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Operant responding with free access to the reinforcer: A replication and extension

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This study was conducted to assess the maintenance of operant responding in the presence of free access to the reinforcer. The results replicated earlier research using food reinforcement and demonstrated that the same general results could be obtained with water reinforcement.

Several studies have been conducted assessing the responses animals would use to obtain reinforcement in situations where two or more responses of varying degrees of difficulty were present. Havelka (1956) showed that rats preferred a longer alley to obtain a variably positioned food reinforcer instead of a shorter alley where the food reinforcer was always in the same position. Recent research in this area has been concerned with the occurrence of a food-reinforced operant response when free food is available in the experimental chamber. Jensen (1963) demonstrated that even when free food was available in the experimental chamber, rats with a history of continuous reinforcement of barpress responding would obtain much of the food consumed during an experimental session by means of the barpress response. Rats having more experience with the barpress operant displayed more responding when the free food was available than did rats with a brief exposure to the reinforced operant. Neuringer (1969) extended these findings to pigeons by demonstrating that a keypeck response was maintained in the presence of free food. In addition, Neuringer (1969) also demonstrated that Ss need not be trained nor deprived to learn and maintain an operant response in the presence of a free reinforcer.

Singh (1970) obtained similar results that demonstrated that rats showed a preference for reinforcement obtained by means of a barpress response over noncontingent reinforcement which was programmed at the same density as the contingent reinforcement. Similarly, this study demonstrated that children would display a preference for response-contingent marbles rather than for noncontingent marbles.

Recently, Carder (1972) demonstrated that rats, previously trained to emit a barpress operant, would earn 83% of the liquid food reinforcer consumed when free access to this reinforcer was permitted. In contrast, the Carder (1972) experiment showed that rats trained to emit a barpress response using water as the reinforcer would earn only 26% of their total water intake under the free access conditions. That experiment did not report the specific influence of free access to the reinforcers on the maintenance of the operant. Since total session length and absolute amounts of reinforcer consumption were not reported, it is impossible to determine indirectly the influence of free access to the reinforcers on barpressing in that study. It might be assumed that the operant performance directly paralleled the reinforcer-consuming behavior. However, the fact that Neuringer (1969) reported instances of unconsumed response-contingent reinforcers when free access to the reinforcer was permitted suggests the possibility that such an assumption may not be warranted. It is technically possible that animals could consume freely and still display a reasonably high operant rate.

The studies which demonstrated sustained responding when free access to the reinforcer was provided have been used to question the necessity of biological motivation in the Hullian analysis of the maintenance of instrumental behavior (Jensen, 1963; Neuringer, 1969). In order to extend these findings to more general analyses of behavior, it seems essential to demonstrate that the phenomenon of sustained responding in the presence of free access to the reinforcer is not unique to food-reinforced operants. The present experiment was designed to replicate the Jensen (1963) phenomenon using both water and food as reinforcers.

METHOD

Subjects

Twelve 156-day-old experimentally naive male hooded rats from the colony of the Department of Psychology at the University of Iowa were used as Ss. The rats ranged in weight from 314 g to 409 g and were housed individually in 24 x 18 x 18 cm cages.

Apparatus

A 23.4 x 20.2 x 19.2 cm operant chamber constructed of Plexiglas and fitted with a Hawley Model HRA-121 retractable lever located 3.5 cm above the grid floor of the chamber was

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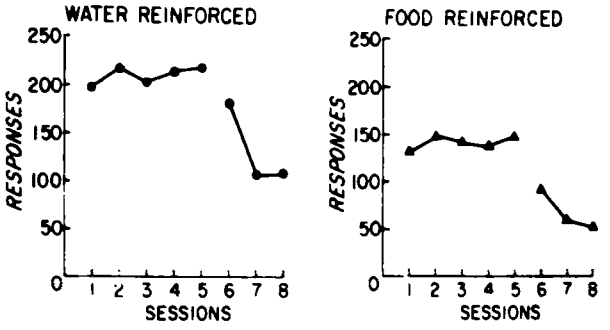

Fig. 1. Mean number of barpress responses per session in rats maintained under food or water reinforcement schedules. During Sessions 6, 7, and 8, free access to the reinforcer was provided.

used. A Lehigh Valley Model 1351 liquid dipper and a Scientific Prototype Model D700 pellet dispenser were located to either side of the lever. Three 7-W lights located above the pellet dispenser, bar, and liquid dipper were used to provide constant illumination throughout all sessions. Events were controlled with standard solid-state circuitry. Responses, and the consumption of free reinforcement, were recorded with electromechanical counters and a Gerbrands four-channel event recorder.

