The effects of prefeeding in autoshaping and omission training

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The effects of reducing the hunger drive by prefeeding were investigated in standard autoshaping and omission training procedures. Prefeeding produced a small but reliable reduction in response rate which was of the same magnitude in both autoshaping and omission training. These results indicate that responding in both autoshaping and omission training is under the control of a Pavlovian conditioning process.

The autoshaping (AS) situation inherently allows behavior to come under the control of both operant and Pavlovian influences. The explicit training procedure conforms to the Pavlovian delayed conditioning paradigm in which the CS is an illuminated key which precedes the food UCS by 5 or 10 sec. Accordingly, several experiments have demonstrated similarities between Pavlovian conditioned responses and autoshaped responses (Jenkins & Moore, 1973; Terrace, Note 1). On the other hand, Skinner (1948) has argued that coincidental pairings of behavior and independently presented food may result in the development of "superstitious behavior." Thus, the autoshaped keypeck may originate through accidental operant conditioning.

A critical test concerning the nature of autoshaped keypecks was provided by Williams and Williams' (1969) application of Sheffield's (1965) omission training (OT) procedure. In OT, keypecks during the signal period cancel the reinforcer scheduled for the termination of the signal. The OT contingency thus assures a negative, rather than an adventitious, relationship between keypecking and reinforcement. Contrary to an operant interpretation, responses continue to occur, canceling as much as 70% of available reinforcers. Thus, it would appear that autoshaped keypecks are Pavlovian in origin.

Despite the simplicity of the above argument, it may involve false assumptions. It may be true, for instance, that OT and AS are sufficiently different procedures that they generate fundamentally different kinds of behavior. Because response rates in AS and OT are similar does not necessarily mean that the responses are of the same character. For instance, Schwartz and Williams (1972) have shown that the distribution of response durations is radically different between AS and OT although response rates are only subtly different.

In the present experiment, another comparison will be made of behaviors generated by AS and OT procedures. We will measure the sensitivity of these behaviors to changes in drive level brought about by prefeeding. If responses in AS and OT are both similar in nature, then we would expect that prefeeding should have similar effects in the two procedures.

METHOD

Subjects

Five male white Carneaux pigeons, maintained at 85% of their free-feeding weight, were used as subjects. Subjects 1, 2, and 3 were experimentally naive; Subject 4 had previous AS experience, and Subject 5 had previous OT experience.

Apparatus

A standard Lehigh Valley pigeon chamber was used. The chamber wall adjacent to the intelligence panel was replaced with a Plexiglas sheet which allowed visual monitoring of the experiment by means of a closed-circuit television system. Experimental events were controlled and recorded by a combination of electromechanical and solid state logic circuitry. Carbon-paper scatter records of displaced pecks (Bachrach, 1966) were obtained during the first half of the OT phase by positioning pressure-sensitive paper on the intelligence panel surrounding the key opening.

Procedure

After hopper training of the three naive subjects was completed, a baseline AS phase was begun. Each trial, consisting of a 7.5-sec illumination of the key followed by a 4-sec hopper presentation, was separated by a minimum of 45 sec and a maximum of 75 sec from the previous trial, with an average intertrial interval (ITI) of 60 sec. During this baseline period all birds were run 5 days per week, 25 trials per day.

Testing with prefeeding was initiated after the completion of 12 baseline sessions. Temporal and stimulus conditions were unchanged, but on half of the sessions each bird was fed 20 g of mixed grains 20 min before the beginning of its experimental session. Prefeeding sessions (PF) alternated randomly with sessions without prefeeding (NPF). Any additional feeding needed to maintain the subjects at their 85% weight was administered approximately 30 min after the final daily session. The AS test phase continued until seven PF and seven NPF sessions were run for each bird.

The AS test phase was followed by 20 days of OT testing. Any keypecks during the signal period canceled the food presentation scheduled at the termination of the signal. Again PF and NPF sessions alternated, with three birds beginning in the NPF condition and the remaining two subjects beginning with PF. At least 20% of each session was visually monitored.

