Schedule-induced drinking as a function of interpellet interval

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Two white rats reinforced with 45-mg Noyes pellets on fixed-interval schedules from 15 sec to 5 min exhibited a bitonic relationship between level of polydipsia and fixed-interval value. This relationship depended on three characteristics of drinking: frequency, distribution, and duration. At shorter FIs drinks occurred frequently shortly after reinforcement, and drink durations and frequencies varied directly with interval length. At longer intervals, drinking seldom occurred after reinforcement but was more frequent later in the interval. Late drinks were usually brief.

When he first described schedule-induced polydipsia, Falk (1961) reported a typical pattern of postpellet drinking behavior. This observation has since been confirmed many times (e.g., Keehn, 1970; Segal, 1969; Stein, 1964). Falk (1966) has also reported an increase in level of polydipsia as interpellet intervals increase, up to a point. This finding has also been confirmed (Burks, 1970; Colotla, Keehn, & Gardner, 1970) and seems to depend more on increased drink durations in longer interpellet intervals than on increased frequencies of postpellet drinks (Colotla et al, 1970). However, when interpellet intervals are long enough (e.g., 3 min or more) fluid consumption decreases back to normal levels (Falk, 1966; Hawkins, Everett, Githens, & Schrot, 1970). It remains to see how drink durations and postpellet drink frequencies are affected by long interpellet intervals (cf. Segal, Oden, & Deadwyler, 1965).

SUBJECTS

Two 300-day-old male albino rats were used. They had previously taken part in studies of polydipsia with and without drugs, but had not been used for experimentation for over a month before the present study. They were maintained at 85% of their free-feeding weights at 100 days of age and were housed in individual cages with tap water always available.

APPARATUS

A standard Grason-Stadler two-bar rat chamber, Type E3125B, was used. The left-hand bar was removed, and its opening covered with a metal plate mounted flush with the wall. A weight of 20 g on the remaining bar served to activate relay programming and recording equipment. A water bottle was attached to the chamber door such that a S could lick at its glass outlet tube through a hole 25 mm above floor level and 90 mm from the wall containing the response bar and food magazine. Licks at this tube were registered on a Gerbrands cumulative recorder via a Grason-Stadler drinkometer. The experimental

chamber was housed in a sound-attenuating ventilated chest supplied with a viewing window.

PROCEDURE

Because the animals were experienced, no pretraining was necessary. Experimental sessions were run daily, except at weekends and occasional holidays, and lasted until S obtained 25 reinforcers (100 in Sessions 54-65) scheduled as follows: FI 1 min (Sessions 1-15), FI 5 min (Sessions 16-30), FI 1 min (Sessions 31-33), FI 2 min (Sessions 34-43), FI 3 min (Sessions 44-53), FI 15 sec (Sessions 54-65). Cumulative licking records and water consumption were logged daily.

Fig. 1. Median fluid intakes per pellet and median percent of interpellet intervals in which drinking occurred within 10 sec of reinforcement (postpellet drinks) and at least 10 sec after reinforcement or drinking (interpellet drinks) over the final three sessions of each FI schedule. Only one postpellet and/or one interpellet drink was scorable per interval.

RESULTS

Major results were clear-cut and are shown in Fig. 1. The familiar bitonic relationship between fluid consumption and interpellet interval was confirmed, although the interval of maximum intake, 1 min, was lower than usual (Colotla et al, 1970; Falk, 1966; Hawkins et al, 1970). The figure also shows that the percentage of pellets followed by drinking within 10 sec (postpellet drinks) bore the same relationship to interpellet interval as did fluid consumption, and that the percentage of interpellet intervals containing interpellet drinks (drinks of six licks or more that occurred at least 10 sec after previous eating or drinking) increased as interpellet interval times increased. The transitions of postpellet drink percentages after reinforcement schedule changes from FI 1 min to FI 5 min and back are shown in Fig. 2.

More detailed data are contained in Fig. 3, which shows typical cumulative licking records with interpellet intervals of 15 sec, 1 min, and 5 min. Almost all the drinking with the FI 15-min reinforcement schedule began within 10 sec of pellet delivery (postpellet drinking), and lasted for the whole 15-sec interval. Likewise, most of the drinks with the FI 1-min schedule were postpellet; examples of interpellet drinks appear in the figure just before the fourth and final

Fig. 2. Percent of intervals in which postpellet drinks occurred on successive sessions under the designated reinforcement schedules. Data of Animal S65 were similar.

reinforcers. Postpellet drinks rarely lasted for the whole of the 1-min interval, but it can easily be seen that drink durations were longer with the FI 1-min than with the FI 15-sec schedule of reinforcement.

Many fewer postpellet drinks and many more interpellet drinks occurred when reinforcers were scheduled at 5-min intervals. Only six examples of postpellet drinks with this schedule appear in the figure—following the 2nd, 3rd, 4th, 5th, 6th, and 11th pellets. Most of these were of relatively long duration, in contrast to the numerous interpellet drinks, which were usually of short duration and which often occurred as short bursts of licks interrupted by barpresses towards the end of the fixed interreinforcement interval.

