hand, results of twin studies, such as those of Bouchard and Lykken suggest that "the cloned person may, under certain circumstances, be seen as surviving, to some degree, in the clone.... However... rather than warranting concern, the potential for survival by cloning ought to help protect against the misuse of the technology" (Agar, 2003, p. 9). In a separate study examining the issue of identical twins and cloning (Prainsack & Spector, 2006), researchers found that identical twins rarely consider the genetic aspects of their real-life experience of being identical twins. In addition, from a personal perspective, they did not view the idea of human cloning as unnatural or immoral but were more concerned about the ethics underlying the *reasons* for human cloning. Of course, this is philosophical discussion so far, but as the prospect of human cloning looms ever closer, it becomes increasingly important and interesting food for thought.

Agar, N. (2003). Cloning and identity. *Journal of Medicine and Philosophy, 28,* 9–26.

Arvey, R., Bouchard, T., Segal, N., & Abraham, L. (1989). Job satisfaction: Environmental and genetic components. *Journal of Applied Psychology, 74*(2), 187–195.

Arvey, R., McCall, B., Bouchard, T., & Taubman, P. (1994). Genetic influences on job satisfaction and work value. *Personality and Individual Differences, 17*(1), 21–33.

Billings, P., Beckwith, J., & Alper, J. (1992). The genetic analysis of human behavior: A new era? *Social Science and Medicine, 35*(3), 227–238.

Bouchard, T. (1994). Genes, environment, and personality. *Science, 264*(5166), 1700–1702.

Bouchard, T. (1999). Genes, environment, and personality. In S. Ceci, et al. (Eds.), *The nature-nurture debate: The essential readings,* pp. 97–103. Malden, MA: Blackwell.

Joseph, J. (2002). Twin studies in psychiatry and psychology: Science or pseudoscience? *Psychiatric Quarterly, 73,* 71–82.

Kendler K., Neale M., Kessler R., Heath A., & Eaves L. (1993). A test of the equal environment assumption in twin studies of psychiatric illness. *Behavioral Genetics, 23,* 21–27.

Loehlin, J. (1992). *Genes and environment in personality development.* Newbury Park, CA: Sage Publications.

Minnesota Twin Family Study (2007). What's spcial about twins to science? Retrieved March 10, 2007 from http://www.psych.umn.edu/psylabs/mtfs/special.htm.

Prainsack, B., & Spector, T. D. (2006). Twins: a cloning experience. *Social Science & Medicine, 63(10),* 2739–2752.

Reading 4: WATCH OUT FOR THE VISUAL CLIFF!

Gibson, E. J., & Walk, R. D. (1960). The "visual cliff." *Scientific American, 202*(4), 67–71.

One of the most often told anecdotes in psychology concerns a man called S. B. (initials used to protect his privacy). S. B. had been blind his entire life until the age of 52, when he underwent a newly developed operation (the now-common corneal transplant) and his sight was restored. However, S. B.'s new ability to see did not mean that he automatically perceived what he saw the way the rest of us do. One important example of this became evident soon after the operation, before his vision had cleared completely. S. B. looked out his hospital window and was curious about the small objects he could see moving on the ground below. He began to crawl out on his window ledge, thinking he would lower himself down by his hands and have a look. Fortunately, the hospital staff prevented him from trying this. He was on the fourth floor, and those small moving things were cars! Even though S. B. could now see, he was not able to perceive depth.

Our visual ability to sense and interpret the world around us is an area of interest to experimental psychologists because, obviously, it affects our behavior in important ways. In addition, within this ability lies the central question of whether our sensory processes are inborn or learned: the nature–nurture issue once again. Many psychologists believe that our most important visual skill is depth perception. You can imagine how difficult, and probably impossible, survival of the human species would have been if we could not perceive depth. We might have run headlong into things, been unable to judge how far away a predator was, or stepped right off cliffs. Therefore, it might be logical to assume that depth perception is an inborn survival mechanism that does not require experience to develop. However, as Eleanor Gibson and Richard Walk point out in their article:

> Human infants at the creeping and toddling stage are notoriously prone to falls from more or less high places. They must be kept from going over the brink by side panels on their cribs, gates on stairways, and the vigilance of adults. As their muscular coordination matures, they begin to avoid such accidents on their own. Common sense might suggest that the child learns to recognize falling-off places by experience—that is, by falling and hurting himself" (p. 64).

These researchers wanted to study this visual ability of depth perception scientifically in the laboratory. To do this, they conceived of and developed a remarkable research tool they called the *visual cliff.*

THEORETICAL PROPOSITIONS

If you wanted to find out at what point in the early developmental process animals or people are able to perceive depth, one way to do this would be to put them on the edge of a cliff and see if they are able to avoid falling off. This is a ridiculous suggestion because of the ethical considerations of the potential injury to participants who were unable to perceive depth (or, more specifically, height). The *visual cliff* avoids this problem because it presents the participant with what appears to be a drop-off, when no drop-off actually exists. Exactly how this is done will be explained shortly, but it is important first to recognize that the importance of this apparatus lies in the fact that human or animal infants can be placed on the visual cliff to see if they are able to perceive the drop-off and avoid it. If they are unable to do this and step off the "cliff," there is no danger of falling.

