of the respiratory tract, and control of pressure within the sac system could account for the retention of 875 g of water per day of the 935 g of water that could be lost by respiration in a 140-kg *Tursiops* under the conditions we assumed for our calculations.

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9. We thank G. A. Bartholomew, Michael Smyth, and F. G. Wood, Jr., for reading this manuscript. This work was supported by the U.S. Naval Missile Center, Point Mugu, California.

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Stimulus Variables Determining Space Perception in Infants

Abstract. *It was shown previously that infants who have neither reached nor crawled discriminate changes in spatial position on the basis of cues other than the projective size of objects displaced in space. It is now shown that binocular vision is not necessary for discrimination and that pictorial cues are not sufficient for discrimination. Parallax variables provide the information used by such infants for the discrimination of size and distance.*

In a previous study (*1*) evidence was presented that 10- to 12-week-old infants can discriminate changes in spatial position on the basis of cues other than changes in the size of the retinal image. The nature of the variables used by infants is of some theoretical importance, since it bears on the question of the "primary cues" to spatial order. The data in this report indicate that motion parallax is the necessary variable, a result in accord with other studies (*2*).

Twenty-seven infants aged 40 to 60 days at testing served as subjects. They were divided into three groups of nine. All three groups were trained and tested in a room bare of furniture save that described below. The walls of the room were of coarsely textured brick and overhead strip lights ran along its length directly above the experimental set-up, shadows thus being minimized. Each infant was placed in a crib on a brown wooden table (5 m long), the crib being inclined at 45 degrees to the table. The head of the infant was clasped between two yielding pads; the left-hand pad contained a microswitch whose closing operated an event-recorder placed below the table. Immediately in front of the crib was a gap beneath which an experimenter was stationed. When the event-recorder operated, the experimenter emerged and peek-a-booed at the infant for 15 seconds and then disappeared from sight. This event served to reinforce the conditioned leftward head movement. The experimenter was able to introduce a translucent screen between himself and the infant for rest-periods and changes of stimulus.

The conditioned stimulus for group 1 was a white paper cube (30 by 30 by 30 cm) placed on the table 1 m from the infant's eyes; the stimulus was viewed binocularly. The conditioned stimulus for group 2 was the same, save that these infants wore a patch over one eye and thus viewed the stimulus monocularly. Both groups could see only one side of the cube, that in their fronto-parallel plane; neither the top nor the sides were visible. The conditioned stimulus for group 3 was a projection, on a translucent screen 1.25 m from the infants' eyes, of the cube to a size such that the visual angles, luminances, fronto-parallel aspects, and vertical and horizontal deviation from a constant line of regard of the projected objects were the same as for the other two groups.

The infants were trained in daily 30-minute sessions. Initially, reinforcement was continuous and the conditioned stimulus continually present. During this period a great deal of response differentiation seemed to occur. General motility decreased greatly and the head movement became more economical. When the response rate reached a criterion of one conditioned head-turn every 2 seconds (excluding intervals during which reinforcement was given) and remained at this rate for 15 minutes, stimulus differentiation was begun. The infants were trained to respond only in the presence of the conditioned stimulus. For group 3, a projection of the table without the cube served as a negative stimulus. The two types of presentation were alternated randomly for 30-second periods, with responses to the conditioned stimulus being continuously reinforced and responses to the negative stimulus never being reinforced. This was carried on until the negative stimulus had been presented 4 times without eliciting a response. After this criterion was reached, the negative stimulus was discontinued and a variable-ratio (VR) reinforcement schedule introduced. Behavior was shaped in four sessions from a VR 2 to a VR 5 schedule (that is, one reinforcement per five responses on average, the exact number of responses varying randomly). This schedule was maintained for 1 hour, after which discrimination testing was begun.

Table 1. Mean numbers of responses elicited by the four presentations.

Group and conditions of viewing	Presentation and visual angle (degrees)			
	(i) 16	(ii) 5	(iii) 54	(iv) 16
1, binocular	98.70	58.10	54.20	22.10
2, monocular	101.00	60.90	53.60	22.91
3, projection	94.78	52.00	44.11	96.00

The three groups were compared with respect to the rate of formation of the discrimination response and the rate of discrimination response at the end of the training period. The mean numbers of responses elicited by the negative stimulus in the three groups were, respectively, 81.84, 82.18, and 80.17 (chi square 1.014; df, 16, not significant). The mean terminal response rates were respectively 1.240 per second, 1.246 per second, and 1.241 per second (chi square 4.06; df, 16, not significant). Since neither of these measures differentiated the groups, it was assumed that any differences in performance in the subsequent tests would not reflect differences in training.

Discrimination tests were conducted as follows. Four presentations were used: (i) the 30-cm cube placed 1 m away from the eyes, (ii) the same cube

3 m away, (iii) a 90-cm cube 1 m away, and (iv) the 90-cm cube 3 m away. For group 3, angularly equivalent projections were used. Each stimulus was presented for four 30-second periods in counterbalanced order. The number of responses elicited by each was tallied. No reinforcement was given during testing.

