Cue selection in discriminative operant conditioning

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Stimulus conditions involved in a discriminative operant learning situation were manipulated to determine which cues were being responded to in order to solve the problem. In a situation where the S^D and S^Δ periods were of equal length and where a bar press resulted in a click of the feeder mechanism only during the S^D period it was found that time interval and/or whether or not a bar press resulted in a pellet of food were utilized by S more so than the cue light or the click of the feeder mechanism.

Although the operations which define the discrimination learning situation are rather clear, the nature of the stimulating conditions actually responded to by S appear to be quite complicated. In fact, the nature of the stimulating conditions in the seemingly less complicated classical conditioning situation are currently being found to be quite complex, e.g., Eggar & Miller (1962).

To develop a discriminative operant response the situation must be arranged so that a certain stimulus becomes the occasion for a response that is followed by reinforcement, this stimulus is called the discriminative stimulus (S^D). There must also be a stimulus which is consistently present when a response is not reinforced; this stimulus is symbolized S^Δ (Holland & Skinner, 1961). Since both the S^D and S^Δ are informative to S they can be said to be relevant, i.e., they can be used to solve the problem (Restle, 1955). It is not enough to say that if a stimulus has merely been present on all occasions when a response is reinforced it will become an S^D ; the stimulus must have been *absent* on occasions when the response was *not* reinforced (Keller, 1954). If a stimulus is present both when a response is reinforced and when it is not reinforced it can be said to be irrelevant because it conveys no useful information to S (Restle, 1955).

A traditional example would be to arrange a Skinner box so that when the light is off it is not reinforced. Under these conditions the light is said to be the S^D and the light-off condition is referred to as S^Δ . But using the above definition of S^D as conditions existing specifically when a bar press will lead to reinforcement it seems other conditions would also qualify, among them would be the following:

(a) *Click-No Click*. If the situation is arranged so that the power to the apparatus is off during the S^Δ period a bar press made during this period would not activate the feeder mechanism and therefore would not result in a click. Under these circumstances a bar press resulting in a click would become a cue to press the bar again, etc.

(b) *Successive Intervals of Time*. If the situation is arranged so that the S^D and S^Δ periods are of equal duration S could learn to respond differentially to successive intervals of time.

(c) *Whether or not a bar press leads to a pellet of food*. The very fact that S pressed the bar and received a pellet of food may act as a cue to press the bar again and the absence of a pellet following a bar press may act as a cue not to press the bar again. The behavior of an animal responding to this cue would be exemplified by increased rate of responding during the S^D period (i.e., a bar press results in reinforcement) and a reduced rate of responding during the S^Δ period (i.e., a bar press does not result in a pellet of food). There will always be "sample" pressing during the S^Δ period, however; otherwise a change in the conditions could not be detected and the cue could not be utilized. Incidentally, this type of behavior often characterizes performance on a discrimination problem and

the discrimination is said to be made when there is *partial* extinction during the S^Δ conditions (Holland & Skinner, 1961).

In order to determine which cue or cues the animal is responding to, E could systematically add and subtract various cue possibilities from the experimental environment and note the effects on the animal's performance. This is a preliminary report of the results of following such a procedure.

METHOD

A 60-day-old, 23-h deprived, female albino rat was trained under the following circumstances: The cue light in a Gerbrands operant conditioning unit was turned on and off in 3 min intervals. The light-off condition (S^Δ) was brought about by shutting off the power to the apparatus and therefore a bar press during this period did not result in a click of the feeder mechanism.

Training under these circumstances proceeded for eight sessions, one on each of eight successive days. The S received 50 reinforcements in each session. Since a reinforcer was given only following an S^D bar press S had to make 50 bar presses under the S^D conditions to terminate a training session. At the end of each of the last three sessions a discrimination ratio (DR) was calculated as follows (after D'Amato, Schiff, & Jagoda, 1962):

$$DR = \text{Total } S^\Delta \text{ Responses} / \text{Total } S^D \text{ Responses}$$

It can be seen that as S comes to make more S^D responses than S^Δ responses the DR becomes lower. The mean DR for the last three days of original discrimination training was .299.

On the next five days the sides of the Skinner box were darkened with newspaper. All other conditions remained the same. The mean DR for these five sessions was .192.

Before the next experimental condition was introduced, seven days had passed and therefore the rat was given another two days of discrimination training under the original conditions, i.e., the sides were not darkened. The mean DR for these two days was .274.

For the following three days the time interval was eliminated and the light and the click were present to serve as relevant cues. This was done by varying the time interval from 1 to 3 min for both S^D and S^Δ periods. However, the total S^D time equalled the total S^Δ at the end of any given experimental session. The mean DR for these three days was .636.

During the next three sessions the light was eliminated as a cue by leaving it off during both the S^D and S^Δ periods. The power to the apparatus was turned on and off in 3 min intervals and therefore a bar press made during a power-on interval resulted in a click of the feeder mechanism and a pellet of food. The mean DR during these three sessions was .304.

For the following three sessions the click was eliminated as a cue by having it result from a bar press during both the S^D and S^Δ periods. This was accomplished by merely disconnecting the plastic tube going to the food cup during the light off conditions. The mean DR for these three sessions was .349.

After an interruption of nine days the rat was given three days of discrimination training under the original conditions. The mean DR was .146.

The last experimental condition was one in which, again, the light was eliminated as a cue by leaving it on during both S^D and S^Δ periods. In addition, the click was eliminated as a relevant cue by disconnecting the plastic tube during the S^Δ

Table 1
Mean Discrimination Ratios for Various Experimental Conditions

Experimental Conditions	Number of Sessions Involved	Mean Discrimination Ratio
(1) Original Discrimination training Light, Click and Successive Time Intervals Relevant	8	.299 (for the last three sessions)
(2) Sides Darkened Light, Click and Successive Time Intervals Relevant	5	.192
(3) Second Discrimination training Light, Click, and Successive Time Intervals Relevant	2	.274
(4) Click and Light Relevant, Successive Time Intervals Irrelevant	3	.636
(5) Click and Successive Time Intervals Relevant, Light Irrelevant	3	.304
(6) Light and Successive Time Intervals Relevant, Click Irrelevant	3	.349
(7) Third Discrimination Training Light, Click and Successive Time Intervals Relevant	3	.146
(8) Successive Time Intervals Relevant, Light and Click Irrelevant	3	.163

period. The only remaining cues were the 3 min time interval and whether or not a bar press resulted in a pellet of food. The

mean DR for these three sessions was .163. The mean DRs for all experimental conditions are shown in Table 1.

The results suggest that in the learning of a discriminative operant S responds to more than only one S^D . In fact the light was found not to be an effective cue at all because DRs were quite low even when it was eliminated as a relevant cue. It is difficult to say, however, why darkening the sides of the Skinner box would reduce the DR if the light was not being utilized as a cue except that perhaps darkening the sides decreased various distractions which would subtract from the effectiveness of any cue.

It was found that either alternating 3 min intervals or the presence of absence of a pellet of food following a bar press, was utilized as a cue because the DRs were highest when they were eliminated as relevant cues. It seems these two cues would inevitably be combined and rather than S learning to respond and not to respond in successive 3 min intervals, he learns that there is a period of time during which a bar press will result in a pellet of food and other periods during which it will not. This is not unlike what happens under fixed interval reinforcement schedules as opposed to variable interval schedule (Ferster & Skinner, 1957). Determining whether the two cues are used together or separately, or whether they would be utilized at all under different circumstances, e.g., random S^D and S^Δ intervals during initial training, must await further research.

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