Gibson and Walk took a "nativist" position on this topic: they believed that depth perception and the avoidance of a drop-off appear automatically as part of our original biological equipment and are not, therefore, products of experience. The opposing view, held by empiricists, contends that such abilities are learned. Gibson and Walk's visual cliff allowed them to ask these questions: At what stage in development can a person or animal respond effectively to the stimuli of depth and height? Do these responses appear at different times with animals of different species and habitats? Are these responses preprogrammed at birth or do they develop as a result of experience and learning?

METHOD

The visual cliff is comprised of a table about 4 feet high with a top made from a piece of thick, clear glass (Figures 4-1 and 4-2). Directly under half of the glass on the table (the shallow side) is a solid surface with a red-and-white checkered pattern. Under the other half is the same pattern, but it is down at the level of the floor underneath the table (the deep side). At the edge of the shallow side, then, is the appearance of a sudden drop-off to the floor, although, in reality, the glass extends all the way across. Between the shallow and the deep sides is a center board about a foot wide. The process of testing infants using this device was extremely simple.

The participants for this study were 36 infants between the ages of 6 months and 14 months. The mothers of the infants also participated. Each infant was placed on the center board of the visual cliff and was then called by the mother, first from the deep side and then from the shallow side.

To compare the development of depth perception in humans with that in other baby animals, the visual cliff allowed for similar tests with other

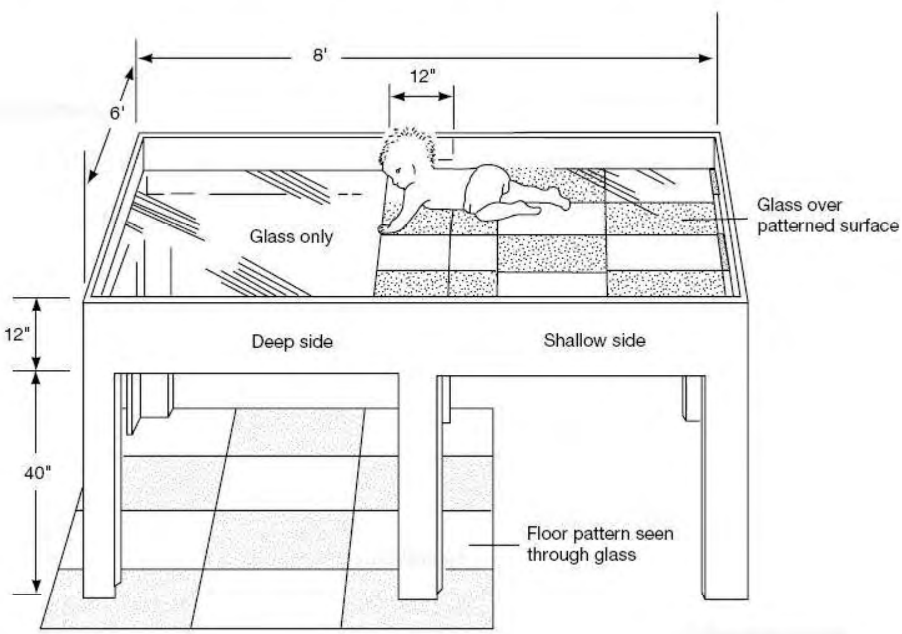

FIGURE 4-1 Gibson and Walk's visual cliff. From *Introduction to Child Development* (5th ed.), by J. Dworetzky (c) 1993. Reprinted with permission of Wadsworth, an imprint of the Wadsworth Group, a division of Thomson Learning.

FIGURE 4-2 The visual cliff in a testing situation. (Mark Richards/PhotoEdit/Courtesy of Joe Campos & Rosanne Kermoian.)

species (without a mother's beckoning, however). The baby animals were placed on the center board and observed to see if they could discriminate between the shallow and deep sides and avoid stepping off "the cliff." You can imagine the rather unique situation in the psychology labs at Cornell University when the various baby animals were brought in for testing. They included chicks, turtles, rats, lambs, kids (baby goats, that is), pigs, kittens, and puppies. One has to wonder if they were all tested on the same day!

Remember that the goal of this research was to examine whether depth perception is learned or innate. What makes this method so ingenious is that it allowed that question to at least begin to be answered. Infants, whether human or animal, cannot be *asked* if they perceive depth, and, as mentioned, human infants cannot be tested on real cliffs. In psychology, answers to perplexing questions are often found through the development of new methods for studying the questions. The results of Gibson and Walk's early study provide an excellent example of this.

