Perimeter, complexity and generalization of a form discrimination by cats[1]

J. M. WARREN and B. O. McGONIGLE,[2] The Pennsylvania State University, University Park, Pa. 16802

Sixteen cats learned a successive discrimination between circles and I-shaped figures and were then tested for generalization with seven new stimulus figures. Seven cats maintained responsiveness to visual cues on the generalization tests, and the results from these Ss indicated that cats classify visual figures as open or closed in terms of both complexity (number of sides) and perimeter. The other nine cats continued to respond correctly to the training figures but manifested strong position preferences on the nondifferentially rewarded test trials. The results are compatible with the argument that stimulus generalization reflects a failure of discrimination.

A recent study of shape generalization by rats (Sutherland & Carr, 1962) suggests that perimeter is an important determinant of the degree of stimulus equivalence found between training and test figures. The present experiment investigated the influence of perimeter upon shape generalization by cats.

SUBJECTS

The 16 experimentally sophisticated adult cats that served in this study had all previously learned simultaneous form discriminations in the Grice box or the Wisconsin General Test Apparatus (WGTA). Four animals without prior experience in the WGTA were adapted to the apparatus before training on the discrimination problem according to the procedure of Derdzinski & Warren (1969).

APPARATUS AND STIMULI

The Ss were tested in the WGTA (Harlow, 1949). The stimuli were black wooden objects with areas of 80 cm^2, cut from 1-in. lumber, supported in the vertical plane by 1/8-in. Plexiglas bases, and presented on a white tray with two food-wells spaced 8 in. apart. The stimuli are illustrated in Fig. 1, which also indicates their perimeter (P) in centimeters and complexity (C), with complexity defined as the number of independent line segments in the contour of a shape.

PROCEDURE

Discrimination Training

The training problem was a successive discrimination between circles and I-shaped figures. An identical pair of stimuli was presented on each trial. Half the Ss were reinforced for responding to the object on the left when two circles were presented, and to the stimulus on the right when two I shapes were presented. The remaining cats were trained with the reverse relation between visual cues and rewarded locus. The Ss were tested on 50 noncorrection trials per day, with intertrial intervals of about 10 sec, to a criterion of 18 correct responses on 20 consecutive trials in a single session, and were then required to meet a second overtraining criterion of 95% correct in 200 trials.

Generalization Testing

Generalization tests with nondifferential reward frequently disrupt discrimination habits in animal Ss (Sutherland & Carr, 1962; Warren & McGonigle, 1969). Each generalization test session was therefore planned to consist of an initial block of 12 training trials followed by 12 test trials, with 2 training trials intervening between each pair of test trials for a total of 46 trials (34 training and 12 test) per session. Responses on the training trials were differentially reinforced as in initial learning, while responses to either of the two identical stimuli were reinforced on the test trials, and E recorded on these trials whether S had responded to the side associated with reinforcement of the circles or of the I figures.

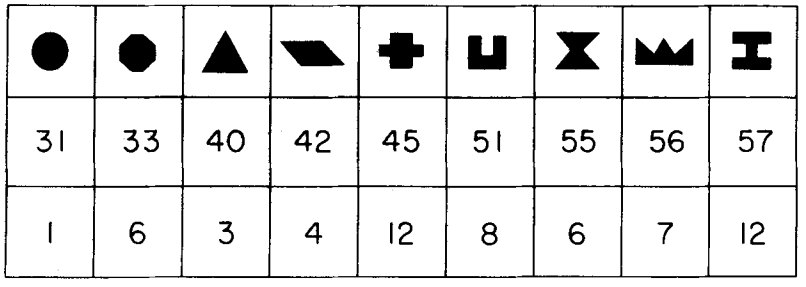
This sequence could, however, be interrupted if S failed to maintain adequate differential responding to the visual cues at one of two stages. If S made more than two errors on the first 10 training trials, it was not tested for generalization in that session and received, instead, 40 additional training trials. Again, if S made more than two errors in the first 12 training trials interposed among the test trials, or if he consistently responded to the same side on all of the first 6 test trials, generalization testing was stopped and S completed the session with 25 training trials. If a cat responded to the same side on the last 6 test trials or made more than two errors on the training trials on the last half of the test-trial series in a session, the following session began with 25 training trials and concluded with a repetition of the generalization trials presented on the previous day. Cats that failed to maintain criterion performance on the training trials and/or manifested consistent position preferences in five consecutive sessions were dropped from the experiment, and the results obtained in all sessions in which the above criteria were not satisfied were discarded.

Four different test figures were presented for three trials each during the generalization tests. The order in which the test figures were presented was varied over days and across Ss to avoid confounding stimulus variables with order of testing. All Ss received 21 generalization test trials with pairs of the seven figures shown in Fig. 2.

RESULTS

The mean number of trials required for learning the initial successive discrimination between circles and I shapes was 252 (range: 50-445). The cats comprised two subgroups in respect to their subsequent performance on the generalization tests. Seven cats responded differentially to the visual cues presented on both the training and test trials; nine maintained a high level of accuracy on the training trials, but consistently responded to one side or the other on generalization test trials, as if they had learned that differential reinforcement contingencies were suspended when novel pairs of test stimuli were presented. The groups which yielded satisfactory and unsatisfactory generalization data could not be distinguished in terms of their initial learning performance; they averaged, respectively, 256 and 249 trials to criterion in discrimination learning.

The results obtained in the acceptable generalization tests are summarized in Fig. 2, which shows the percentage of test trial responses to the "open" side, the position associated with reinforcement of the perimeter of the test figures. The cats responded to the open side significantly less often than



P	31	33	40	42	45	51	55	56	57
C	1	6	3	4	12	8	6	7	12

Fig. 1. Perimeter (P) and complexity (C) values of the forms used in this experiment.