Procedure

Using a stratified sampling procedure, the Ss were assigned according to weight to either a food reinforcement group or a water reinforcement group. The Ss in the food reinforcement group were maintained at 80% (±2%) of free-feeding weight, with water continuously available in the home cage. These Ss were trained to barpress by the method of successive approximation using 45-mg Noyes pellets as reinforcers. Following acquisition of the barpress response, these rats were submitted to five daily 30-min sessions of continuous reinforcement (CRF). During the fourth and fifth sessions of CRF, an empty 5.4 x 4.1 x 1.3 cm free reinforcement container was located in one corner of the operant chamber at the end opposite the response lever, and the response lever was not inserted until approximately 10 sec after the rats were placed in the chamber. Following the five sessions of CRF baseline, the Ss in the food reinforcement group were assigned randomly to two groups and tested during three daily sessions for responding with free access to the reinforcer. The group submitted to Condition 1 was required to make two barpress responses prior to the filling of the free food container with 45-mg Noyes pellets. The group submitted to Condition 2 was required to eat a pellet from the free food container prior to the insertion of the response lever.

The six Ss in the water reinforcement group were maintained on a 23-h water-deprivation regimen, with 30 min access to water following each experimental session and continuous access to food in the home cage. The water reinforcement group was submitted to the same training procedure as the food reinforcement group, except that a 0.01-cc dipper of water was used as the reinforcer. Following five 30-min sessions of CRF, three of the water-reinforced rats were submitted to Condition 1 and required to make two leverpresses prior to the filling of the free reinforcer container with water. Three water-reinforced rats were submitted to Condition 2. These Condition 2 rats were required to drink water from the free reinforcer container prior to the insertion of the manipulandum.

During the three test sessions, a trained observer recorded the consumption of response-contingent reinforcers and the amount of time engaged in free reinforcer consumption by making a switch closure for the duration of reinforcer-consuming responses.

RESULTS

Figure 1 shows the mean number of responses during each 30-min session for the water- and food-reinforced groups. All rats in both groups continued to emit barpress responses in the presence of free access to the reinforcer. During the first session of free access to the reinforcer, the mean number of leverpress responses displayed by both groups was considerably greater than 50% of the responses emitted during each baseline session. The water-reinforced group displayed close to 50% of the baseline number of responses during Sessions 7 and 8 also. The responding of the food-reinforced group declined to approximately 40% of the baseline during Sessions 7 and 8. It is apparent in Fig. 1 that the water-reinforced group displayed more leverpress responding than did the food-reinforced group during each session.

In addition to the differences between the water-reinforced groups and the food-reinforced groups in the mean number of barpress responses, the water-reinforced groups and the food-reinforced groups also differed in terms of the distribution of responses and free reinforcer consumption within sessions. Figure 2 displays mean barpress responding and mean time engaged in free reinforcer consumption during successive quarters of each test session for each group. The food reinforcement group under either condition displayed a sustained low rate of barpress responding during the test sessions and generally reflected a decline in the amount of time engaged in free reinforcer consumption within each session. The exception was the food reinforcement group under Condition 1 which displayed sustained free reinforcer consumption during Session 7. In contrast, the water reinforcement groups generally displayed a marked decline in the barpress

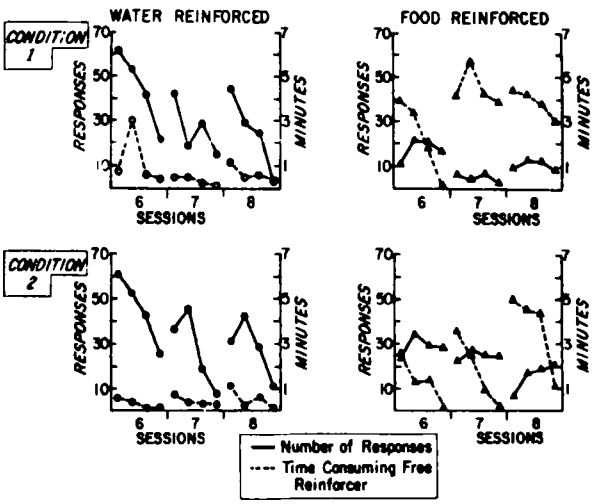

Fig. 2. Barpress responding and time engaged in free reinforcer consumption within each of three test sessions. Each 30-min session is divided into successive 7.5-min segments.

responding within each session, but displayed sustained free reinforcer consumption within each session.

