The effects of nondifferential reinforcement on two-cue discrimination learning

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Giving nondifferential reinforcement with one visual cue present did not alter the rate at which rats subsequently learned a visual discrimination with that cue and a second visual cue relevant, nor did it change the relative amount learned about each cue. A two-cue discrimination, involving a strong visual cue and a weak tactile cue, was learned faster after nondifferential pretraining on the tactile cue than after nondifferential pretraining on the visual cue.

Lubow & Moore (1959) found that when goats were repeatedly exposed to a stimulus, the subsequent learning of a classically conditioned response to that stimulus was impeded. One interpretation is that when a stimulus is not followed by further consequences of importance to the animal, the level of attention to that stimulus is lowered, and hence, it becomes more difficult to learn to make a response to it (Sutherland, 1964). If this is correct, it would be expected that, if animals are pretrained to approach either of two simultaneously presented stimuli and are always rewarded whichever they choose, attention to the dimension along which the stimuli differ will be lowered, and it will therefore be more difficult for the animal subsequently to learn to discriminate between them. Siegel (1945) found that nondifferential reinforcement retarded the learning of a simple positional discrimination in a T-maze. Bitterman, Calvin, & Elam (1953) tested the effects of rewarding rats regardless of choice on a subsequent simultaneous discrimination. The discrimination to be learned was between horizontal and vertical striations, and different groups received nondifferential reinforcement with three kinds of stimuli—plain grey cards, horizontal and vertical striations exposed successively, and horizontal and vertical striations exposed simultaneously. The last group learned faster than the other two; this suggests that nondifferential reinforcement on two values of a dimension does not reduce attention to that dimension. Bitterman & Elam (1954) confirmed this finding and showed that the more nondifferential reinforcement was given whether on plain grey cards or on horizontal and vertical striations, the

slower was the subsequent learning of a simultaneous horizontal-vertical discrimination. We are therefore left with the paradox that the more nondifferential reinforcement is given, the slower is subsequent learning, but that learning is less impaired when the nondifferential reinforcement is given with the stimulus configuration to be discriminated. No satisfactory explanation for these findings has been forthcoming, nor are we in a position to offer one. It is, however, known that rats have a strong preference for horizontal over vertical stripes, and this may have been a confounding factor in Bitterman's results since, in his experiments, nondifferential reinforcement may have modified this preference as well as changing attention.

The effects of nondifferential reward are of considerable theoretical interest. We, therefore, repeated Bitterman's experiments with two modifications. We used pairs of stimuli for which rats do not show any marked preference. In addition, we used a different dependent variable that might be more sensitive to changes in attention. Instead of merely measuring speed of learning, we presented two relevant cues during discrimination learning and measured how much was learned about each after nondifferential reinforcement of one or the other cue.

METHOD

The Ss were 80 male hooded rats, about 100 days old at the start of training. The apparatus was a modified Lashley jumping stand (with landing platforms in front of the windows), as described by Sutherland & Holgate (1966). The stimuli in Experiment 1 were ¼-in.-thick Perspex shapes mounted on brown hardboard doors: They were black and white 5 x 5 cm squares and horizontal and vertical black, white, and grey rectangles, measuring 10 x 2.5 cm. In Experiment 2, the white rectangles were again used, together with a tactile cue—five plates were made to fit over the Y-shaped jumping platform, two with rubber on one side and metal on the other, one with sandpaper on both sides, one all rubber, and one all metal. On rewarded trials, Ss received a 10-sec access to wet mash.

All Ss were kept on a 24-h feeding schedule, with 1.5 h of ad lib food per day from a week before the start of the experiment. The Ss were pretrained to jump to open doors. During nondifferential reward training Ss received 12 trials per

day for 20 days, with all responses rewarded. Each stimulus was presented on each side on six trials a day; to equate the number of jumps to each stimulus in each position, jumps were forced over the last few trials of each day. During discrimination training, Ss received 10 trials a day, using a correction procedure: When they jumped incorrectly, they were left on the landing platform for 5 sec and then rerun until they jumped to the positive stimulus; after three incorrect jumps, they were forced to the correct side. Only initial errors were counted. At the conclusion of training, transfer tests were given, alternated with retraining trials. On transfer trials, Ss were always rewarded, whichever side they chose.

