

with other environmental changes to elevate oestrogen levels in the female. The fact that some females may eventually build nests in the spring without a male (6) suggests that the male does not initiate oestrogen production, but rather accelerates it so that levels sufficient to ensure nest building are reached early in the season.

Since exogenous oestrogen restricts hypophyseal secretion of gonadotrophins and thereby suppresses ovarian growth, the birds treated with the hormone did not lay eggs after nest building. However, one bird from each of the treated groups showed incubation behavior after completion of the nest. Incubation is easy to identify because, once it is firmly established, the female can actually be picked out of the nest; birds which are not incubating rarely sit in the completed nest, and if they do they fly from the nest as soon as the cage door is opened or a hand approaches them.

This incubation of the eggless nest indicates that eggs or egg-substitutes are not essential for incubation to occur. Nor is ovulation a *sine qua non* for incubation. That nest construction is not a prerequisite for ovulation has previously been shown. In the spring birds may ovulate (albeit delayed beyond the normal period), if they are prevented from building nests, and may even show incubation behavior (9).

Proper timing of the physiological changes associated with the successive phases of reproduction is essential for successful breeding. If young are to be raised and fledged at the biologically correct time, the proper hormonal states must occur appropriately. It is clear that none of these changes depend on single factors—rather, in each case a number of factors act synergistically to promote the next stage. In the absence of all the appropriate factors, those present may be effective if they continue to act over a long period. Thus incubation may occur without ovulation and even without a nest (10).

ROSLYN P. WARREN\*  
R. A. HINDE

Department of Zoology,  
Cambridge University,  
Madingley, Cambridge, England

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\* Present address: Department of Zoology, Howard University, Washington, D.C.

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### Specificity of Discrimination Learning to the Original Context

**Abstract.** Rats learned a black-white discrimination at one location in a maze. Subsequently, most rats required over half as many trials to learn the same discrimination when it was placed in another location in the maze. Additional evidence was consistent with the assumption that the relevant cues are, in effect, modified by interaction with the contextual stimuli.

The fact that a change in the background contextual environment produces some disruption in the performance of learned behavior is widely recognized. However, there are not many clear-cut demonstrations of this fact, particularly in a laboratory setting. The purpose of this report is to describe a striking and somewhat unexpected instance encountered during research designed for other purposes.

Rats were being run in a maze whose floor plan is shown in Fig. 1. As depicted, if the rat turned to the right after leaving the start box, it would take two additional right turns and then arrive at a second choice point displaying a black-white discrimination problem. That is to say, reward at the goal was contingent on the rats' selecting, let us say, the black swinging door regardless of its position at that choice point.

If, alternatively, the rat turned to the left after leaving the start box, it would take two additional left turns and then be forced to take a left (or, on half of the trials, a right) turn through a grey swinging door. Frequency of reward in this case was matched to the level of success on the discrimination problem. Specifically, when early in training the rats had strong position preferences at the discrimination choice point, so that they were obtaining reward on that half of the trials when the positive cue was in their preferred position, they were also rewarded on half the trials in the other wing of the maze. Subsequently, as the rats mastered the dis-

crimination problem in the right wing of the maze, the reward frequency in the left wing rose correspondingly. Throughout, the reward was arranged so as to be nondifferential with respect to position at any choice point.

The data of immediate interest arose when, in order to evaluate the strength of the general preference for the non-discrimination wing of the maze, the location of the discrimination was changed to the left wing of the maze. It was expected that, after perhaps a slight disruption, the animals would transfer their previous learning. As will be seen, however, the degree of transfer was small.

Eight hooded rats were run on the problem schematized in Fig. 1, some with white positive and some with black, and some with the discrimination in the right wing and some with it in the left wing. The maze was illuminated by six 7-watt bulbs spaced equally 1 foot above the maze to minimize differential extra-maze cues. The rats were run after 23 hours' deprivation on a 12 g/day maintenance schedule and were given four 45-mg pellets as reward when appropriate. Both free and forced trials were given at the first choice point to equate the number of runs in each wing. All trials at the discrimination choice point were free, and all trials at the nondiscrimination choice point were forced in such a way as to insure equal and nondifferential reinforcement. The number of trials given in the original problem varied, but all rats used in the experiment had attained a criterion of 15 correct choices out of 16 at the discrimination choice point before its location was changed to the opposite wing.

One rat showed essentially perfect transfer in that it met the above criterion in its first 16 trials with the discrimination in its new location. The other rats, however, adopted position responses, their savings scores being 56, 32, 31, 28, 19, 15, and 13 percent. The median number of trials to learn the original discrimination was 424. The median number of trials to learn the same discrimination in its new position was 280.

Two somewhat different (though not incompatible) interpretations of the role of context might be advanced to account for this finding. According to one, contextual stimuli interact with the relevant cues, modifying them by patterning so that a change in context changes the pattern and hence disrupts performance. That is to say, a white door in the right wing of the maze is different from the same white door in the left wing, and there is a generalization decrement when shifting from

