bottom to 4000 years near the top. The lateral extension of the peat is only several feet wide and was laid down in bogs far offshore during the entire duration of the Lake Chippewa low-water stage. At Michigan City, 5½ feet of organic fossiliferous clays and some shallow-water sands were deposited above the yellowish-gray clays in shallow lakes and marshes during the later part of Lake Chippewa time, between 6300 and 5475 years ago. The shoreline of Lake Chippewa has shifted probably a few miles to the west into the present Lake Michigan. Numerous grass fragments and the presence of the ostracod genus *Cyclocypris* strongly suggest marsh environment.

Dated shallow-water deposits of the Lake Chippewa low-water stage are exposed at both localities. The lake level was about 280 feet below the present level then. The extensive outcrops of the blue fossiliferous clays in Michigan City are remnants of a shallow-water deposit which was much more extensive than the peat-producing bog near South Haven. The lakes which developed in shallow depressions on older beach sands were dammed up by former fore-dunes and overflowed or drained out through the dunes into Lake Chippewa. The subsequent rise of the water level to the Lake Nipissing stage, about 25 feet above the present lake level, must have caused extensive erosion of the clays. The final drop of the lake level from the Algoma lake stage to the present lake level about 2500 years ago renewed the erosional process of the clays. Recent construction of jetties and breakwaters intensified erosion at the Michigan City harbor near the clay outcrop (*6*).

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Visual Depth Perception of a 10-Month-Old Monocular Human Infant

Abstract. A monocular infant tested on the "visual cliff" crawled over glass which had a patterned surface just beneath it and would not cross glass which had the same pattern 40 inches below its surface. Since this infant, using only monocular visual cues, was able to discriminate depth, the experiment disproves a general belief in the primacy of binocular cues in depth perception.

It is a "common sense" view that binocular vision is necessary for proper depth perception. Binocular disparity can be shown, by itself, to yield an impressive depth effect through the use of stimulus cards in a stereoscope. While stereopsis can be a sole determinant of depth, it is not necessarily the only or the primary determinant of depth perception in everyday life. Textbook writers usually list both binocular cues (binocular disparity and convergence) and monocular cues (monocular parallax, accommodation, aerial perspective, linear perspective, and so forth), and rarely try to assess the importance of each. Ophthalmologists are more prone to stress the primacy of binocular cues (*1*); psychologist J. J. Gibson (*2*) has stressed for a long time the importance of monocular factors—in particular, monocular motion parallax and differential gradients of texture in the environment.

Gibson and Walk have used the "visual cliff" to show that binocular human infants can discriminate depth as soon as they can crawl (*3*). Our investigation was an empirical one to determine whether a monocular infant can discriminate depth on the visual cliff. This infant's ability to discriminate visual depth may help disprove a general belief in the primacy of binocular factors.

The visual cliff apparatus for testing infants is a large, hollow, rectangular box topped with glass, 8 feet long by 6 feet wide and 40 inches high. The inside surface of the box (bottom and four sides) is painted gray; the top is covered with ½-inch thick Herculite glass. A 12-inch wide center board divides the glass into two segments each about 4 by 6 feet. Flush under the glass on one side of the center board (the "shallow" side) is a checked pattern. The same pattern is placed 40 inches below the glass on the other, the "deep," side.

Only visual cues differentiate the "shallow" and the "deep" sides. Tactual, auditory and olfactory cues are equalized by the glass. Since the apparatus is enclosed on the deep side, no familiar objects, such as the feet and legs of the mother, serve as cues to distance. Motion parallax and texture density remain. The gray sides of the apparatus project a fairly homogeneous, indefinite texture. While surface textures on the deep and shallow sides are the same, the surface texture on the deep side projects a finer optical texture.

The female infant was 10½ months old when tested. Cancer (retinoblastoma) had necessitated surgical removal of her right eye when she was 5½ months old. This eye had been blind for an unknown period before the operation. A tumor from the left (sighted) eye had been removed 1 week before the right eye was removed.

During testing the infant was placed on the center board; the mother called her alternately from the shallow and the deep sides. When the infant was placed on the board from the west, the sighted eye was toward the deep side; when she was placed on from the east, the eye was toward the shallow. The mother twirled a tinkling pinwheel and urged the infant to come to her. The procedure follows:

Trial 1. (Infant placed on center board in a sitting position from the west. Mother called from shallow side.) The infant immediately crawled off the center board, over the shallow side, and reached the mother 15 seconds after the start of the trial.

Trail 2. (Infant placed on board from west. Mother called from deep side.) The infant crawled onto the shallow side at once and reached the pinwheel in 12 seconds. The mother called again from the deep side. She went back toward the mother, looked down into the "void," and backed away. She watched the pinwheel being twirled by the mother and reached a hand toward it. Then, she started crawling around on the shallow side and continued until the trial terminated at 3 minutes.

Trial 3. (Infant placed on board from east. Mother called from shallow side.) The infant looked over quickly to the deep side, crawled off the center board, and reached the mother within 5 seconds.

