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THE VISUAL DEPTH PERCEPTION IN THE HUMAN INFANT ON THE VISUAL CLIFF

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Two infants were tested on the visual cliff. An infant 5 months of age, that is, 1 and a half months before he can crawl, whom we started to test on visual the cliff from 4 months of age, behaved negatively to the deep side. Another infant, 13 months of age, was not frightened at the deep side at all, though she seemed to discriminate the depth to some degree.

PROBLEM

The visual cliff is a way to examine the depth perception of human infants. Using it, it is reported that the average human infant discriminates depth as soon as it can crawl (Gibson & Walk, 1960; Walk & Gibson, 1961). And very precise discrimination is said not to be present until the infant is about 10 months of age (Walk, 1969; 1969). It is also reported that the experience of falling from a high position is connected with the development of the visual depth perception (Kume, 1968). In these studies the subjects were limited to infants who can crawl or move about by themselves.

On the other hand, there are some reports that human infants have some depth perception before they can crawl (Bower, 1966).

Once I examined 10 infants, who were 10 months old and could scarcely crawl, on the visual cliff. The negative response to the deep side; *e.g.*, being petrified or crying, was observed already.

Then the problem is that at what time is the behavior observed which suggests the perception of depth in the developmental process, when the infants who could not crawl were shown the deep side. So an infant was subjected to the follow-up experiment from 4 months of age, intended to catch the change of behavior on the visual cliff (case I).

In addition, whether the infant went across the deep side or not seemed to depend upon a lure in some degree. Another case was added as a reference to consider the matter (case II).

On the other hand, the heart rate (HR: beats per minute) is noticed to be decelerated in the infant's eye fixation. As it is thought that the change of the HR may suggest that the subject recognizes the change of the stimulus, the HR was recorded here as well as the observation of infant behavior on the visual cliff.

METHOD

Apparatus

The visual cliff was an enclosed table that measured 200×130 cm and was 90 cm high. The cliff table had the checked patterns directly under the glass on each side, one of which patterns can be moved out easily to make the deep side. It seemed that the response of infant to the cliff could be caught more accurately by this; that is, the subject on the center board would see both sides as shallow at first, and then find that the one side had changed suddenly to the deep side.

The shallow side pattern and the deep side pattern were both 10 cm black and white checks. A center board on the glass bisected the glass into two equal segments. It was 30 cm wide and 3 cm high, and which was covered with the same checked pattern. The 16 cm high boards surrounded the cliff table to keep the infant from falling off accidentally.

Nihon Kohden AD 2-22 type DC amplifier coupled with a Nihon Kohden APB-20 type biophysical preamplifier was used to record the heart beats. The ECG was recorded with 2 sec in time constant from Nihon Kohden adhesive type silver electrodes, 1 cm in diameter, which were attached to the right and left infrascapular regio.

Procedure

The infant before he could move about by himself was subjected to the following test procedure.

First of all, the infant took the Gesell's developmental examination of behavior. And then the electrodes were attached to the infant while being held on his mother's lap, from that time on heart beats were continuously recorded. He was placed on the center board of the cliff table lying on his belly to look at the shallow side which would change to the deep side. Soon after he looked about, the pattern directly under the glass was moved out quickly and the deep side appeared. The behavior of the infant was observed during the time. Then he was held on his mother's lap and his heart beats were recorded for about 3 minutes as the post control data.

The infant after he could creep was subjected to the following test procedure.

The infant took the Gesell's developmental examination of behavior. And the electrodes were attached to him while being held on his mother's lap, from that time on heart-beats were continuously recorded. Then, in order to accustom him to the apparatus, he was allowed to play freely on the cliff table which apparently had the same shallow sides in both directions. He was placed on the center board on all fours and called by the mother standing at either side. If the infant got off the board and reached the mother at either side, he was put back on the board. Then the pattern directly under one side of the glass was moved out quickly and the deep side appeared. After about 1 minute, the mother at the deep side called the infant, and he was observed for 2 minutes. Then he was held on his mother's lap and his heart beats were recorded for about 3 minutes as the post control data.

