The conditions governing secondary reinforcers

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Three groups of rats were allowed to make 50 bar-press responses with a 1-sec delay of reinforcement. Following 25 of these responses, a 1-sec cue light was presented with the patterning varied between groups. The group which had the cue present from the beginning of training showed the greatest resistance to extinction.

Operationally, a neutral stimulus may acquire reinforcing properties as a consequence of being paired with primary reinforcement. This generally appears to be at least a necessary condition in order to establish a secondary reinforcer (S^r) (Kelleher & Gollub, 1962). Factors such as the number of stimulus-food pairings, amount of primary reinforcement, time relationships between stimulus and food presentations, level of deprivation during training, etc., have been previously reviewed by Kelleher and Gollub. The results of these studies appear to indicate that the reward effectiveness of an S^r is determined by an associative mechanism under conditions similar to those described by Pavlov to establish a CS.

The present study was designed to study the effects of introducing the S^r at different stages of training. Is it necessary to have the S^r present at the beginning of training, or will it be effective if introduced later? It appears likely, a priori that if a rat learns to press a bar without a particular stimulus present, such a stimulus introduced later in training may prove redundant, irrelevant, and ineffective. Should this be the case, it would be inadequate to define an S^r as a stimulus that accompanies a primary reinforcer; that would not be a sufficient condition.

Method. The Ss were 22 male albino rats, maintained during the experiment at 80% ad lib body weight. Two Ss were discarded for not making the bar-press response, and a third due to apparatus failure.

A standard Foringer Skinner box in a sound attenuated chamber was used. Two lights over the bar served as the house light, while two other 6-W lights

at the rear of the box provided the S^r . Grason-Stadler solid-state modules controlled all programming and recording. Primary reinforcement consisted of Noyes 45 mgm food pellets.

Procedure. Following deprivation, Ss were randomly divided into three groups. Training for all groups consisted of 50 reinforced responses in a single session, with a 1-sec delay between the occurrence of the response and the presentation of reinforcement. Group I (N = 6) received 25 1-sec presentations of the cue light following the first 25 responses (i.e., during the delay of reinforcement period). Group II (N = 6) received the cue light during the last 25 responses. For Group III (N = 7) the cue was presented 25 times randomly with the restriction that it follow no more than three consecutive responses. At the end of the 50 reinforced responses, an extinction procedure was in effect. For all Ss a bar-press continued to produce a 1-sec flash of the cue light.

Results. Responses were cumulated for four 5-min extinction periods, and the mean total responses for the three groups are presented in Fig. 1. Group I shows the greatest resistance to extinction followed by Groups II and III. A Lindquist (1953) Type I analysis of variance of these data revealed that the difference between groups was significant at the .01 level ($F = 7.27$, $df = 2,16$). As would be expected, the decline in responding over the four extinction periods was highly significant ($F = 34.35$, $df = 3,48$). The Group by Period interaction, however, proved not to be significant.

Discussion. The reward value of a stimulus previously paired with food does not depend only on the number of such pairings. Rather, the present study indicates that the patterning of these pairings is important. If the stimulus is present continuously at the beginning of training, it is more effective in maintaining the bar-press response during extinction. If the stimulus is introduced later in training, its reinforcing effectiveness is reduced. It is reasonable to assume that Group II would have learned to "bridge" the delay of reinforcement for the first 25 responses, and the introduction of the cue was therefore less significant to S. In Egger & Miller's (1962, 1963) terminology, the addition of the cue after 25 responses was "redundant" since it provided no new "information." Similarly, it could be argued that the random presentation of the stimulus in Group III did not provide "reliable information" about the arrival of primary reinforcement, therefore reducing the reward value of this stimulus.

The present experiment was conducted as part of a larger plan of study in analyzing the role of stimuli in relation to their cue function and therefore no further theoretical explanations will be attempted. Because of the significance of the present results with the small groups involved, it was decided to present them in their own right as they suggest many potentially fruitful investigations. Among them is the analysis of the role of cues in partial reinforcement studies where the cue is intermittently presented. The role of scheduled cues is also open to study. Our own investigations are planned to introduce substitute stimuli as training continues.

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NOTE

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Fig. 1. Mean number of responses during four 5-min extinction periods for three groups.