STIMULUS BIAS IN THE ABSENCE OF FOOD REINFORCEMENT

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Pigeons sometimes peck a key at different rates in the presence of different stimuli, even when the same schedule of reinforcement is correlated with each of these stimuli. The possibility that the occurrence of such stimulus bias is dependent on adventitious effects of food reinforcement in the presence of the stimuli was evaluated by correlating extinction with two stimuli. Both pigeons showed stimulus bias, indicating that the occurrence of this phenomenon is not critically dependent upon any effects of scheduled food reinforcements.

Irwin (1958) suggested the term "bias" to describe differential responding which is uncorrelated with explicit differential consequences. A distinction between biases involving the properties of stimuli and biases involving the properties of responses also seems warranted. The occurrence of a given operant at different frequencies in the presence of different stimuli will be referred to as *stimulus bias*. For example, a pigeon might peck at a key more frequently when it is lighted than when it is darkened. The term *response bias* will be applied to cases in which different operants occur with different frequencies in a given stimulus situation. For instance, an animal might turn in a clockwise direction more frequently than in an anticlockwise direction in a given situation. The terms stimulus bias and response bias are intended to be purely descriptive, and not necessarily mutually exclusive. The distinction between these biases is congruent with that commonly made between stimulus generalization and stimulus discrimination on the one hand, and response generalization and response differentiation on the other.

Stimulus bias was demonstrated by Kieffer (1965) who found that rats responded at a higher rate in the presence than in the absence of an auditory stimulus, under a multiple schedule of reinforcement. Pigeons also exhibit stimulus bias under schedules employing different visual stimuli. The behavior of nine

pigeons, reported in an unpublished study by the present author, is illustrative. These pigeons were placed under a multiple schedule in which variable-interval reinforcement was scheduled in two components which differed only in their correlation with red and green illumination of the response key. During the first five sessions, three of the pigeons consistently responded at a higher rate in the presence of red illumination, four consistently responded at a higher rate in the presence of green illumination, and two showed no consistent stimulus bias. No relation was found between stimulus bias and the order of presentation of the stimuli, or any obvious situational variables. With continued training under this schedule, quite large unsystematic shifts in stimulus bias occurred which sometimes involved changes in the magnitude, and sometimes reversal in the direction of the original bias. Although the procedure employed was the same for all birds, these shifts occurred irregularly at different points in the training of different pigeons.

It is clear that stimulus bias in this case cannot be accounted for solely in terms of stimulus characteristics such as wavelength or brightness, nor differential reinforcing properties of different stimuli on a dimension, nor stimulus change, novelty, or duration. Since the stimulus conditions were the same throughout training, any effects of such stimulus properties would necessarily be unidirectional, whereas stimulus bias occurred and shifted in both directions. Moreover, any consistent effects of initial training, generalization from this training, or situational variables seem to

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be ruled out since these were the same for pigeons which showed stimulus bias in opposite directions.

On the other hand, stimulus bias is susceptible to the effects of a number of reinforcement variables. To the extent that differential stimulus control can be produced by scheduling differential frequencies, magnitudes, or contingencies of reinforcement, stimulus bias can be altered by manipulating these variables. Since these variables are known to exercise very powerful effects on stimulus control, it seems worth considering the possibility that stimulus bias is dependent upon some reinforcement effect even when the stimuli are correlated with identical schedules of reinforcement. For instance, Morse and Skinner (1957) found differential response rates in the presence of stimuli randomly inserted in a variable-interval schedule for short periods; these were apparently due to the effects of adventitious reinforcement. Similarly, a stimulus bias could be produced or maintained in multiple schedules by adventitious reinforcement of differential response rates in the presence of two stimuli correlated with identical schedules of reinforcement. For instance, the adventitious coincidence of reinforcement and a high local rate of responding in the presence of one stimulus would tend to increase the probability of subsequent responses occurring at a similarly high rate. This, in turn, would increase the probability of high rates of responding being reinforced in the presence of this stimulus, which would tend to maintain this behavior. In the same manner, low rates of responding could be generated and maintained by adventitious reinforcement. It is worth noting that the shifts observed in stimulus bias were very similar to those found in behavior under the control of adventitious reinforcement. Thus, the possibility that stimulus bias is dependent upon some, possibly adventitious, effect of food reinforcement seemed worth examining. The present experiment sought to determine whether stimulus bias occurred in the absence of food reinforcement.

METHOD

Subjects

Two adult homing pigeons, one male (#22) and one female (#024), maintained at 80%

of their free-feeding weights, were given daily 1-hr experimental sessions. Neither pigeon had any previous experimental experience.

Apparatus

A single plastic response key was located in the center of one wall of the sound attenuating experimental chamber. This could be illuminated from behind by white, red, or green light. Pecks on this key having a force of 15 g or more were recorded on counters and a cumulative recorder, and could be reinforced by a 2.5-sec presentation of grain at an aperture directly below the key. During reinforcement the light behind the key was off and a light over the food magazine was on. A 10-w house light was on and white masking noise was present throughout each session. Scheduling was controlled automatically by electromechanical circuitry.

