

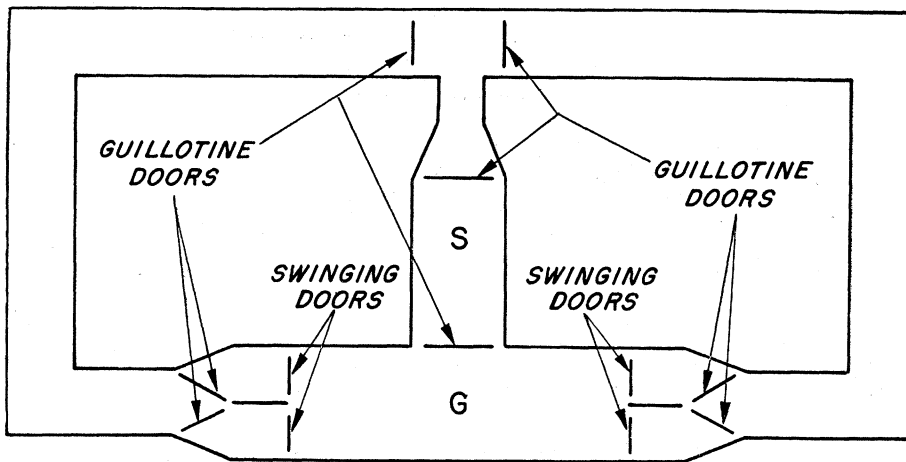


Fig. 1. Floor plan of the maze. The swinging doors in the right wing were black or white so as to present a brightness discrimination problem. The swinging doors in the left wing were grey, and the rat was forced by a closed guillotine door to turn right or left there.

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.

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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

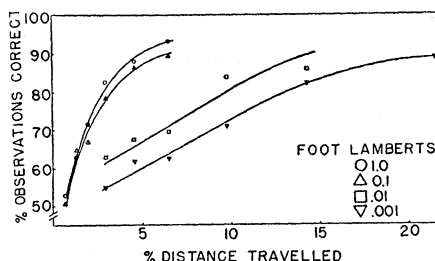


Fig. 1. Accuracy of detecting movement in depth as a function of the observed distance traveled for four luminance levels. The 50-percent value on the ordinate represents chance performance. The curves are the average for binocular and monocular conditions. Each point is based on 400 observations.

with a chin rest adjusted so that he could view the stimulus object through an aperture in the front of the booth. This arrangement provided direct visibility of the stimulus object in an otherwise totally stimulus-free visual field. The subject was alerted a few seconds prior to each trial presentation. The stimulus object then appeared for a controlled duration. The subject responded with a two-way throw switch to indicate whether the object appeared to approach or recede. Subjects were not informed of the correctness of their responses. A two-category, forced-choice method was used—that is, the subject had to respond with his best guess. The order of presentation (whether the object approached or re-

ceded) was selected from a table of random numbers, but was controlled so that each condition appeared an equal number of times.

Some of the results showing the percentage of correct observations as a function of the percentage of the original distance traveled for the four luminance levels used in the study are presented in Fig. 1. The percentage distance traveled is directly proportional to observation duration and, for the range of values involved, it approximates percentage change in visual angle subtense of the stimulus object. The curves shown are the average curves for both binocular and monocular vision. The 50-percent value on the ordinate represents chance performance, since with no information the subject, by guessing, would be correct about 50 percent of the time.

The data shown are for the average of the measures for conditions when the stimulus approached and receded. Although each condition occurred an equal number of times, on 51.9 percent of the observations the subjects reported that the object was approaching. This small, though statistically significant bias, may indicate that when the object approached, the movement in depth was more easily perceived than when it receded for any given observation duration. This would be expected because a slightly greater visual angle change occurs per unit time when the object is approaching than when it is receding. Also, there may have been a response preference independent of the stimulus conditions which would account for this small bias.

Figure 2 presents the percentage distance traveled required for 75-percent correct detection of movement in depth as a function of luminance for monocular and binocular viewing conditions. The percentage distance traveled required for 75-percent correct detection decreases with increasing luminance up to 0.1 ft-lam. The further luminance increase to 1.0 ft-lam does not affect binocular performance and only slightly lowers thresholds for monocular performance. This finding is in general agreement with studies of other visual functions as they relate to luminance (1).

The marked superiority of the binocular over the monocular viewing condition for the lower luminances is not easily accounted for. Since no other stimuli were in the visual field, disparity cues were not present and convergence cues could contribute very little, if any, information for the viewing distances involved. The only reasonable cue available for discriminating the movement in depth was the change in retinal image size in time. Conceivably, bin-

ocular summation of the stimulus energy could account for at least part of the superiority of the binocular condition at the lower luminance levels (2). Smith (3) found a definite superiority for binocular over monocular viewing in a similar visual task. However, Smith used luminance levels in the order of the higher levels used in the present study, and at these luminance levels binocular summation of energy should contribute little, if any, improvement. An analysis of the superiority of binocular over monocular visual acuity has been reported elsewhere (4).

No improvement in performance was evident with the practice afforded during the course of the experiment. The intersubject variability in the performance of this task was considerable at the lower two luminances, but was small for the higher two luminances.

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Auxin Gibberellic Acid Interaction in Controlling the Hypocotyl Growth in Seedlings

Abstract. High concentrations of indole-3-butyric acid, when applied at a concentration of 100 to 200 parts per million (ppm) to presoaked seeds, cause a marked inhibition of hypocotyl length in the seedling growth of *Phaseolus mungo* var. T-2. Gibberellic acid, when applied at a concentration of 5 ppm, quantitatively reversed this inhibition. It is suggested that the interaction between these two growth substances controls the morphogenetic differentiation in regard to hypocotyl formation in seedling growth.

Interactions of growth substances are known to regulate the morphogenetic changes as the production of roots or buds in the tobacco pith callus tissue (1) and the growth of the preformed buds in the pea stem sections (2). Kuse (3) showed that both auxin and gibberellin were required for the growth of the petiole in the leaves of *Ipomea batatas* Cv. Norin No. 1, and Skinner et al. (4) brought forward evidence that interactions between gibberellins and substituted purines indeed control seed germination. The phenomenon of the different mode of seedling growth in different genera of the same plant

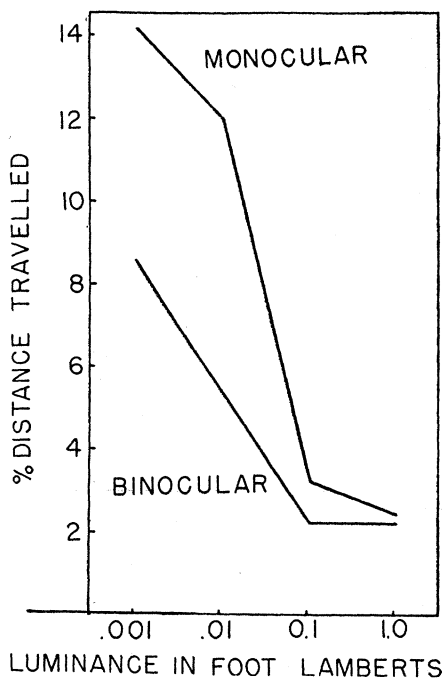


Fig. 2. The percentage distance traveled required for 75-percent correct detection of movement in depth as a function of luminance level for monocular and binocular viewing conditions.