Irrelevant cues and shape discrimination learning by cats

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Experimentally naive cats learned to discriminate a pair of objects (circle and triangle) that differed in external contour, with no irrelevant cues ($N = 30$), with irrelevant brightness cues ($N = 26$), and with irrelevant size and brightness cues ($N = 26$). In a second experiment, naive cats were trained to discriminate bidimensional patterns (circle and triangle) with no irrelevant visual cues ($N = 24$) or with irrelevant size and brightness cues ($N = 26$). Irrelevant cues did not significantly affect the rate of shape discrimination learning in either experiment. The findings disagree with the results of several similar experiments with rats.

If the amount of information an animal can process on a single discrimination trial is limited, and if cues compete for the subject's attention (Sutherland & Mackintosh, 1971), animals trained with irrelevant cues should learn discrimination problems more slowly than animals trained without irrelevant cues. Several experiments with rats support this view (Lawrence & Mason, 1955; Mackintosh, 1963; Waller, 1971; Wortz & Bitterman, 1953), but cats and monkeys often perform differently from rats on visual learning tasks (Warren, Derdzinski, Hirayoshi, & Mumma, 1970; Warren & McGonigle, 1969; Warren & Warren, 1969). The present experiments investigated the effects of irrelevant cues upon the rate with which cats learn relatively easy and difficult visual discriminations. Their purpose was to determine the degree to which results from rats may be used to predict the visual discrimination behavior of other species of mammals.

EXPERIMENT I

Method

Subjects. Eighty-two experimentally naive mongrel cats, aged 120 days at the start of the experiment, were studied. They were tested under 16 to 23 h of food deprivation and received a 6-mm cube of pork kidney for each correct response. All of the cats learned to discriminate two objects that differed in external contour, a circle and a triangle: Group 0 ($N = 30$) in the absence of irrelevant visual cues, Group 1 ($N = 26$) in the presence of irrelevant brightness cues, and Group 2 ($N = 26$) in the presence of irrelevant size and brightness cues.

Apparatus. The discrimination box was 37 cm high and painted gray throughout. A 28 x 56 cm startbox, with an opaque and a transparent door, opened into a 41-cm deep choice area and thence into two 31 x 44 cm response compartments, separated by an opaque wall.

The stimuli were eight wooden objects, cut from 2-cm lumber and differing in size, brightness, and contour, presented in the vertical plane: large (81 cm²) and small (36 cm²) black and white circles and triangles. In discrimination training the incentive was concealed behind the correct stimulus, which appeared in the right and left positions in a balanced irregular sequence.

A discrimination trial began when the experimenter raised the opaque door of the startbox and, after a 3-sec delay, the

transparent door. The subject was allowed to enter only one response compartment. If it chose correctly, it was permitted to eat the reinforcement. If it made an error, it was allowed to approach the nonreinforced stimulus, but was prevented from correcting its error and taking the meat.

Procedure. Adaptation: The cats were first tested in the apparatus with no objects present, and with visible meat in both response compartments, until they completed 24 trials in 10 min. On the next day, each subject was given 24 nondifferentially reinforced trials under the conditions to which it had been assigned for discrimination training; that is, with 0, 1, or 2 irrelevant cues present. The purpose of this test was to determine the strength of the cat's preference for specific shape, position, brightness, and size cues, to establish the relative salience of cues in these dimensions before training with differential reinforcement. On the basis of preference test scores, cats were assigned to subgroups trained with the circle or triangle correct, which were equated for initial shape preference.

Discrimination Training: Half the animals in each experimental group were trained with the triangle, and half with the circle correct. The cats were tested on 24 noncorrection trials a day to a criterion of 21 correct responses in a single session.

The cats in Group 0 were trained with pairs of figures that differed only in shape and that were constant in size and brightness within and between trials. Subgroups of 7 or 8 were tested with small black (SB), large black (LB), small white (SW), or large white (LW) circles and triangles.

The animals in Group 1 were trained with sets of objects that presented, within trials, differences in both shape and brightness: B circle and W triangle, and W triangle and B circle. Half the Group 1 cats were always tested with L, and half with S, objects, so size was an invariant cue for the members of this group. In order to solve the discrimination problem, the animals in Group 1 had to ignore brightness differences, and to select the reinforced shape, regardless of its brightness on a particular trial.

All of the cats in Group 2 received the same treatment. They were trained with four sets of stimuli that presented, within trials, irrelevant differences in size and brightness: LB triangle and SW circle; LW triangle and SB circle; SB triangle and LW circle; SW triangle and LB circle. Group 2 cats were thus required to disregard differences in both the size and brightness of the reinforced shape over trials.

The order in which the two sets of stimuli were presented to Group 1, and the four sets used with Group 2, was varied in a balanced irregular sequence. Each set was presented equally often in each test session, and the reinforced stimulus in each set appeared on the right and on the left an equal number of times.

Results

The results of the preference test are presented in Table 1, which shows the proportion of cats in each

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Table 1
Number of Cases With Significant Preferences

Group	Position	Shape	Brightness	Size
0	15/30	1/30		
1	8/26	1/26	4/26	
2	9/26	4/26	1/26	3/26
Sum	32/82	6/82	5/52	3/26
Percent	39	7	10	12

Table 2
Errors in Object Discrimination Learning

Group	Mean	SD	Range
0	71	34	22-171
1	72	28	31-124
2	97	52	36-262

group that manifested a significant preference (17/24, $p < .05$) for a specific stimulus value on the four dimensions studied. It is apparent that in the absence of differential reinforcement naive cats are more likely to develop preferences for positional than for nonspatial visual cues, and that shape cues are not conspicuously more effective than size or brightness cues in eliciting strong preferences.

