Water drinking patterns under several dry food reinforcement schedules¹

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Abstract

When hungry rats are reinforced with dry food for licking from a water trough, the resulting performances differ from those seen when other responses, such as bar pressing, are reinforced on the same schedules, in that thirst-motivated drinking intrudes on the food-reinforced pattern.

Problem

The selection of the "representative" response in research on operant behavior seems to be governed largely by the experimental design and the ease of recording the responses of different species. Bar pressing, chain pulling (Findley, 1963), key pecking, wheel running (Skinner & Morse, 1958), candy eating (Premack, 1959), fighting (Skinner, 1959) and saying words (Kapostins, 1963) are only a few of the responses that have been used. Generally, these responses have yielded comparable results under comparable reinforcement schedules. However, we have obtained anomalous performances from rats whose water drinking was reinforced on several standard reinforcement schedules. The anomalies can be traced to an additional variable that shared control of drinking with the experimental reinforcement contingencies. Such dual control over a single response topography opens a way to explicit experimental analysis of the multiple control of behavior.

Method

Two male albino rats with no previous experimental history were maintained at 80% of ad lib. weight. Initially, they were placed individually in the experimental chamber and given a 45 milligram food pellet every 60 seconds. Their licks from a water trough inside the chamber were recorded, via a drinkometer, on a cumulative response recorder. After 15 or 16 daily sessions on this free reinforcement schedule (F60 seconds), the rats were placed on an FI 60 second schedule for licking. The first water lick to occur 60 or more seconds after delivery of the last pellet produced another pellet. After 7 days of FI 60 seconds, the FI was raised to FI 2 minutes for 7 days. Next, the reinforcement schedule was changed to a fixed ratio of licks, and the FR requirement was gradually raised to FR 200. After 12 days on FR 200, the rats were shifted to a DRL 20 second schedule: Only water licks spaced at least 20 seconds apart were reinforced. Thirty-two days of DRL 20 terminated the experiment.

Results

Figure 1 shows the results. Both rats showed fairly high rates of water licking on F60 seconds, shown in the top graphs. (The recording pen reset to baseline following the delivery of each food pellet, in this and the suc-

Fig. 1. Drinking patterns of two rats under several dry-food reinforcement schedules.

ceeding 3 records.) S 0-23 drank following almost every pellet, emitting between 20 and 200 licks per drinking episode. In most cases, the time between delivery of the pellet and initiation of drinking was so short as to be indiscernible in the record. Once licking began, the rate of licking remained high and constant until licking terminated abruptly, some seconds before the arrival of the next pellet. Rat C-3 did not drink so consistently following pellets, and the number of licks per drinking episode was lower, between 5 and 90 licks. Moreover, the rate of licking within a drinking episode sometimes slowed before licking ceased entirely. (These differences between the rats in tendency to drink persisted throughout the experiment.) We call the drinking seen on the free food schedule prandial drinking, following Teitelbaum & Epstein (1962). That is, it seems to be mainly under the control of the dry food as a thirst stimulus. However, the high incidence of water drinking on several time-correlated reinforcement schedules (Clark, 1962; Falk, 1961; Segal & Holloway, 1963) suggests that such drinking may not be exclusively controlled by thirst, but may be specifically related to temporal reinforcement contingencies in some way. One possibility is that the drinking begins as prandial drinking but then increases in frequency as it comes to be reinforced adventitiously by the arrival of the next food pellet. Our results do not support an adventitious reinforcement account of the present data, inasmuch as licking always ceased many seconds before the arrival of the next pellet, introducing a delay of reinforcement of a magnitude to make adventitious reinforcement unlikely.

The second and third pair of graphs in Fig. 1 show the performances on the last day of FI 60 seconds and FI 2 minutes. Most pellets were followed immediately by a licking pattern closely resembling that seen on the free food schedule. After this initial prandial drinking, the pattern shifted abruptly to that typical of FI reinforcement (Ferster & Skinner, 1957). A pause in licking was followed by a gradual acceleration in licking rate until the arrival of the next pellet. The acceleration is seen most clearly in the FI 2 minute records. The terminal rate of the FI licking pattern was rarely if ever as high as the initial prandial licking rate.

The fourth pair of records shows the final performances on FR 200. They are like those seen for other operants when the number of responses required for reinforcement is high (Ferster & Skinner, 1957). Some ratios were run off at rapid and steady rates, with fairly short pauses following reinforcements. Other ratios showed frequent starting and stopping of responding, and a gradual lengthening of pauses within ratio runs. (In contrast, FR 175 produced ratio performances at high and steady rates with only short pauses following reinforcements.)

The bottom pair of graphs shows the final performance on DRL 20. (The recording pen reset to baseline following the completion of each 550 licks.) Performances typical of DRL schedules for other operants (Segal & Holloway, 1963) alternated with performances typical

of prandial drinking. The control of the experimental reinforcement schedule appears in the periods of low-rate licking, and the control of the thirst stimulus in periods of high-rate licking.

Discussion

Generally, the licking performances on the free-food and FR schedules resembled those seen for other operants on FR schedules, while the licking that occurred on the FI schedules resembled a mixture of FR and FI behavior, and the licking occurring on the DRL schedule resembled a mixture of FR and DRL behavior. These results suggest that drinking is normally under control of fixed-ratio-like contingencies related to the removal of thirst. That is, the reinforcing event that terminates drinking does not occur until some quantity of licks has occurred. The effect of superimposing other reinforcement contingencies on the basic FR is to produce mixed performances including elements appropriate to the experimentally-imposed schedule as well as elements appropriate to the fixed-ratio character of prandial drinking.

It would be interesting to know if there are other response topographies that generate performance patterns resembling those produced by reinforcement schedules, and what the effects of experimentally imposed reinforcement contingencies might be in such cases.

References

- CLARK, F. C. Some observations on the adventitious reinforcement of drinking under food reinforcement. *J. exp. Anal. Beh.*, 1962, 5, 61-63.
- FALK, J. Production of polydipsia in normal rats by an intermittent food schedule. *Science*, 1961, 133, 195-196.
- FERSTER, C. B., & SKINNER, B. F. Schedules of reinforcement. New York: Appleton-Century-Crofts, 1957.
- FINDLEY, J. D. An experimental outline for building and exploring multi-operant behavior repertoires. *J. exp. Anal. Beh.*, 1962, 5, 113-166.
- KAPOSTINS, E. E. The effects of drl schedules on some characteristics of word utterance. *J. exp. Anal. Beh.*, 1963, 6, 281-290.
- PREMACK, D. Toward empirical behavior laws. I. Positive reinforcement. *Psychol. Rev.*, 1959, 66, 219-233.
- SEGAL, EVALYN F., & HOLLOWAY, S. M. Timing behavior in rats with water drinking as a mediator. *Science*, 1963, 140, 888-889.
- SKINNER, B. F. An experimental analysis of certain emotions. *J. exp. Anal. Beh.*, 1959, 2, 264.
- SKINNER, B. F., & MORSE, W. H. Fixed-interval reinforcement of running in a wheel. *J. exp. Anal. Beh.*, 1958, 1, 371-379.
- TEITELBAUM, P., & EPSTEIN, A. N. The lateral hypothalamic syndrome: Recovery of feeding and drinking after lateral hypothalamic lesions. *Psychol. Rev.*, 1962, 69, 74-90.

Note

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