Two types of depth discrimination by the human infant with five inches of visual depth[1]

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Infants 6½-15 months of age were tested on the visual cliff with the textured visual surface 5 in. below the glass. Infants were called by the mother from the bisection of shallow and deep sides or from across the deep side. The bisection condition was a threshold in that only 73% of the infants went to the shallow side compared to over 90% at greater visual depths. Most infants could be coaxed across the deep side at 5-in. visual depth, a big change from the 10-in. visual depth, particularly for infants over 10 months of age, few of whom crossed the deep side with 10-in. visual depth.

This experiment stemmed from the use of different experimental procedures to investigate depth perception, and thus it is an attempt to resolve questions raised by earlier visual cliff research with the human infant. The early visual cliff research had the mother try to coax the infant across the deep side (Walk & Gibson, 1961). Very few (11%) were able to do so. Subsequent research confirmed this finding as long as definite visual patterns were used on both the shallow and deep sides of the visual cliff. However, as the deep side pattern was moved closer to the glass (20 in., 10 in., rather than 40 in.), more and more infants could be coaxed to the mother, particularly infants less than 10 months of age, though even at 10-in. visual depth only 38% of the children crossed the glass to the mother (Walk, 1966). Could infants less than 10 months of age discriminate depth at these lesser depths? To answer this question, infants were called by the mother from the end of the center board or the bisection of shallow and deep sides, as in Fig. 1, rather than being coaxed across the deep side, as in Fig. 2. Under all conditions tested infants with the bisection condition chose the shallow side over 90% of the time. The question then arose: where will the overwhelming choice of the shallow side break down, i.e., where is the threshold? Five inches of visual depth was chosen. Second, will the "younger" infants make "mistakes" with this new procedure? As an experimental control, an approximate equal density condition was included along with the regular one. Also, to compare with earlier experiments, infants were also coaxed across the deep side since so few infants were coaxed to the mother at 10-in. visual depth.

PROCEDURE

The infant was placed on the wide end of the center board and called by the mother from the narrow end (Fig. 1). To reach the mother the infant was almost forced to leave the center board and crawl to her over the shallow or the deep side of the visual cliff. If he did not crawl to her within 3 min he was called by the mother from the shallow side. Normally, infants reached the mother as she stood at the narrow end of the center board. They were then replaced on the wide end of the center board and called by the mother from the deep side, then again replaced on the center board and called to her from the shallow side. The infant was next placed on the glass over the deep side and called by the mother from the shallow side; this was followed by placement on the shallow side with the mother calling him from the deep side. On the last trial he was again put on the wide end of the center board and called by the mother from the narrow end. The last trial was usually monocular, using an elastic eye patch with a small disposable gauze bandage beneath it. The only portion of the experiment reported here is the initial choice trial and the subsequent trial when the mother called from the deep side. The monocular data, combined with monocular data from other experiments, has been reported elsewhere (Walk, 1968).

APPARATUS

The visual cliff was an enclosed box that measured 8 x 6 ft and was 40 in. high. The shallow side pattern, directly under the glass, was either

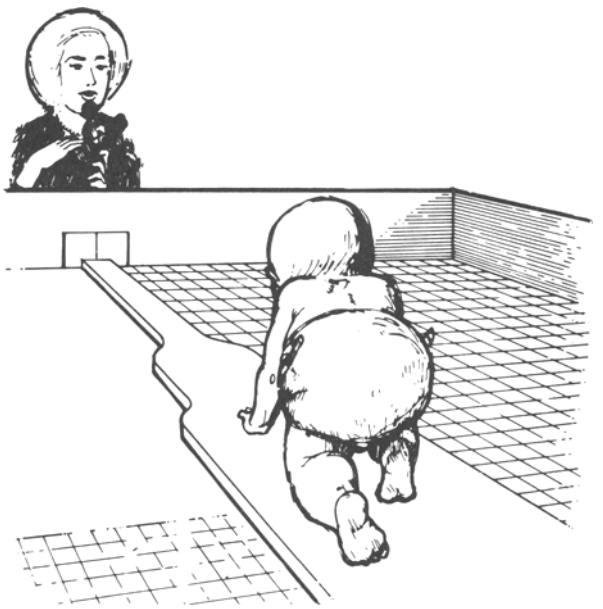

Fig. 1. Mother calls to infant with the bisection condition.

¾-in. red and white checks (unequal density) or ¼-in. red and white checks (an approach toward equal density, though actually with much coarser projected density from the deep side). The ¼-in. pattern was also included as a comparison with prior research. The deep side pattern was ¾-in. red and white checks 5 in. below the glass for the main part of the experiment, although comparison is made with other experiments where the same pattern was 10 in., 20 in., or 40 in. below the glass. On top of the glass a center board bisected the glass into two equal segments. It was 14 in. wide at one end and tapered to 3 in. wide at the other end. An 8-in.-high border surrounded the apparatus to keep the infant from falling off accidentally. Illumination was through cotton sheeting to diffuse the light and minimize reflections. A Weston Master V light meter that measured light directly reflected off of the patterns had a reading of 1.3 ft-c on both shallow and deep sides. The apparatus is diagrammed in Walk (1966).

SUBJECTS

A total of 86 infants from 6½ to 15 months of age were the Ss. The average age was 10.2 months (median 10.0 months), standard deviation 1.9 months. Fifty-two infants had the standard condition (¾-in. shallow pattern) and 34 the other condition (¼-in. shallow pattern).