RESULTS

The results are summarized in Figures 1a and 1b. The histograms show that responding was reduced slightly by

Figure 1. Rates of keypecking in autoshaping and omission training as a function of prefeeding. Figure 1a gives the mean daily percentage of trials with at least one response and Figure 1b gives the mean daily total of trial responses.

prefeeding in both AS and OT. The ordinate function in Figure 1a is the mean percentage of trials with at least one response. In Figure 1b the ordinate gives the mean for total trial responses per session. While these variables are not independent, separate pairs of ANOVAs were performed for each set, with drive state and subjects as factors. For the response trial data the drive effect yielded an F of 7.56 ($p < .01$), while individual differences gave an F of 3.43 ($p < .05$) in the AS condition. In OT the corresponding F scores were 8.50 ($p < .01$) and 8.35 ($p < .01$). For the total response data the F scores in AS were 14.71 ($p < .01$) for subject differences and 2.67 (insignificant) for the drive effect. The corre-

sponding F scores in OT were 3.30 ($p < .05$) and 5.13 ($p < .05$).

Visual monitoring of the test sessions suggested that prefeeding decreased keypecking by decreasing general activity. There was no obvious shift to off-key pecks associated with prefeeding.

The scatter plots from the OT phase indicated the development of idiosyncratic patterns of off-key pecking in four of the subjects. The remaining bird (Subject 3) gave incomplete pecks toward the key which were not detected by this method. Subjects 1 and 4 pecked predominantly with a vigorous downward motion in a 3×2 cm area directly below the key. Bird 2 pecked less

forcefully, restricting most of its responses to a semi-circular ring surrounding the upper half of the key. Bird 5 showed a similar pattern, with the major portion of its responses falling within a roughly circular area nearly 4 cm across and, again, just above the key.

DISCUSSION

The results of this study show that a relatively high hunger drive is associated with slightly increased rates of keypecking, regardless of whether the response is followed by reinforcement (AS) or nonreinforcement (OT). The similarity of the direction and size of the prefeeding effects in AS and OT supports the simplifying notion that responding in these two procedures is dominated by a single process. Furthermore, these data and others indicate that this process is most likely Pavlovian in origin. Several studies (Ost & Lauer, 1965; Wagner, Siegel, Thomas, & Ellison, 1964) have shown that the strength of a conditioned response is directly related to the UCS intensity. Correspondingly, if AS and OT responding were Pavlovian in nature, it would be expected that rates of keypecking would positively covary with the effective strength of the food UCS. Prefeeding would reduce this effective UCS strength of food presentations and should thus generate decreased rates of keypecking in both AS and OT.

While the Pavlovian account is straightforward and simple, it does not positively preclude an operant interpretation of performance in AS and OT. From this viewpoint the keypeck is an operant maintained by adventitious reinforcement in AS. Pecking rates would be expected to covary positively with the effective strength of the reinforcer, which is identical to the prediction made by the Pavlovian account.

However, the operant contingency in the OT procedure is inhibitory—responding is negatively correlated with reinforcement. If the OT contingency is effective in suppressing keypecking, then this suppression should be more pronounced when hunger is increased. Nevertheless, the present results indicate an increase in OT keypecking, resulting in fewer reinforcers, when subjects are in a relatively high deprivation condition. Therefore, alternative forms of operant interpretations must be considered if the operant framework is to be applied in the analysis of OT performance.

The inhibitory operant contingency in OT is similar to differential reinforcement by low rate (DRL) schedules. Deprivation and satiation effects on DRL performance (by rats) have been studied by Conrad, Sidman, and Herrnstein (1958). They found that low levels of hunger reduced the overall response rate and increased the relative frequency of long (reinforced) interresponse times (IRTs). Beer and Trumble (1965) studied incentive effects on an AB DRL task, in which reinforcement is earned only when a response to the A manipulandum precedes the next response to the B manipulandum by a set period of time. Consistent with the Conrad et al. data, reductions in reinforcement magnitude increased the relative frequency of criterion IRTs. Thus, it appears that DRL performance deteriorates as motivational factors are enhanced, which is consistent with the results of the present study.

