Fixed-ratio schedules of token reinforcement

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Two rats received token reinforcement for lever-pressing on FR 20 schedules. Initially, tokens were immediately exchangeable for food. The rats were subsequently required to obtain groups of tokens before they could be exchanged. As the number of tokens required for exchange was gradually increased, response rates for token production decreased. The fixed-ratio patterns of responding remained intact as the rats responded at high rates or not at all, and all pauses followed reinforcement.

Several studies have investigated the effectiveness of token reinforcers in maintaining responding of chimpanzees in extended behavior sequences. With fixed-ratio schedules of token reinforcement Kelleher (1956, 1957, 1958) found that response rates followed the bi-valued patterns typical of fixed-ratio schedules in general; the chimpanzees either responded at high rates or not at all, and pauses followed token delivery. A previous study (Malagodi, 1967) demonstrated that laboratory rats can be trained to lever-press via token reinforcement, and that rates and patterns of responding for token reinforcement are similar to rates and patterns of responding for comparable schedules of primary reinforcement, when the tokens are immediately exchangeable for food. In the present study investigations were made of the effects of increasing the number of tokens required for exchange under conditions in which tokens were delivered on a fixed-ratio (FR) schedule.

Method

The Ss were two adult male non-agouti brown rats (R-3 and R-5). A detailed description of their experimental histories and of the apparatus has been presented elsewhere (Malagodi, 1967). The Ss had been trained in a modified Skinner box experimental chamber which contained a Gerbrands rat lever, a token hopper into which tokens (dark glass marbles) were dispensed, a token receptacle into which the rats deposited the tokens, and a pellet hopper into which 45 mg Noyes standard formula food pellets were

dispensed. Automatic programming and recording equipment was located in an adjacent room. The rats were maintained at 80% of their free-feeding body weights, and were run daily.

In the presence of illumination from a stimulus lamp located above the lever, lever-presses resulted in the delivery of tokens on a 20-response fixed-ratio schedule of token reinforcement (FR 20 TOK). A brief tone accompanied token delivery. In the presence of localized illumination of the token receptacle and a continuous low-frequency clicking sound, token deposits into the receptacle resulted in the delivery of food pellets on a continuous schedule of primary reinforcement (crf). Initially, the exchange schedule was a one token fixed-ratio exchange schedule, or FR 1 EX; that is, the tokens were exchangeable for food as they were delivered. Then, with Rat R-3, the exchange ratio was gradually increased to an eight token variable-ratio exchange schedule, or VR 8 EX. The combined schedule may be viewed as a second-order schedule of reinforcement (Kelleher, 1966), and designated as VR 8 EX (FR 20 TOK); that is, tokens were delivered on an FR 20 schedule and, on the average, eight tokens had to be obtained before the tokens could be exchanged for food. Rat R-5 also performed under an FR 20 schedule of token reinforcement, and the exchange ratio was gradually increased from FR 1 EX to FR 7 EX. The number of sessions at each value of the exchange ratios varied between the two rats, and from value to value, and are presented in Table 1.

Results and Discussion

It may be seen in Table 1 that overall rates of lever-pressing decreased as the exchange ratios were increased. A breakdown in stimulus control occurred with Rat R-3 on the second session at VR 8 EX, when the rat started to deposit each token as it was delivered; the exchange ratio was reduced to VR 3 EX and these "deposit errors" stopped occurring. No errors occurred as the exchange ratio was further

Table 1. Number of sessions and mean response rates at each value of exchange ratios

Rat R-3						Rat R-5		
1st Series			2nd Series					
Schedule	Sessions	Rate	Schedule	Sessions	Rate	Schedule	Sessions	Rate
FR 1 EX	11	35.46	VR 3 EX	4	32.56	FR 1 EX	9	107.16
FR 2 EX	5	33.28	VR 4 EX	4	32.78	FR 2 EX	3	98.58
VR 3 EX	6	35.07	VR 5 EX	5	27.24	FR 3 EX	2	107.50
VR 5 EX	7	26.55	VR 6 EX	12	19.23	FR 4 EX	2	106.92
VR 6 EX	2	22.92				FR 5 EX	3	86.43
VR 7 EX	2	21.23				FR 6 EX	4	73.35
VR 8 EX	2	18.76				FR 7 EX	13	63.06

Fig. 1. Cumulative records for two rats under FR 20 schedules of token reinforcement. Oblique pips indicate token delivery. The points at which the tokens were exchanged for food are indicated by the closed circles in the FR 5 EX record for Rat R-5 and by reset of the response pen in the record for Rat R-3. The recorder was inoperative during exchange.

increased to VR 6 EX. Rat R-5 made several deposit errors only on the first session at FR 2 EX. The decreases in overall response rates as a function of increased exchange ratios were characterized by increases in the frequency and durations of post-reinforcement pauses. Representative cumulative records for both rats are presented in Fig. 1. It may be seen that performance of Rat R-5 under FR 5 EX is essentially identical to performance under FR 1 EX insofar as running rates are concerned; under FR 5 EX, however, there is a higher frequency of

pausing and several of the pauses are considerably longer in duration than those occurring under FR 1 EX. The record for Rat R-3, under VR 6 EX, shows performance similar to that of Rat R-5, with the exception that the post-token pauses are considerably longer in duration and more frequent in occurrence.

The results are similar to those reported by Kelleher (1956, 1957, 1958). In Kelleher's studies chimpanzees received tokens on fixed-ratio schedules ranging from FR 20 to FR 125 with both fixed-interval and fixed-ratio exchange schedules; although Ss paused as long as 2 h at the beginning of sessions under FR 50 EX (FR 125 TOK), for example, the patterns of responding were typical of fixed-ratio schedules. The degree of stimulus control that was obtained over lever-pressing and token-depositing also compares favorably with the results of Kelleher's studies. In previous studies by Wolfe (1936) and Cowles (1937) chimpanzees were prevented from depositing tokens prior to the completion of the exchange requirements via a shutter that closed off the receptacle. In Kelleher's studies, and in the present study, the two response classes were brought under stimulus control.

References

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