EXPERIMENT 1

There were three main groups, each of 16 rats. Each group received a different treatment at Stage 1; thereafter, the procedure was identical for all groups.

Stage 1

Groups HV and BW were given 240 trials of nondifferential reinforcement; Group HV was presented simultaneously with a grey horizontal and a grey vertical rectangle and Group BW with black and white squares. Group C (control) received no nondifferential training.

Stage 2

All Ss were given simultaneous discrimination training, with both the orientation and the brightness cue relevant. Within each group, four Ss were trained with each of the four possible combinations of the two values of the two cues, e.g., with black horizontal positive and white vertical negative, with black vertical positive and white horizontal negative, etc. All Ss were trained to a criterion of 18 correct responses in 20 successive trials.

Stage 3

All Ss were given transfer tests with the following six pairs of shapes: black and white vertical rectangles, black and white horizontal rectangles, black and white squares, horizontal and vertical black rectangles, horizontal and vertical white rectangles, and horizontal and vertical grey rectangles. Ten transfer tests were given with each pair.

Results

The main results are set out in Table 1. There were no significant differences between the scores of the three groups either during training or in the horizontal-vertical and black-white transfer tests. Nor were the results affected by which stimulus was positive. It will be seen that, although not significant, the differences in performance on transfer tests were in the predicted direction: Group BW performed slightly less well than Group HV on brightness transfer tests and slightly

Table 1

Experiment	Group	Trials to Criterion	Per Cent Correct on HV Transfer Tests	Per Cent Correct on BW and RM Transfer Tests
1	HV	37	83	86
	BW	39	85	78
	C	48	85	77
2	HV	72	88	61
	RM	42	84	60

better on orientation transfer tests. Sutherland & Andelman (1967) have suggested that there may be a hierarchy of analyzers such that depressing one visual analyzer depresses others. It was, therefore, thought worth repeating the experiment with two cues more widely separated.

EXPERIMENT 2

The design of this experiment was the same as that of Experiment 1, except that the control group was omitted and a tactile cue (rubber-metal) was substituted for the black-white cue. There were 16 Ss in each group. Group HV was given nondifferential reinforcement on horizontal and vertical white rectangles with a sandpaper stand, and Group RM received nondifferential reinforcement on rubber-metal with grey doors.

Results

The results are shown in Table 1. There were no significant differences between the groups in the transfer test results; Group RM did not perform better in horizontal-vertical transfer tests than Group HV. The results were not affected by which stimulus was positive. The groups do, however, differ in trials to criterion—the group pretrained on rubber-metal learned the two-cue

discrimination faster than did the group given nondifferential training on horizontal-vertical ($F = 10.82$, $df = 31$, $p < .005$). The transfer test results make it clear that the discrimination was learned predominantly in terms of the horizontal-vertical cue, and therefore it would appear that, in this experiment, giving nondifferential reinforcement with horizontal-vertical retarded learning of that cue.

DISCUSSION

The results of these experiments may be summarized as follows: When nondifferential reinforcement is given with one visual cue present, there is no effect on the number of trials taken to learn a discrimination with that cue and a second visual cue of roughly equal dominance present and relevant. When the two cues are in different modalities, and one cue is much stronger than the other, then giving nondifferential reinforcement on the dominant cue results in slower learning than does giving nondifferential reinforcement on the less dominant cue, though it does not affect the relative amounts learned about the two cues.

The results of Experiment 2 suggest that attention to a strong cue is weakened by nondifferential reinforcement with that cue present. The failure to find this effect in Experiment 1 may be due to the fact that a second strong cue was added during discrimination learning, and learning may initially have occurred mainly about this cue. Alternatively, it is possible that attention was focused on the visual cues at the beginning of discrimination learning, since the visual stimuli used actually changed at this point of the experiment as a result of superimposing a second cue on that used in nondifferential training. The

results of Experiment 2 contradict those of Bitterman & Elam (1964) inasmuch as they found a stronger effect of nondifferential reinforcement when nondifferential reward training was given on the cue to be used in the discrimination than when it was given with that cue absent. In the present experiment, the main cue used in discrimination learning was the visual cue, and nondifferential training on that cue retarded learning. The Bitterman and Elam result could have arisen because, in their experiment, one effect of nondifferential reinforcement was to equalize preferences for the two values of the cue.

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NOTE

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