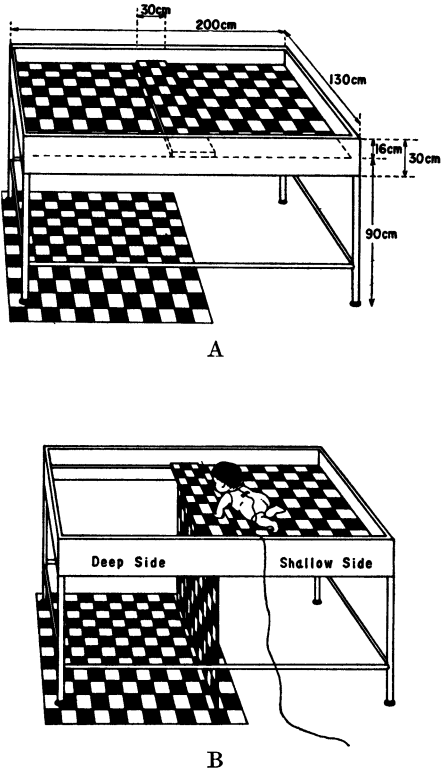


Fig. 1 Apparatus of the visual cliff — A: both sides are shallow; B: the one side changes the deep side.

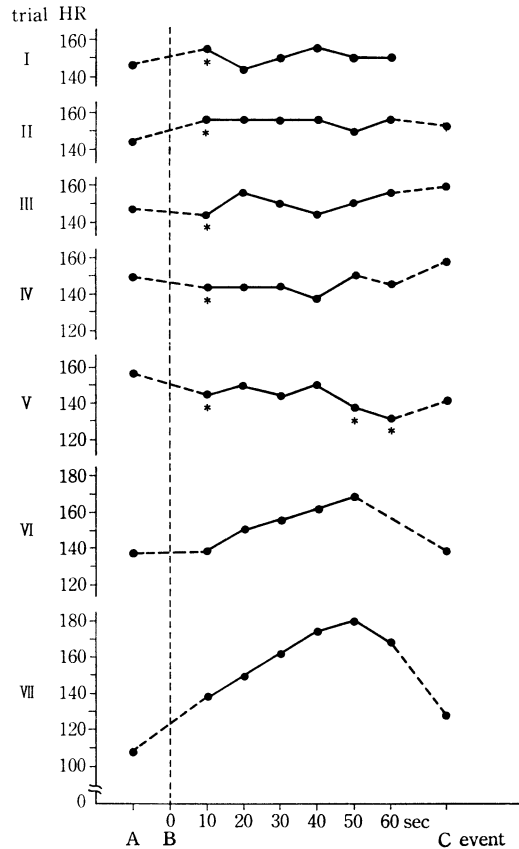


Fig. 2 The heart rate (beats per minute) of S_1 — A: on the center board before the deep side appears; B: the deep side appears; C: the post control; *: the time he stares the deep side.

Subject

Two infants were the subjects. One was a boy, 4 months old, whose mother permitted the follow-up study to 12 months old. He was examined 7 times about once every month. The other was a girl, 13 months old, who was examined 3 times once every month.

RESULTS

Case I

Subject S₁: Boy. The experiment was started at 4 months of age, when the infant could hold his head sustainedly lifted with the chest up, lying on his belly for a while. From that time to 12 months of age the experiment was repeated 7 times about

once a month. His DQ by Gesell's developmental examination of behavior was 121 when he was 4 months old. He began to crawl when he was 6 months old. Soon after that time he fell, according to the mother, from a floor about 50 cm high on to the hard ground with his walking crib and he cried extremely.

Trial I — 4 months (19 weeks) old

Development of motor behavior: Holds the head sustained, lying on his belly.

Behavior on the visual cliff: (Both are shallow sides) — lying on his belly, he looks about cheerfully. (Deep side appears) — he looks about cheerfully in the same way, and little change is found in his overt behavior, even when he looks down into the deep side.

HR: As soon as the deep side appeared, the HR was accelerated. When the infant was looking down, the HR decelerated, and soon recovered (see Fig. 2).

