Deficit in depth perception of 90-day-old dark-reared rats¹

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Dark- and light-reared 90-day-old hooded rats were tested on the visual cliff. Dark-reared animals preferred the shallow side at 10 in., but not at 4 in., of visual depth. Light-reared controls preferred the shallow at both depths. The results show an impairment in motion discrimination from prolonged rearing without light even though gross depth discrimination remained intact.

In 1934 Lashley and Russell showed that rats reared in the dark for three months exert more force in jumping for distant pedestals than for near ones. They inferred that depth perception in the rat is innate. Walk, Gibson, & Tighe (1957) used a visual cliff apparatus to corroborate their findings, and subsequent research has replicated the Walk et al study under different conditions (Nealey & Edwards, 1960; Walk & Gibson, 1961; Carr & McGuigan, 1965).

Is this depth perception of dark-reared animals as good as that of the light-reared? Evidence, so far, indicates that it is, but this paper will show that it is not.

The visual cliff apparatus has a center board that bisects a piece of glass. Directly under one-half of the glass, the "shallow" side, is a textured pattern; the textured surface is some distance below the glass on the other side, the "deep" side. For an animal standing on the center board motion parallax differentiates the two sides; when the animal moves its head the distant and close patterns appear to move at different rates, and it descends to the "safe" surface.

The original visual cliff used a 53 in. visual depth. Subsequent research has shown that a visual depth of 10 in. is sufficient. If the deep visual surface were brought closer to the glass, a point of relative indifference should be reached. Booher (1967) constructed an apparatus that allowed the deep side to vary continuously in its approach toward the shallow side. The 75% preference point for the hooded rat was at 3 in. of visual depth; at greater visual depth, over 80% of the descents were to the shallow side. From 1/2 in. to 1-1/2 in. of differential visual depth the preference for the shallow side was about at a chance level with about 60% choice of the shallow at 2 to 2-1/2 in.

Method

The present study used Booher's apparatus. The patterns were lighted from below to eliminate any shadows as the deep side was brought toward the shallow side. An 18 x 30 in. wooden box (inside dimensions) with sides 15-1/2 in. high and a floor

of glass was bisected by a center board 4 in. high, 4 in. wide, and 18 in. long.

Below the glass on one side of the center board (the shallow side) was a 14-1/2 x 21 in. box 12 in. deep with two standard 15-W bulbs mounted on its floor. Plexiglas W-247 was on top of the box to diffuse the light, and a cloth pattern of 1 in. checks was on top of the Plexiglas. The box was held in grooves and could slide from one side to another to control for position or environmental preferences. The deep illuminance came from a 5 ft long x 3 ft wide x 1 ft deep box of plywood on rollers, with 15 15-W bulbs in it, a Plexiglas top, and 1 in. checks.

The frame for the box that enclosed the visual cliff consisted of two 7 ft long boards, supported by four legs that rested on the floor and two 30 in. boards perpendicular to them. The middle 18 in. of this frame made up the shorter sides of the cliff (parallel to the center board) while the two 30 in. boards formed the longer sides. Wooden blocks were placed under the legs of the apparatus to raise the visual cliff to the variable visual depths used in the experiment.

Our pilot-tested animals discriminated depth well at 10 in. visual depth on the deep side but not at 3 in., Booher's 75% point for shallow preference. At 4 in. a definite shallow preference appeared.

Hooded rats were reared in the dark for 90 days except for a brief interval (less than 10 min) at 40 days of age to remove the mother and place males and females in separate cages. Experimental animals were matched with adult light-reared controls, most of whom were split-litter controls. Dark-reared animals were removed in groups of four from the dark to be tested. The light-reared were also tested in groups of four. Each animal was tested twice. The animal was placed at one end of the center board and allowed 3 min to descend. Visual depth was changed after the entire group of four had been run. Balancing procedures assured that no bias was introduced by position of shallow side, first visual depth tested, or end of center board on which each S was placed. The glass was cleaned after each S's descent.

Results

The results, presented in Table 1, show that the dark-reared animals discriminate depth at 10 in. but not at 4 in. The depth discrimination of the light-reared is approximately the same at both visual depths. Fisher's exact test applied to the first re-

Table 1. Depth Perception of Dark- and Light-reared Rats with Visual Depth Varied.

Visual Depth	Descent	Light-reared (N = 24)		Dark-reared (N = 20)	
		Response	%	Response	%
4 in.	Shallow side	10	71	1	11
	Deep side	4	29	8	89
	No descent	10	—	11	—
10 in.	Shallow side	9	75	5	83
	Deep side	3	25	1	17
	No descent	12	—	14	—

Note: Percentage figured only on actual descents.

sponses only of the dark-reared animals (to avoid an inflated N) shows a significant difference ($p < .05$) for the dark-reared on the 4 in. as compared to the 10 in. visual depth. The responses of the dark-reared also differ significantly from those of the light-reared to the 4 in. depth ($p < .02$). Light- and dark-reared do not differ significantly at the 10 in. depth; both choose the shallow about 80% of the time.

Table 1 also shows a definite preference for the deep side in the dark-reared animals at the 4 in. depth. We have no explanation for this and must assume, tentatively, that it is a chance finding since illumination of the two sides was equal and other factors were controlled.

After two weeks in the light, the dark-reared and some of the light-reared were run again. A method to induce more descents without frightening the animals was devised by one of us (EKB). A long narrow pan of cold water was placed on a lower center board with a total descent distance to the glass about the same (3 in.). The dark-reared made six shallow descents and six deep descents at 4 in. visual depth along with eight no descents. At 8-1/2 in. visual depth there were 13 shallow and 2 deep descents and five no descents. The light-reared (N=13) made 10 shallow and three deep descents at 4 in. and seven shallow, four deep, and two no descents at 8-1/2 in. of visual depth. Order of testing was counterbalanced. The results after two weeks in the light corroborate the findings secured on first emergence from the

dark: impairment in finer motion discrimination but none in grosser discrimination.

Discussion

These results from sensory deprivation are related to research on the normal development of depth perception. Human infants less than 10 months of age are more likely to be coaxed across the deep side of the visual cliff than are 10-12-month-old infants. The difference appears for lesser visual depths (10 or 20 in.), but not for greater (40 in.) ones (Walk, 1966). Ames & Silfen (1965) have shown the development of preferences for moving patterns in young infants, seven to 24 weeks old. The older infants showed better discrimination of motion than did the younger ones. Both experiments would appear to show the development of sensitivity to motion in the infant.

The present experiment cannot determine whether dark-rearing inhibits the development of motion discrimination in the rat or whether dark-rearing atrophies the innate mechanisms. The technique employed does, however, lend itself to solution of this problem.

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Note

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