Presentations ii and iii were differentiated from i, the conditioned stimulus, by all three groups (Table 1). This discrimination could be made on the basis of changes in the size of the retinal image. The differentiation of iv from i, where the retinal image size of the cubes was the same, was accomplished only by groups 1 and 2 ($t = 14.97, 16.02$; $p < .001$). Presentation iv elicited the smallest number of responses from groups 1 and 2, a fact which I interpret to mean that these infants could not only detect changes in spatial position but could also detect size at a distance. That is to say, they manifested size constancy. Group 3, on the contrary, failed to differentiate presentation i from presentation iv ($t = .097$, not significant).

The implications of these data are clear. Both presentations i and iv, as seen by group 3, were rich in pictorial cues which were quite sufficient to specify to the adult eye that the cube in iv was further away and larger than the cube in i. Relative height on the projection screen, density of table texture at point of contact with the cubes, density of wall texture occluded by the cubes, and linear perspective of table to point of contact with the cubes were some of the available variables. Only the angular size of the two cubes was the same. This rich array of pictorial cues was quite insufficient for the infants in group 3 to be able to discriminate the distances and the sizes of the objects placed at different distances. Their responses were apparently controlled by the angular size of the cubes alone. This single cue sufficed for the discrimination of ii and iii from i, but its limitations are shown up by this group's failure to discriminate iv from i. The static monocular array of a picture apparently conveys no information about the distance and size of an object presented at a distance to infants of this age.

The performance of groups 1 and 2 was markedly different, manifesting some degree of size-constancy. Group 2 also had a monocular array, but for them it was not static, frozen onto a picture plane, as for group 3. The difference is the availability of motion parallax. For this group every head movement produced relative displacements of every object in the visual field, nearer objects being displaced further, faster, and in a direction opposite to farther objects. This conglomeration of variables obviously conveyed sufficient information for the discrimination of i from iv. Group 1 had binocular-parallax available in addition, but, since their performance was not better than that of group 2, it may be concluded that, while motion parallax is necessary for the discrimination of angularly equivalent but objectively different sizes by 50- to 60-day-old infants, binocular parallax is not. Whether or not motion parallax is sufficient as well as necessary is not an issue which can now be decided.

It may be argued that these infants were responding to motion parallax itself, rather than distance and size as specified by motion parallax. This objection has some face value but is operationally meaningless. A system which responds to motion parallax itself is isomorphic, in the full sense of the word, with one which responds to size and distance as specified by motion parallax. On no perceptual task can the two systems be other than identical.

These data have some interesting implications for theories of the development of perception. The fact that motion parallax is the necessary variable for space perception in infants allows one more precision in theorizing about the relation between perception and action (*3*). An active observer creates for himself a whole system of potentially informative transformations of the optic array (*4*). As we have seen, one of these, motion parallax, is sufficient for young infants, while an untransformed array is not. The performance of group 3 is especially interesting since this group did not even differentiate presentations i and iv, much less give any indication of a space-specific response. This indicates that the available variables had not even been detected, much less become informative. If a like process of discrimination learning (*5*) occurs earlier with motion parallax, as seems likely, the deleterious effects of enforced inaction on perceptual adjustment (*3*) become more comprehensible. With no opportunity to produce transformations, a subject cannot begin to discriminate these transformations.

As for later learning, the discrimination or detection of static pictorial variables may be followed by correlation of them with the more primary parallax variables.

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Cerebral Temperature Changes Accompanying Sexual Activity in the Male Rat

Abstract. *Cerebral temperature was continuously recorded in male rats during sexual activity. The temperature showed a persistent increase in the presence of females and a relatively brief, rapid increase during sexual intromission. Cerebral temperature may be usable as a sensitive measure of immediate and persisting motivational effects of transitory and long-term conditions of stimulation.*

Changes in intracranial temperature accompany behavioral changes from sleep to wakefulness and responses to alerting stimuli (*1*). Such measurement of temperature is relatively simply made and provides a sensitive measure of change in the motivational state of the animal. We now report on temperature changes, measured by a thermistor implanted in the cerebral cortex of the male rat, recorded continuously before, during, and after sexual activity.

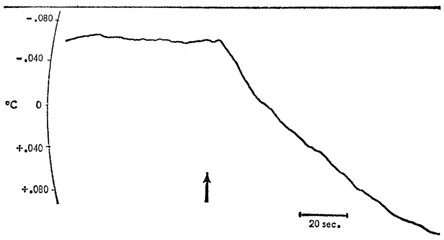

Fig. 1. Change in cerebral temperature of a male rat resulting from introduction of a female (at arrow) into same enclosure; downward deflection represents increase in temperature.