The results of discrimination training are summarized in Table 2, which gives the mean, standard deviation, and range of errors to criterion for each group. The performance of Groups 0 and 1 is quite similar, while the mean for Group 2 is about 37% higher than those of the other groups. The standard deviation for Group 2 is also substantially larger than those for Groups 0 and 1.

Bartlett's test indicates that the assumption of homogeneity of variance is untenable ($X^2 = 9.84$, $p < .01$ with 2 df). The significance of the differences among groups was therefore assessed by a Kruskal-Wallis nonparametric analysis of variance, which failed to yield a significant value of H .

Discussion

This experiment indicates that cats trained on a visual shape discrimination with irrelevant brightness cues do not make more errors in attaining criterion than animals trained without irrelevant cues. The absence of a difference between Groups 0 and 1 can hardly be attributed to the intrinsic conspicuity or salience of shape cues. Shape, like brightness and size, elicited relatively few strong preferences from naive cats, which manifest significant preferences for positional cues far more frequently than for any visual cues.

The findings, however, cannot be regarded as completely definitive. Even though Group 2, trained with two irrelevant cues, did not differ significantly from the control Group 0, the animals in Group 2 made, on the average, an appreciably larger number of errors. Perhaps if cats were trained on a visual discrimination task under more demanding conditions, animals trained with multiple irrelevant cues might learn significantly more slowly than controls trained with no irrelevant

cues. This hypothesis was tested in Experiment II.

EXPERIMENT II

The stimuli used in Experiment I were objects that differed in external contour. It is well known that such objects are easier to discriminate than bidimensional patterns that provide no differences in external contour (Meyer, Treichler, & Meyer, 1965; Warren, 1973). In order, therefore, to determine if the absence of a significant relation between number of irrelevant cues and shape discrimination learning in Experiment I was due to the use of rather easily discriminated objects, Experiment II investigated whether a similar result would be obtained with less readily discriminated pattern stimuli.

Method

Subjects. Fifty naive mongrel cats, aged 140 to 180 days at the beginning of the experiment, served as subjects in this study.

Procedure. The conditions of this experiment were the same as in Experiment I, with two exceptions. First, the same eight shapes (black and white, large and small, circles and triangles) were used as in the first experiment, but the figures were made from 6-mm plywood and mounted on identical medium gray 12.5 x 14 cm rectangles. The pattern stimuli differ only in respect to the characteristics of the superimposed figures, and provide no differential external contour cues.

Second, only two groups were tested: cats trained with no irrelevant visual cues (Group 0; $N = 24$), and cats trained with irrelevant size and brightness cues (Group 2; $N = 26$).

Results

The preference test results are summarized in Table 3, which shows the number of animals with significant preferences for stimuli in the four dimensions tested. Almost half the cats had position preferences; the number of animals with preferences within any visual dimension was much less.

The discrimination learning results are presented in Table 4. The means and standard deviations for Groups 0 and 2 are almost identical. Since there was no reason to reject the assumption of homogeneity of variance, the results of this experiment were evaluated by analysis of variance. Between groups was not a significant source of variance ($F < 1$).

Table 3
Number of Cases With Significant Preferences

Group	Dimension			
	Position	Shape	Brightness	Size
0	10/24	3/24		
2	13/26	0/26	0/26	4/26
Sum	23/50	3/50	0/26	4/26
Percent	46	6	0	15

Table 4
Errors in Pattern Discrimination Learning

Group	Mean	SD	Range
0	139	66	30-278
2	135	69	61-369

DISCUSSION

As would be expected, the cats made more errors in learning to differentiate the pattern stimuli of Experiment II than the objects used in Experiment I. Even so, the animals that discriminated shape patterns with two irrelevant visual cues made slightly fewer errors in gaining criterion than the cats tested with no irrelevant cues. It thus appears reasonable to conclude that irrelevant visual cues have no strong or reliable effect on the rate of visual discrimination learning by cats.

Upon reflection, it is hard to imagine how these experiments could have had any other outcome. The concepts of restricted channel capacity and competition between stimuli for the subject's attention derive from experiments, like Broadbent's (1958) on dichotic listening, in which the stimuli are presented very briefly, for only a few milliseconds. Animals in the typical self-paced discrimination learning experiment have, in contrast, a very greatly prolonged time for inspection and classification of the stimuli which ends only when they make a definitive choice response. Subjects tested with one or two irrelevant cues in such situations may take more time to compare and categorize stimuli than subjects tested without irrelevant cues, but, in the absence of temporal constraints, there is no obvious reason why they should require more trials or make more errors in mastering the discrimination than subjects trained without irrelevant cues.

There is no ready explanation yet for the fact that irrelevant cues retard the rate of visual discrimination learning by rats, but not by cats. It is, however, important to note that the present experiments are only the latest in a series of failures to observe in cats (Warren, in press; Warren et al, 1970; Warren & McGonigle, 1969) effects that are frequently obtained in visual discrimination studies with rats, and that figure prominently in

Sutherland and Mackintosh's (1971) attention theory of discrimination learning. The consistent lack of success which has attended attempts to validate Sutherland and Mackintosh's theory in cats indicates that there are major differences in attention and visual discrimination learning between rats and cats. Analyses of these differences may eventually help us to understand interspecies differences in the mechanisms of learning and their role in the adaptation of different kinds of mammals.

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