Procedure

After four sessions of training in which every key-peck response was reinforced, the pigeons were introduced to a schedule under which responses were reinforced after variable intervals, the average of which was 3 min (VI 3-min). Pigeon 22 was placed directly under this schedule. Pigeon 024, on the other hand, was introduced to this schedule gradually by increasing the average interval between scheduled reinforcements from 2 sec to 3 min over a series of 30 sessions. When both pigeons had completed six sessions under the VI 3-min schedule, they were placed under a multiple schedule for one session, given six more sessions under the VI 3-min schedule, followed by a further session under the multiple schedule, and so on. The multiple schedule was presented four times in this manner, with six sessions of training under the VI 3-min schedule interposed between each presentation. During all training, except that under the multiple schedule, the key was illuminated by white light. The multiple schedule consisted of two extinction components which were correlated with red and green illumination of the key respectively. These components were alternately in effect during successive 3-min intervals. Thus, 3 min of red illumination was followed by 3 min of green illumination, and so on throughout a 1-hr session; no reinforcements were delivered in the presence of these stimuli.

RESULTS AND DISCUSSION

The results of this experiment are presented in Fig. 1 which shows the rates of responding in the two components of the multiple schedule for each pigeon. It can be seen that Pigeon 024 responded at a higher rate in the presence of red than green illumination, while Pigeon 22 responded at a higher rate in the presence of green than red. In the case of Pigeon 22, quite a high rate of responding was maintained during each presentation of the multiple schedule. The difference between this bird's rates of responding in the presence of the two stimuli remained consistently large and was in the same direction throughout the experiment. In the case of Pigeon 024, the initial difference between response rates in the presence of the two stimuli was completely obscured during the third and fourth sessions of the multiple schedule by a very rapid extinction of responding. The poor resistance to extinction of this pigeon is hard to understand. The procedure employed with this bird differed only in the gradual introduction of

the VI 3-min schedule of reinforcement. Although it seems unlikely, it is possible that some feature of this training contributed to the very rapid extinction of this pigeon's responding.

Figure 2 shows the cumulative records of each pigeon during the first session of the multiple schedule. These records indicate that the overall differences between component response rates depicted in Fig. 1 represent regular differences in response rate in the presence of the stimuli during successive 3-min presentations. Pigeon 024 made more responses in the presence of red than green in every successive pair of 3-min stimulus presentations over the first two sessions under the multiple schedule. Thus, even though the data were drawn from only two sessions, it can be said that the difference in this pigeon's response rate in the presence of red and green illumination was very reliable. No such differences in the response rates of either pigeon were found between successive 3-min intervals during training on the variable-interval schedule of reinforcement when the key was illuminated only with white light. Clearly, the differential responding of both these pigeons with respect to red and green illumination was sufficiently consistent to be regarded as stimulus bias.

Within the limited range of observations made, the stimulus bias found in this experiment closely resembled that obtained when the same stimuli were correlated with equated schedules of variable-interval reinforcement. In the case of Pigeon 22 there was, if anything, less variability in the magnitude of the stimulus bias between sessions than is generally found with schedules of reinforcement. This is interesting since in the present experiment presentations of the multiple schedule were separated by six days of training on another schedule. The only other difference found between the performance of these pigeons and those under reinforcement was that the cumulative records of the former tended to be more "grainy" due to the absence of reinforcements.

The present results show that stimulus bias occurs under multiple schedules in the absence of food reinforcement and may persist under these conditions for at least short periods of time. The determinants of this stimulus bias are still unknown. There is now evidence that its occurrence does not necessarily depend

Fig. 1. Response rates under extinction in the presence of red (circles) and green (triangles) illumination of the key. Sessions were separated by periods of training under variable-interval reinforcement in the presence of white key illumination.

Fig. 2. Cumulative records of each pigeon's first session under the multiple schedule. Each reset of the recording pen indicates a change between red (R) and green (G) illumination of the key at the completion of each 3-min interval.

upon the differential effects of specific training procedures or physical properties of the stimuli employed, or upon the effects of reinforcements in the presence of these. One possibility is that stimulus bias derives from prior experience of differential reinforcement with respect to the stimulus dimension employed. It is also possible that the responding of different pigeons comes under the control of different stimulus elements during the initial training phase. This could produce a difference in generalization to the stimuli employed, and hence a difference in the direction and magnitude of stimulus bias in different pigeons. Finally, stimulus bias may come under the adventitious control of scheduled reinforcements on some occasions, perhaps in the manner described by Morse and Skinner (1957). The shifts observed in stimulus bias over long periods of training under reinforcement schedules might be related to such

effects. Thus, whether food reinforcement has any role in the type of stimulus bias described has yet to be determined. In any case, it is now clear that the occurrence of this stimulus bias is not critically dependent upon the effects of food reinforcement scheduled in the presence of the different stimuli.

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