFF, G. E. Collateral responding during differential reinforcement of low rates. *Journal of the Experimental Analysis of Behavior*, 1969, 12, 971-976.

NOTES & NEWS

Judson S. Brown has returned to the Department of Medical Psychology at the *University of Oregon Medical School* after spending the past few years at the University of Iowa.

David Burrows is now Assistant Professor of Psychology at *State University College at Brockport*, New York.

Robert L. Colegate, who has just finished his PhD at the University of Illinois, is now Assistant Professor of Psychology at *Norfolk State College*, Virginia.

Chizuko Izawa, who has been at SUNY, Buffalo, for the past several years, is now Associate Professor at *Tulane University*, New Orleans.

Donald J. Levis is now Professor and Director of the Clinical Psychology Program at *SUNY, Binghamton*. He formerly was associated with the Department of Psychology at the University of Iowa.

Robert W. Newby has just received his PhD from the University of Texas at Austin and has taken a position as Assistant Professor of Psychology at the *University of the Americas* in Puebla, Mexico. Puebla is located some 86 miles southeast of Mexico City.

George Paxinos has just received his PhD from McGill University and is a postdoctoral fellow in Dr. John Flynn's laboratory at the *Yale University School of Medicine*.

Gregory L. Peters has received his PhD in Experimental Psychology and is at the *Air Flight Dynamics Laboratory* at *Wright-Patterson Air Force Base*, Ohio.

Gordon R. Redding, who has just received his PhD from the University of Wisconsin, Madison, has accepted a position as Assistant Professor of Psychology at *Illinois State University*, Normal.