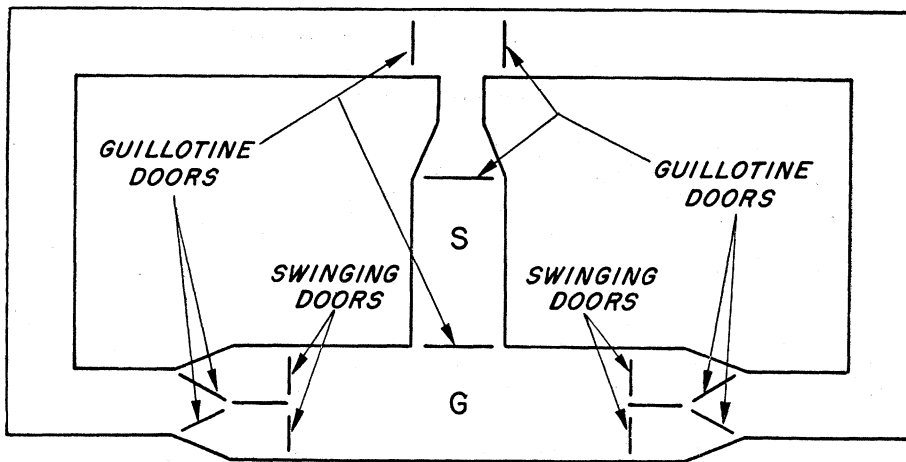


Fig. 1. Floor plan of the maze. The swinging doors in the right wing were black or white so as to present a brightness discrimination problem. The swinging doors in the left wing were grey, and the rat was forced by a closed guillotine door to turn right or left there.

one to the other. In the present case, then, the rats were, in effect, faced with a different discrimination problem.

The second interpretation assumes that discrimination learning requires, at least in part, that the subject learn to look at, attend to, or perceive the relevant cues, and the role of context is to elicit these perceptual responses. In the present case, then, the context in the left wing had not trained the rat to attend to the brightness of the doors; indeed, any such tendency generalized from the right wing would have been extinguished because brightness was not differentially reinforced on that side.

Three additional observations bear on these conceptions. First, the perceptual approach could handle very sudden learning of the discrimination in its new location because, once the perceptual response came in, the subject could perform perfectly the task he had previously solved. In fact, although the transition from position habit to correct preference was fairly abrupt, it was not noticeably more so in the new location than it had been in the original location. All animals continued to err occasionally for a number of trials after they first broke from their preferred position, as would be expected from the patterning interpretation.

Secondly, according to the perceptual interpretation, attending to the brightness of the doors in the original wing would be extinguished during the reversal training because reward was no longer differential there. This would lead to a comparable difficulty in transfer during a second reversal when the discrimination problem again appeared in its original location. In fact, all of the five rats tested in this way transferred essentially perfectly, performing, as the patterning approach would de-

mand, correctly when the original stimulus complex reappeared.

Finally, if rats are trained on the discrimination problem in the right wing without also being run in the left wing, then the perceptual approach could account for near-perfect transfer when the rats first run and encounter the discrimination problem in the left wing. This derivation assumes that the attending response should generalize and would not have been extinguished by nondifferential reinforcement. In fact, three rats run through this sequence had transfer scores of 78, 72, and 51 percent. These scores, while perhaps somewhat larger than those obtained after the original procedure, are in line with what one would expect from the patterning approach, since the stimulus change should be essentially the same in either case, but the original procedure should make it somewhat more difficult to break up position preferences.

It should be clear that these results do not show that perceptual behavior is not involved in this type of discrimination situation, and certainly conditions could be devised that would require characteristic receptor-orienting behavior in particular contexts. The results do show that position preferences are not eliminated by extensive nondifferentially reinforced forced occurrences of the alternative responses, and they are generally consistent with the assumption that the relevant cues in a discrimination interact with the contextual stimuli and are modified by this interaction in such a way that changing the context effectively also changes the relevant cues.

FRANK A. LOGAN

Department of Psychology, Yale University, New Haven, Connecticut

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## Perceived Movement in Depth as Function of Object Luminance

**Abstract.** Thresholds for the binocular and monocular perception of movement in depth for a circular stimulus object decreased as target luminance was increased to 0.1 ft-lam. Above 0.1 ft-lam little change in threshold was observed. Superiority of binocular over monocular conditions decreased with higher luminances.

This report deals with the ability of human subjects to perceive whether an object, viewed in an otherwise totally dark field, is approaching or receding as a function of the luminance of the object for various durations of observation under binocular and monocular viewing conditions. Renewed interest in this area of research results from an analysis of anticipated visual skills required in certain manned space vehicle operations. The stimulus object was a circular, electroluminescent lamp, 3.5 in. in diameter. It was mounted on a cart which traveled on tracks, either directly toward or away from the subject, at a constant speed of 3.3 in./sec. The stimulus lamp was energized when the cart supporting the target crossed a microswitch. At this point the stimulus lamp was 25 ft from the subject and subtended a visual angle of 40 min of arc. The angular subtense of the stimulus, depending on whether it moved toward or away from the subject, increased or decreased at an initial rate of approximately  $\frac{1}{2}$  min of arc per second. The lamp, depending on the experimental condition, had a luminance of 0.001, 0.01, 0.1, or 1.0 ft-lam. The nine durations of exposure used were 0.6, 1.2, 1.8, 2.7, 4.2, 6, 9, 13.2, and 19.8 sec. Only six durations were used for a given luminance condition, the shorter six durations being used for the higher luminance levels.

Four adult subjects with several hours of familiarization training in the task were used in a 4 by 4 Latin-square design. The subjects, run individually, were allowed to adapt to the dark for 15 min prior to an experimental session. Each experimental session consisted of 25 trials at each of six exposure durations for a given luminance and viewing (monocular or binocular) condition. An experimental session lasted about 90 min. Each subject had each luminance condition twice for each viewing condition, requiring a total of 16 sessions and yielding 2400 observations per subject.

The experiment was conducted in a light-tight room 50 by 20 ft with a 12-ft ceiling. The walls and ceiling were covered with a black matte flocking material to minimize reflected illumination. During the experiment the subject was seated in a booth and was provided