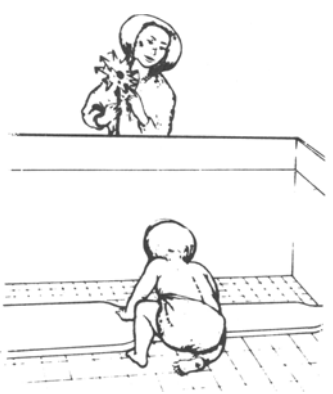

Fig. 2. Mother tries to coax infant across the deep side.

Table 1
Choice of Shallow or Deep Side for the Bisection Condition as a Function of Visual Depth
(¾-in. checked pattern on both shallow and deep sides)

Visual Depth	Effective N	Choice of Shallow	Deep	Per cent Shallow
5 in.	41	30	11	73%
10 in.	28	26	2	93%
20 in.	32	32	0	100%
40 in.	22	21	1	95%

Note: Effective N only includes infants who crawled to mother and left board to either shallow or deep sides.

RESULTS

Bisection Condition

As Table 1 shows, only 73% of the infants crawled to the shallow side with the 5-in. depth when the ¾-in. pattern was under the shallow side. Five inches thus represents an approximate threshold for differential visual depth perception for the human infant. The 5-in. condition, as compared to the other conditions listed on Table 1, is highly significantly different ($\chi^2 = 12.34$, $p < .001$); yet, the babies still choose the shallow side significantly more often than the deep side ($z = 2.81$, $p < .01$).[2] The ¼-in. pattern condition, surprisingly, gave 88% choice of the shallow side (21 shallow, 3 deep, 10 did not move from the center board of the 34 tested). However, the ¼-in. pattern condition did not give results significantly different from the regular condition so it is difficult to evaluate whether this has any significance.

The overall age differences were in the expected direction but far from statistically significant. The average age of the infants choosing the shallow side was 10.3 months, of those going to the deep side 9.8 months. A significant age difference did appear when the eye patch was put on; then more young infants went to the deep side. This has been reported previously as part of the monocular study (Walk, 1968).

Coaxing Condition

While the overwhelming initial choice was toward the shallow side, most of the Ss were later coaxed across the deep side. With the regular ¾-in. pattern on the shallow side 82% of the Ss were coaxed across the deep side and 86% of the Ss went to the mother at the deep side with the ¼-in. shallow pattern. The most interesting aspect of these data is shown in Table 2 where comparable conditions, with only visual depth varied, are given. The ¾-in. pattern on the shallow side is held constant and visual depths of 0 in., 5 in., 10 in., 20 in., and 40 in. are represented. The age condition is particularly interesting here. At very definite depths (40 in.) infants older than 10 months of age and younger than that are similar: few cross to the mother. By 20 in. of visual depth more infants crawl to the mother at the deep side and the younger and older infants begin to diverge. The only significant difference, however, is at 10 in. of visual depth. Here 65% of the younger infants and only 21% of the older infants cross the deep side to the mother. By 5 in. of visual depth the two groups are almost similar again and the same for the 0-in. condition. Essentially, a threshold for motion sensitivity seems to have been crossed for the younger infants at 10 in. of visual depth and they begin to disregard visual cues and crawl to the mother. For the older infants this threshold is not reached until 5 in. of visual depth.

Table 2
Infants Coaxed by Mother to the Deep Side as a Function of Visual Depth and Chronological Age
(¾-in. checks on both shallow and deep sides)

Visual Depth	N	Crawled deep No Go	Young	Old	Per cent Young	Old	P
40 in.	63	11	2	2	8%	7%	–
20 in.	63	11	8	6	32%	22%	–
10 in.	63	10	13	7	65%	21%	< .01
5 in.	50	6	12	24	92%	77%	–
0 in.	19	2	7	10	100%	83%	–

Note: "Young" is less than 10 months (300 days) of age; "old" is 10 months of age and more.

DISCUSSION

The most important finding of this experiment is its demonstration of multiple thresholds. The threshold for the bisection condition is at 5 in. of visual depth while the threshold for the coaxing condition is at 10-in. visual depth.

At 5 in. infants in the bisection condition begin to lose the overwhelming preference for the shallow side that was previously observed for visual depths of 10 in., 20 in., and 40 in. The preference drops from over 90% choice of the shallow side to 73%. Chronological age did not appear to be so important for the 5-in. bisection condition when infants were tested binocularly, but age was important for infants monocularized with an eye patch.

The 10-in. visual depth is sufficient for infants less than 10 months of age to be coaxed across the deep side. Older infants require about 5 in. of visual depth. The age difference must reflect the development of motion discrimination. This motion discrimination becomes precise enough so that older infants distinguish between the dangerous drop of 10 in. and the harmless 5-in. distance. Very precise discrimination is shown, precision not present until the infant is about 10 months of age.

We know from other research (Bower, 1966; Fantz, 1961) that human infants have some depth perception before they can crawl. The present studies confirm this by finding no age effects in the bisection condition when the visual depth is 10 in. or more. Here, infants of all ages almost unanimously crawl to the shallow side. The weakness shown near thresholds in the dynamic crawling situation of free locomotion fits in with observations of mothers who frequently report that their children crawl off places like beds and would injure themselves if unrestrained. The present experiment shows that such carelessness is partially based on a visual weakness and not entirely on such factors as poor locomotion or lack of foresight. By working near thresholds the researcher can discover the organismic factors (such as age, monocular vision) that interact with stimulus conditions during the development of depth perception.

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NOTES

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2. "Chance" for the bisection condition must be, by definition, 50% since only infants that crawl to either shallow or deep sides are represented. The coaxing condition has no way of assessing "chance" performance.