One should not be tempted to overemphasize the consonance of these findings since there is a major distinction between DRL and OT schedules. The DRL contingency provides reinforcement for all responses preceded by some minimum IRT. The essence of the DRL schedule is thus a temporal discrimination, and several studies (i.e., Gray, 1964; Powell, 1971) have shown that increasing deprivation adversely affects performance on difficult discrimination tasks. Motivational effects of DRL performance may therefore be realized by interference with the timing response. The OT paradigm never reinforces the inhibited response and no temporal discrimination is involved. The subject must simply differentiate keypecks from other be-

haviors and then associate nonreinforcement with keypecks. However, to the extent that DRL performance represents the effect of motivation on an inhibitory contingency, these data suggest that an operant interpretation of the prefeeding effect in OT is plausible.

Another strategy for interpreting the OT results within an operant framework arises from the work on response variability. The decrease in responding to the key when hunger is reduced may be attributable to an increase in response variability rather than to a decrease in response strength.

One approach emphasizes the role of variability in patterns of responding. Vogel and Annau (1973) have shown that, when several alternative sequences can lead to reinforcement, the variability of response sequences decreases with continued experience. Carlton (1962) trained rats to displace any of five response keys to advance to a condition in which reinforcement could be earned by pressing a different lever. He found that, as motivational variables were strengthened (increasing either deprivation or magnitude of reinforcement), the variability of the distribution of key responses decreased. These findings have been cited to illustrate behavioral manifestations of the selective aspect of reinforcement. Learning theorists have long considered reinforcement as a selective process (i.e., Antonitis, 1951) and prefeeding reduces the effectiveness of food as a reinforcer. In the OT paradigm, satiation-induced variability can lead to the adoption of various patterns of proximity pecking, and can thus account for the reduced rates of keypecking in the PF condition.

A weakness of this interpretation is that it presumes reinforcement for correct responses. Because reinforcement for keypecking is precluded in OT, this interpretation requires that the effect of additional reinforcement established in AS carries over into the OT phase. This is improbable in light of the direct inhibitory contingency present in OT.

A final interpretation of the consonance of the AS and OT procedures with respect to the prefeeding effect can be inferred from the work of Wessels (1974). This author argues that the OT procedure does not preclude accidental reinforcement of non-keypeck behaviors such as approaching or orienting to the key. He further argues that keypecking may be a natural sequel to key approaching in the pigeon. Thus, during the OT procedure, key approaches are often adventitiously reinforced. When they are sufficiently strengthened, keypecks begin to more or less automatically follow the approach response. Although these keypecks are not followed by reinforcement because of the OT contingency, they do not extinguish because they involuntarily follow the orientation response and are not sensitive to their consequences.

Although it is well understood that orientation responses to the key do precede the initial occurrence of autoshaped keypecks, it is not established that those keypecks are in any sense automatic sequels to orienting responses. Indeed, it was demonstrated in the same paper that approaching and pecking can be controlled independently by reinforcement contingencies.

The foregoing interpretations are, at best, cumbersome in comparison to a Pavlovian account of the prefeeding effect in AS and OT. While it may be tempting to assume that Pavlovian principles exclusively account for these data, some moderation is in order. It should be noted that in the present experiment the AS phase preceded the OT phase. It may be the case, therefore, that the degree of Pavlovian control of OT responding may have been enhanced by prior AS training. It would be reasonable to determine the degree of Pavlovian control in OT with prior training in a discriminated operant procedure.

In summary, the homogeneity of the prefeeding effect in AS and OT indicates that no more than one conditioning paradigm need be used to account for keypecking in the two procedures. Furthermore, the observation that prefeeding reduces responding in both AS and OT is most compatible with the assumption that keypecks in AS and OT are of Pavlovian origin. Taken together, these observations encourage a strong Pavlovian account of autoshaping and omission training.

REFERENCE NOTE

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