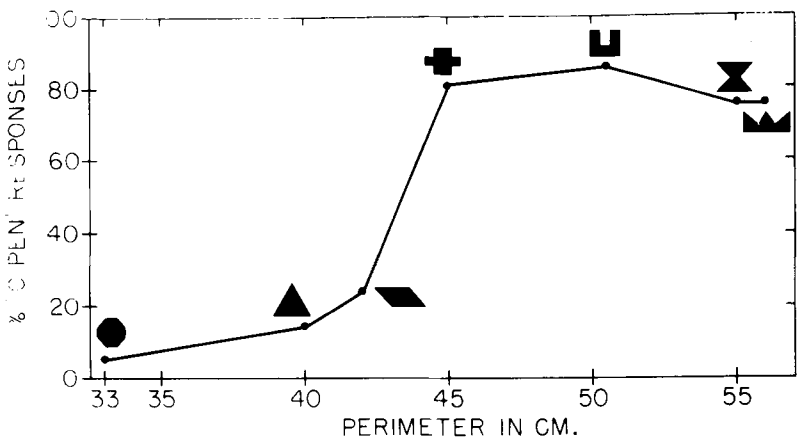


Fig. 2. Percentage of responses to the position associated with reinforcement of the open training figure on generalization tests.

chance when tested with pairs of hexagons, triangles, and parallelograms (ps $< .001$ by χ^2 tests), indicating that these figures were treated as similar to circles. The number of responses to the open side on trials with the remaining four figures was significantly greater than chance expectancy (ps $< .001$ by χ^2), indicating that these shapes were treated as more or less equivalent to the I shape. The rank order correlations between percentage open responses to a figure and its rank in similarity to the I stimuli in perimeter and complexity were +.68 and +.75 ($p < .05$), respectively. The seven figures were also ranked in terms of the sum of their ranks on both perimeter and complexity; the rank order correlation between open responses and this composite index was +.95 ($p < .001$). The composite ranks represent a crude means of weighting the number of sides (complexity) by their length or conspicuity (perimeter). The fact that the correlation between the combined ranks of the stimuli and the cats' choices is so much higher than the rhos for single stimulus variables implies that the cats' behavior is controlled by both dimensions, which are only moderately correlated (rho = +.50).

DISCUSSION

Two distinct patterns of response were observed when the cats in this experiment were tested for stimulus generalization with responses to both test stimuli reinforced. Nine Ss consistently responded to position cues on the test trials, while seven others responded differentially to the visual characteristics of the test stimuli and did not display strong position biases. These disparate results are consonant with Prokasy & Hall's (1963) argument that stimulus generalization represents a failure of discrimination. Some cats discriminated the difference between training and test figures, and quickly reverted to a more congenial pattern of responding to their preferred position on test trials with nondifferential reinforcement, while maintaining appropriate responses to the training stimuli associated with differential reinforcement. The remaining cats apparently failed to discriminate the training and test shapes and consequently responded to the position associated with reinforcement of the circle on test trials with closed figures, and to the position correlated with reinforcement of the I figure on test trials with open figures.

The interpretation of the generalization data as reflecting a failure of discrimination is supported by a previous study of form discrimination learning by cats. Derdzinski & Warren (1969) trained groups of naive cats on simultaneous discriminations between the 10 pairings possible among circle, triangle, cross, and U and I shapes. They found that cats made almost twice as many errors in learning to discriminate two open or two closed shapes than in learning to discriminate between an open and a closed form. They also obtained significant rank order correlations between errors to criterion and intrapair disparity in complexity (−.79) and perimeter (−.72). Thus, the shapes which Derdzinski and Warren found to be difficult to discriminate were treated as equivalent by the Ss in this experiment which generalized their responses to visual cues, and the correlations between the stimulus parameters, complexity, and perimeter, and both difficulty in discrimination learning and generalization scores are similar in magnitude.

REFERENCES

DERDZINSKI, D., & WARREN, J. M. Perimeter, complexity and form discrimination learning by cats. Journal of Comparative & Physiological Psychology, 1969, 68, 407-411.

HARLOW, H. F. The formation of learning sets. Psychological Review, 1949, 56, 51-65.

PROKASY, W. F., & HALL, J. F. Primary stimulus generalization. Psychological Review, 1963, 70, 310-322.

SUTHERLAND, N. S., & CARR, A. E. Visual discrimination of open and closed shapes by rats: II. Transfer tests. Quarterly Journal of Experimental Psychology, 1962, 14, 140-156.

WARREN, J. M., & McGONIGLE, B. O. Attention theory and discrimination learning. In R. M. Gilbert and N. S. Sutherland (Eds.), *Animal discrimination learning.* London: Academic Press, 1969. Pp. 113-136.

NOTES

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2. Now at the University of Edinburgh, Edinburgh, Scotland.

Does d-amphetamine anorexia conform to the law of initial value?

DONALD C. BOUGHTON and ROBERT CLARK, Pharmaceuticals Division, E. I. du Pont de Nemours and Company, Inc., Stine Laboratory, Newark, Del. 19711

d-Amphetamine reduced the milk consumption of fasted mice in a dose-related manner. Each dose level of d-amphetamine reduced milk intake by a fixed amount, which increased with dose, but which appeared to be independent of the level of milk intake of the concurrent control animals. These data suggest that the anorexic effects of d-amphetamine did not conform to the law of initial value; that is, following drug administration, the magnitude of response of the test system was not a function of the initial state of the system.