Trial II — 5 months (22 weeks) old

Development of motor behavior: Rolls. Sits with support.

Behavior on the visual cliff: (Both are shallow sides) — babbles cheerfully lying on his belly. (Deep side appears) — babbles cheerfully at first, and begins to fret 1 minute later; he cries and looks down, putting his trunk on the center board and his hands on the glass of the deep side.

HR: As soon as the deep side appeared, the HR was accelerated.

Trial III — 6 months (27 weeks) old

Development of motor behavior: Sits alone. Creeps backward (not forward).

Behavior on the visual cliff: (Both are shallow sides) — pats on the glass with his hand cheerfully, lying on his belly. (Deep side appears) — fixes his eyes on the bottom of the deep side, and creeps backward little by little after 50 seconds, with an expressionless face.

HR: As soon as the deep side appeared, he fixed his eyes on the bottom of the deep side, when HR was decelerated.

Trial IV — 6.5 months (29 weeks) old

Development of motor behavior: Creeps forward unskillfully from a few days before. Stands holding furniture.

Behavior on the visual cliff: (Mother at either shallow side) — creeps forward little by little to the middle of the shallow side. (Deep side appears) — stares at the deep side; then the babbling is changed to the fretting; creeps back a little to the shallow side, and turns 90 degrees along the center board. (Mother at deep side) — stares at the deep side, frets, and cries; does not get off the board.

HR: As soon as the deep side appeared, he stared at the deep side, when the HR was decelerated.

Trial V — 7 months (31 weeks) old

Development of motor behavior: Creeps well.

Behavior on the visual cliff: (Mother at either shallow side) — creeps across the

shallow side to the mother soon. (Deep side appears) — fixes his eyes on the bottom of the deep side, creeps back one-and-a-half minutes later. (Mother at deep side) — lifts his hip up and down on all fours, looking at the bottom of the deep side and at mother's face as if he wants to go, but keeps the edge of the center board in the hand, so can't move forward; then frets and cries soon.

HR: When he fixed his eyes on the bottom of the deep side, the HR was decelerated.

Trial VI — 8 months (35 weeks) old

Development of motor behavior: Pulls to stand by furniture. Creeps well.

Behavior on the visual cliff: (Mother at either shallow side) — creeps across with a smile instantly to the mother. (Deep side appears) — at this moment, the babbling stops and he fixes his eyes on the bottom of the deep side. (Mother at deep side) — looks down at the deep side and at the mother, with an unpleasant voice; lifts his hip up and down on hands and kness, but does not go forward; holds out his hand toward the mother, as if he asks for help; then leans forward and happens to touch the glass; soon after he finds that he does not fall down, he creeps across the deep side to the mother.

HR: The HR was accelerated gradually, and was enhanced when he held his hand toward the mother.

Trial VII — 12 months (52 weeks) old

Development of motor behavior: Walks alone, and seldom creeps.

Behavior on the visual cliff: (Mother at either shallow side) — creeps across to the mother immediatly. (Deep side appears) — stares at the deep side on hands and knees, and cries after 20 seconds. (Mother at deep side) — goes on crying, looking at the deep side and the mother by turns, and does not try to go.

HR: The HR was accelerated at the instant the deep side appeared, and kept on elevating because of S_1 's crying.

Case II

The experiment was not done before the infant crept in this case, and the experimental condition was not controlled enough. Nevertheless, this was taken, for her behavior on the visual cliff was interesting as infant behavior.

Subject S_2 : Girl. The experiment was started at 13 months of age (DQ: 120), and continued 3 times once a month, to 15 months of age. She began to crawl from 11 months of age, and soon after that she fell, according to the mother, from a passage about 50 cm high on to the ground, and she cried extremely.

Trial I — 13 months (56 weeks) old

Development of motor behavior: Stands up alone. Walks a few steps.