The two different test conditions did not differentially influence the barpress response or consumption of the free reinforcer by either the water-reinforced or the food-reinforced groups. All of the water-reinforced and the food-reinforced Ss consumed each response-contingent reinforcer during all sessions.

DISCUSSION

The results of this experiment replicate and extend previously reported results. Operant behavior is maintained even in the presence of free access to the reinforcer, whether that reinforcer is food or water. In addition, differences in overall response rates and within-session response patterns emerged between the water-reinforced and food-reinforced groups.

With respect to overall response rates, the water-reinforced group responded more than the food-reinforced group. Although this difference in overall responding could reflect a basic motivational difference between food and water deprivation, it could also reflect a smaller amount of time required to consume the 0.01-cc water reinforcer. Observations of the Ss suggest that the latter hypothesis is a tenable one. Rats could rapidly consume the liquid from the dipper and immediately emit another barpress, while the food pellet required slightly more time between responses.

The Carder (1972) study suggested differential effects of types of reinforcers in a free access paradigm, for in that study, food (10% sucrose solution) was primarily earned and water was primarily unearned. With respect to overall response rates, the present results suggest no differential effects of reinforcer type on the operant response during a free access to reinforcement situation. While it is possible that both the Carder (1972) consuming results and the present barpress results could be concurrently obtained, the relatively small amount of time engaged in free water consumption argues in favor of a lack of parallel effects in the two studies. One possible account for these potential differences relates to apparatus differences and the prior water-consuming experiences of laboratory rats. The Carder (1972) study used a licking tube for free access because it was suitable for both reinforcers. The present study used an open dish because it was suitable for both pellets and water. Laboratory housing conditions usually provide water via licking tubes, but rarely provide food via tubes. Open dishes are generally not used in modern rat colony facilities for food or water. If prior consuming experiences with the free access container influence consuming behavior in the free access to the reinforcer paradigm, then the present study and the Carder study could be expected to differ. An assessment of apparatus variables and reinforcers in the free access to reinforcement paradigm seems in order.

In the present study, the within-session differences are more interesting than the overall differences. The water-reinforced groups reflected a marked decline in the barpress response, but a sustained consumption of the free reinforcer. The food-reinforced groups displayed declining free reinforcer consumption, but sustained operant responding. The 0.01 cc of water represents less of the total daily reinforcer consumption than does the 45-mg Noyes pellet. It is possible that this reinforcer magnitude difference could be involved in this within-session difference. Also, to account for these within-session differences, differences in reaching satiation could be suggested. However, all Ss required postexperimental exposure to food or water to maintain the requisite deprivation levels. Thus, satiation difference is an unreasonable account of these results. Unfortunately, the food-reinforced and water-reinforced groups differed not only in the reinforcer used, but also in the manner in which deprivation was maintained. That is, the water-reinforced groups were maintained on a 23-h deprivation regimen and the food-reinforced groups were maintained at 80% normal body weight. Consequently, it is impossible to ascertain whether these group differences are a function of the reinforcers or of the deprivation regimens. These two different deprivation procedures were adopted because of their respective high frequency of use in behavioral research. It would be reasonable for future research to determine whether a time-based food-deprivation procedure would result in the within-session response pattern characterizing the water-reinforced group in this experiment.

The Jensen (1963) study reported that informal observations suggested the absence of switching between operant responding and free reinforcer consumption within sessions. Figure 2 reflects the fact that in this experiment both water-reinforced and food-reinforced Ss distributed free reinforcer consumption and operant responding within the entire session. Unlike the Jensen (1963) experiment, observations indicated regular patterns of alternation between free reinforcer consumption and barpress responding. As in the Neuringer (1969) study, rats in the food-reinforced condition did not engage in hoarding behavior. Neuringer (1969) also reported occasional instances of response-contingent reinforcers which were not consumed. This effect was never observed in the present experiment.

Although this experiment raises questions regarding possible variables in the maintenance of operant responding in the presence of free reinforcement, it extends the results of the previously reported research, emphasizing the generality of the phenomenon of maintained operants in the presence of free reinforcers.

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