DISCUSSION

The bitonic relationship between level of schedule-induced polydipsia and interreinforcement interval duration appears to depend mainly upon two different behavioral characteristics controlled by the reinforcement schedule: (1) The increasing level of fluid consumption as interpellet interval increases results from an increase in postpellet drink durations (Colotla et al, 1970); (2) the decreasing level of fluid consumption when interpellet intervals exceed some value stems from a decline in postpellet drink frequencies. In both cases complications arise. In the present study, frequencies as well as durations of postpellet drinks increased substantially between 15- and 60-sec interreinforcement intervals, and interpellet drink

frequencies increased as postpellet drink frequencies declined in the longer interreinforcement intervals. It is doubtful, though, if these complications much affected the overall shape of the curve relating fluid intake to interreinforcement interval.

Drink durations and drink frequencies could be measures of two different types of drinking that contribute to the total amount of fluid

consumed. Falk's (1961) original report of schedule-induced polydipsia referred only to drinks that occurred "shortly after a pellet," i.e., postpellet drinking. Since then other drinking by intermittently fed rats has also been reported. Thus, Segal (1969) has described some schedule-induced drinking as operant, i.e., occurring before rather than after reinforcement, Rosenblith (1970) has reported "a second type of drinking" that occurs with second-order reinforcement schedules, and Keehn, Colotla, & Beaton (1970) have distinguished between postpellet and interpellet drinking, the latter depending on palatability. In all these cases, the second type of drinking has differed from the first in occurring more remotely in time from preceding feeding or reinforcing events and in being less orderly in terms of duration and frequency of occurrence (Keehn & Colotla, in press; Keehn, Colotla, & Beaton, 1970).

It is, however, questionable whether there is more than one kind of schedule-induced drinking or whether the differences are merely stages of transition to a terminal (unstable) pattern of behaving (cf. Keehn, 1970) that is maintained by the proximity of the cessation of drinking to reinforcement (operant drinking, Segal, 1969) and initiated by the onset of nonreinforcement (extinction-induced drinking, Keehn & Colotla, 1970). We have been able to control schedule-induced drink durations by way of

Fig. 3. Cumulative licking records of S65 under FI 15 sec, FI 1 min, and FI 5 min. Data of Animal S54 were similar.

interreinforcement intervals (Colotla et al, 1970), but this means of control is limited to intervals that maintain high frequencies of postpellet drinking, i.e., those intervals in which reinforcement is available shortly after the cessation of drinking.

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inordinate amount of parental beatings. The children, in turn, would aggress toward their peers with such intensity that it was often the cause of law-enforcement difficulties and consequent referral to the Juvenile Court. In an attempt to validate experimentally this clinical observation and to extend the nature of the variables affecting pain-elicited fighting, young rats were shocked in the presence of another peer, their own natural mother (NM), or a surrogate mother (SM). It was hypothesized that young rats paired with their NMs would exhibit less aggression than those paired with SMs. It was further expected that the number of encounters between littermates would be greater than that exhibited in the presence of NM or SM.

SUBJECTS

The Ss were 20 male and 22 female Sprague-Dawley albino rats. There were seven litter groups born within the laboratory: four were all male, one was all female, and two were mixed, i.e., half male and half female. All Ss were weaned at 34 days of age. The seven NMs, weighing on the average 288 g, were matched with seven SMs who had a mean weight of 295 g. Half of all the peer groups were tested in the presence of NM and the other half with SM.

APPARATUS

The experimental chamber measured 10 x 12 x 9 in. Two sides were of sheet metal, while the remaining sides and ceiling were made of clear Plexiglas. The grid floor consisted of 20 steel rods, 1/8 in. in diam and spaced .5 in. apart. A small 15-W lamp provided the sole source of illumination in the darkened testing room. Auditory masking was provided by a white-noise generator. Scrambled shock was delivered by a Lafayette constant-current stimulator. Shock intensity was 1.50 mA for the first 3 days and 1.75 mA for the remainder of testing.

PROCEDURE

On the day after weaning, each young was paired with either a NM or SM and with another young from the same litter group. This resulted in three pairings per litter-test group, i.e., young No. 1 was shocked with young No. 2, and both were independently shocked with the mother. The order of testing was balanced throughout the experiment and was identical for all litter groups.

A trial consisted of 30 shock presentations. Since each S was tested twice per day, a total of 60 shocks for 12 consecutive days was administered. The intershock interval was 8 sec, while shock duration was 1 sec. The intertrial interval was 60 sec.

The primacy of size-age dimension over familial relationships in shock-elicited aggression in rats*

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In a shock-elicited fighting situation, young rats tested between 34 and 47 days of age exhibited significantly more attacks when paired with a littermate as compared with a natural or a surrogate mother. Attack suppression occurred during the initial test sessions only for the natural mother paired with her young when contrasted with the number of encounters between the young and the surrogate mother.

If rats are shocked together, consistent attack behavior is observed. This pain-aggression syndrome was originally conceived as reflexive in character with fighting considered as an unconditional response to pain (Ulrich & Azrin, 1962). Even paired housing over several weeks did not alter the fighting rate, although this latter position has been challenged

(Roberts & Larson, 1967). Furthermore, fighting is monotonically related to age. From 33 days of age to 43 days, fighting probability (i.e., number of attacks/total number of shocks) increased from .27 to .41 (Hutchinson, Ulrich, & Azrin, 1965).

It was observed by one of us (RPJ) in the Juvenile Court of Bridgeport that behavior-problem children were frequently the recipients of an

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