Behavior on the visual cliff: (Mother at either shallow side) — creeps across to the mother soon. (Deep side appears) — sitting on the center board, plays with blocks;

after 20 seconds looks at deep side and stares at the bottom of it, and throws the blocks to the deep side; then cackles for pleasure to see the blocks bounding on the glass of the deep side. (Mother at deep side) — stands up on the center board, walks a few steps to the deep side, the same as she walks on the shallow side without fright, sits down on the deep side near the mother, and plays with the blocks.

Trial II — 14 months (61 weeks) old

Development of motor behavior: Walks alone stiffly. Walks up and down stairs with one hand held.

Behavior on the visual cliff: (Mother at either shallow side) — walks across to the mother. (Deep side appears) — sitting on the center board, looks at the deep side but seems not to be frightened at it. (Mother at deep side) — When the mother calls the

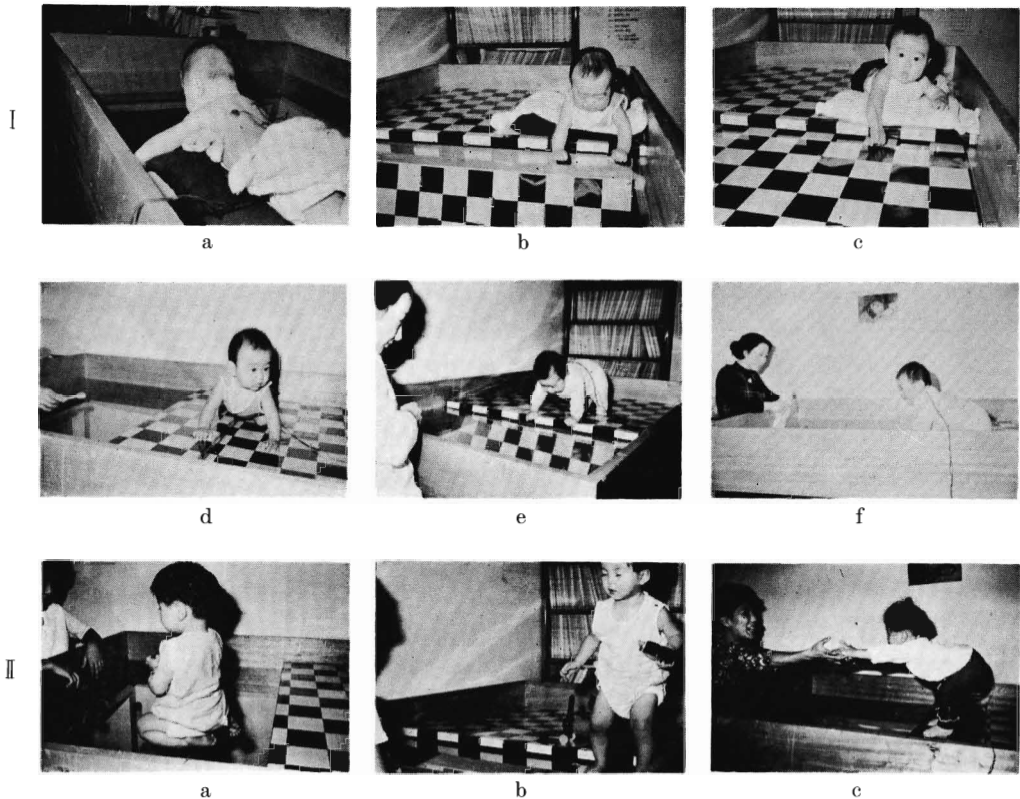


Fig. 3 The infant behavior on the visual cliff — I: *subject S₁* a: (4 months old) — looks about cheerfully; b: (5 months old) — cries and looks down, putting his hands on the glass; c: (6 months old) — pats on the glass with his hand cheerfully, when both are shallow sides; d: (6.5 months old) — creeps back and turns 90 degrees; e: (7 months old) — lifts his hip up and down, keeping the edge of the center board in the hands; f: (12 months old) — stares at the deep side and cries.

II: *subject S₂* a: (13 months old) — sits down on the deep side and plays with the blocks; b: (14 months old) — walks across the deep side; c: (15 months old) — standing on the center board, she holds out her hands towards the mother.

infant, showing her the blocks as a lure, she stands up on the center board and walks across the deep side to the mother, the same as she walks on the shallow side; then she gets the blocks from the mother, sits on the glass of the deep side and plays with the blocks.