Trial 4. (Infant placed on board from east. Mother called from deep side.) The infant crawled immediately onto the shallow side. She alternated between crawling to the center board,

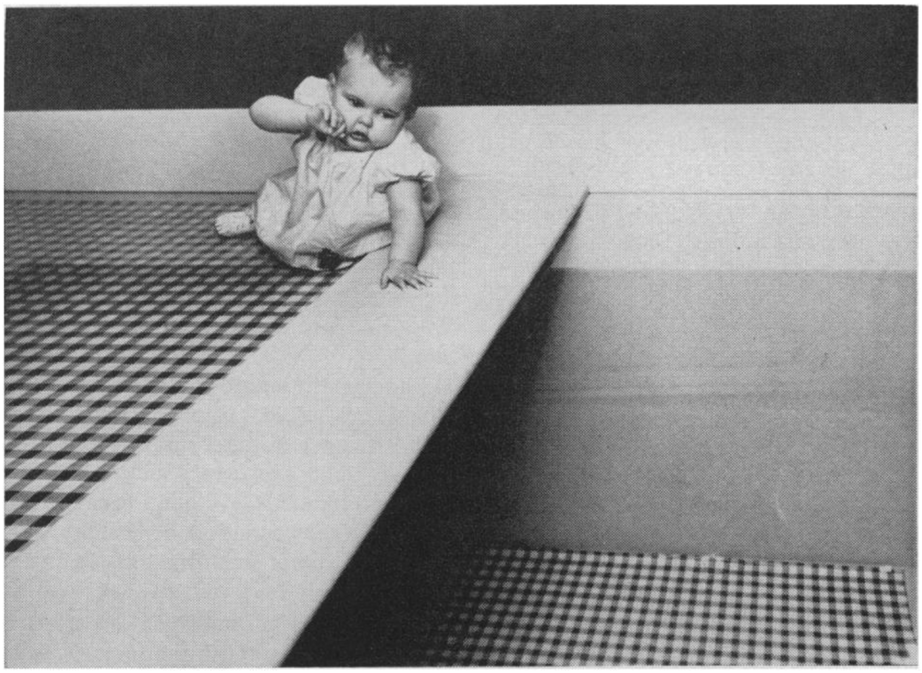

Fig. 1. The infant (the right eye is glass) refuses to cross over the "deep" side to the mother. The photograph was taken 1 week after the experiment. Most of the photography time (30–40 minutes) was spent in calling the infant from the deep side. However, she never crossed the "void" and crawled to the mother at the "shallow" side only.

reaching toward the mother at the deep side, and crawling around on the shallow side. The trial terminated at 3 minutes.

Before the start of trial 5, the mother decided that a nursing bottle, filled with orange juice, would be a better lure. The infant was given a sip and then was placed back on the center board from the west.

Trial 5. (Mother with nursing bottle called from shallow side.) The infant crawled to the mother within 5 seconds.

Trial 6. (Infant placed on board from west. Mother with nursing bottle at deep side.) The infant crawled immediately to the shallow side. When urged by the mother, she crawled back to the center board and looked down. Then she crawled to the experimenter standing near the shallow side and put her arms around his neck. He replaced her on the center board and the mother continued calling. The infant became very upset as the mother urged her to cross the deep side. She began to whimper and then to cry. The trial terminated at 2 minutes.

This monocular infant thus behaved similarly to the average binocular infant. She crawled to her mother over the shallow side, but would not cross the deep side. She looked down into the "void" many times and, in doing so, did not move her head excessively (Fig. 1).

The behavior of this infant is also congruent with the behavioral pattern of animals. The monocular 1-day-old chick and the 60-day-old hooded rat can discriminate depth in a manner comparable to their binocular controls, even when a larger pattern (larger projected texture) is used on the deep side. This feature permits monocular motion parallax to be the main cue (*4*).

Our experiment, therefore, demonstrates that monocular cues suffice for efficient depth perception and may help explode a "common sense" myth about the primacy and necessity of binocular vision for depth perception (*5*).

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Operant Conditioning of Heart Rate

Abstract. Delay of shock was made contingent upon acceleration of heart rate in human subjects. The number of accelerations rose across sessions for these subjects and fell for their yoked-controls who received equal amounts of noncontingent shock. A shorter delay produced more accelerations but faster adaptation. Interpretation of changes in heart rate is confounded by related respiratory changes.

While feedback would seem to characterize autonomic behavior in the biological system (*1*) little research has been directed toward the use of feedback of external origin. Practically all exteroceptive control of the heart in the laboratory has involved classical conditioning (*2*) despite the striking efficiency of operant conditioning in differentiating skeletal response rate, magnitude, and form.

In the work I am describing, I used operant conditioning techniques as a first step toward differentiation of human heart rate in which the selected response was a temporary acceleration (*3*). Because the research was an initial attempt to manipulate heart rate through response-contingent techniques, the strategy was one of an unhampered attack on heart rate alone. Therefore, while respiration was recorded, no attempt was made to control it.

The procedure employed a modified Sidman-avoidance schedule similar to that used by Verhave (*4*). In the Sidman procedure, shock pulses are delivered at regular intervals (designated SS intervals) unless a lever is depressed by the animal. Depressing the lever delays shock for a specified time. No external warning signal is used. In my research five responses (heart beats) had to occur within a criterion interval in order to postpone shock. Shock was delayed for a time equal to the SS interval. Because of the drifts in heart rate during sessions, average heart rate over the preceding few minutes was used to establish a criterion interval in which five beats had to occur to postpone shock. The criterion time was arbitrarily selected as 5 percent below the average time required for five beats during the preceding period.

Subjects were allowed to watch an illuminated reset timer which timed the SS interval, resetting and delaying shock whenever criterion accelerations in heart rate occurred. A 0.34-second, 18-volt alternating current was delivered to the ankle through an initial skin re-