Trial III — 15 months (65 weeks) old

Development of motor behavior: Walks alone and seldom falls. Runs stiffly.

Behavior on the visual cliff: (Mother at either shallow side) — walks across to the mother. (Deep side appears) — walks to the shallow side without noticing the deep side. (Mother at deep side) — When the mother calls her, she comes back to the center board, and stares at the deep side; standing on the center board, she holds out her hands towards the mother to grasp the mother's hands, but does not step down to the deep side; as the mother calls her again, she holds out her hands, and grasps the mother's hands at last; then steps down to the deep side readily and walks across the deep side to the mother; after coming to the mother, she walks about on the glass of the deep side freely, without holding the mother's hands.

The ECG was recorded in these 3 trials, but the data was omitted from this paper, because the change of the HR at the time when the deep side appeared could not be caught clearly.

DISCUSSION

In the former visual cliff study, the subjects were limited to the infants who can move about by themselves. On the other hand, a subject (S_1) in this study, who was shown the deep side from 4 months of age, could not crawl yet. The negative behavior to the deep side was observed from the age of 5 months, when the subject could not crawl and had no falling experience yet. He was usually cheerful when lying on his belly, and the overt attachment behavior to the mother was not found yet at this time. So it seemed that he cried, not because of discomfort in position or separation from mother, but because of fear of depth he perceived.

He crawled backward as he found the deep side when 6 months old. At this time he could crawl not forward but only backward. But he didn't crawl and was cheerful on either shallow side, and on the other hand, when shown the deep side, he became not cheerful and crawled backward. So this was seemed avoidance response to the deep side. From that time on, avoidance response to the deep side was consistently observed in him.

In this case, the HR was accelerated, as soon as the deep side appeared, at the age of 4 and 5 months, but it was decelerated after the age of 6 months. Whether the change of the HR at the age of 4 months is connected with the perception of depth or not is uncertain. But it can't be denied that such HR change may suggest the perception of depth.

It was suggested that the depth perception was possible to some degree in the human infant before he crawled, by the age of 5 months as in this case, and that

regardless of the falling experience, though there was only one subject in this study.

The case of S_2 , though the control of experimental conditions was not good enough, is a sample in which the behavior on the visual cliff was thought to be closely connected with a lure.

She seemed not to be frightened by the deep side and did not avoid it at the age of 13 months and 14 months, even though she began to creep from a few months before, and that she had once fallen down to the ground. But it was not thought that she could not perceive the depth. In the trial I, she was given the blocks which pleased her when she played on either shallow side while becoming accustomed to the apparatus, and the deep side appeared when she had the blocks in her hands. Then she threw all the blocks not to the shallow side but to the deep side. In the developmental examination of behavior before the experiment, she threw the toys not to the table but to the floor. This behavior suggested that she found the deep side lower; that is, she could discriminate the depth. And she might have found that there was the glass over the deep side, for she cackled for pleasure to see the blocks bounding on the glass, but it was very doubtful if she considered it to be safe on the glass. As she didn't behave carefully at all when she stepped down to the deep side where the blocks were, the deep side must not be dreadful to her after all.

When she was 14 months old, she walked indifferently across the deep side to get the blocks which the mother offered as a lure.

It seemed that the infant walked indifferently across the deep side in these trials because she was absorbed in the lure and could not notice the other surroundings.

What the infants are interested in, or lures, are individually different, and even in the same child, they are also different at different stages in the developmental process. After all, if the infant creeps indifferently across the deep side, it cannot be said that he cannot discriminate the depth.

CONCLUSION

- 1) Human infants have some depth perception before they can crawl, even if they have no experience of falling.
- 2) There may be individual difference, but in the case of S_1 , the depth perception is possible to some degree by the age of 5 months.
- 3) And when a lure is attractive, the infants who can crawl already may go across the deep side, even if they can discriminate the depth.

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