RESULTS AND DISCUSSION

Nine children in the study refused to move at all off the center board. This was not explained by the researchers, but perhaps it was just infant stubbornness. When the mothers of the other 27 called to them from the shallow side, all the infants crawled off the board and crossed the glass. Only three of them, however, crept, with great hesitation, off the brink of the visual cliff when called by their mothers from the deep side. When called from the "cliff" side, most of the children either crawled away from the mother on the shallow side or cried in frustration at being unable to reach the mother without moving over the "cliff." There was little question that the children were perceiving the depth of the "cliff." "Often they would peer down through the glass of the deep side and then back away. Others would pat the glass with their hands, yet despite this tactile assurance of solidity would refuse to cross" (p. 64).

Do these results prove that humans' ability to perceive depth is innate rather than learned? It does not, because all the children in this study had at least 6 months of life experience in which to learn about depth through trial and error. However, human infants cannot be tested in this way prior to 6 months of age because they do not have adequate locomotor abilities. It was for this reason that Gibson and Walk decided to test various other animals as a comparison. As you know, most nonhuman animals gain the ability to move about much sooner than humans. The results of the animal tests were extremely interesting, in that the ability of the various animals to perceive depth developed in relation to when the species needed such a skill for survival.

For example, baby chickens must begin to scratch for their own food soon after hatching. When they were tested on the visual cliff at less than 24 hours of age, they never made the mistake of stepping off onto the deep side.

Kids and lambs are able to stand and walk very soon after birth. From the moment they first stood up, their response on the visual cliff was as accurate and predictable as that of the chicks. Not one error was made. When one of the researchers placed a one-day-old baby goat on the deep side of the glass, the goat became frightened and froze in a defensive posture. If it was then pushed over the shallow side, it would relax and jump forward onto the seemingly solid surface. This indicated that the visual sense was in complete control and that the animals' ability to feel the solidity of the glass on the deep side had no effect on the response.

For the rats, it was a different story. They did not appear to show any significant preference for the shallow side of the table. Why do you suppose this difference was found? Before you conclude that rats are just stupid, consider Gibson and Walk's much more likely explanation: a rat does not depend very much on vision to survive. Because it is nocturnal, a rat locates food by smell and moves around in the dark using cues from the stiff whiskers on its nose. So when a rat was placed on the center board, it was not fooled by the visual cliff because it was not using vision to decide which way to go. To the rat's whiskers, the glass on the deep side felt the same as the glass on the shallow side and, thus, the rat was just as likely to move off the center board to the deep side as to the shallow side.

You might expect the same results from kittens. They are basically nocturnal and have sensitive whiskers. However, cats are predators, not scavengers like rats. Therefore, they depend more on vision. And, accordingly, kittens were found to have excellent depth perception as soon as they were able to move on their own: at about 4 weeks.

Although at times this research article, and this discussion, risk sounding like a children's animal story, it has to be reported that the species with the worst performance on the visual cliff was the turtle. The baby turtles chosen to be tested were of the aquatic variety because the researchers expected that they might prefer the deep side of the "cliff" because their natural environment is water. However, it appeared that the turtles were "smart" enough to know that they were not in water: 76% of them crawled off onto the shallow side, while 24% went "over the edge." "The relatively large minority that chose the deep side suggests either that this turtle has poorer depth perception than other animals, or its natural habitat gives it less occasion to 'fear' a fall" (p. 67). Clearly, if you live your life in water, the survival value of depth perception, in terms of avoiding falls, would be diminished.

Gibson and Walk pointed out that all of their observations were consistent with evolutionary theory. That is, all species of animals, if they are to survive, need to develop the ability to perceive depth by the time they achieve independent movement. For humans, this does not occur until around 6 months of age; but for chickens and goats it is nearly immediate (by 1 day old); and for rats, cats, and dogs, it is about 4 weeks of age. The authors conclude, therefore, that this capacity is inborn because to learn it through trial and error would cause too many potentially fatal accidents.

If we are so well prepared biologically, why do children take so many falls? Gibson and Walk explained that the human infants' perception of depth had matured sooner than had their skill in movement. During testing, many of the infants supported themselves on the deep side of the glass as they turned on the center board, and some even backed up onto the deep side as they began to crawl toward the mother across the shallow side. If the glass had not been there, some of the children would have fallen off the "cliff"!

CRITICISMS AND SUBSEQUENT RESEARCH

The most common criticism of the researchers' conclusions revolves around the question of whether they really proved that depth perception is innate in humans. As mentioned, by the time infants were tested on the visual cliff, they had already learned to avoid such situations. A later study placed younger infants, ages 2 to 5 months, on the glass over the deep side of the visual cliff. When this happened, all the babies showed a decrease in heart rate. Such a decrease is thought to be a sign of interest, not fear, which is accompanied by heart rate increases (Campos et al., 1978). This indicates that these younger infants had not yet learned to fear the drop-off and would learn the avoidance behavior somewhat later. These findings argued against Gibson and Walk's position.

It is important to notice, however, that although there was and still is controversy over just when we are able to perceive depth (the nativists vs. the empiricists), much of the research that is done to find the answer incorporates the visual cliff apparatus developed by Gibson and Walk. In addition, other related research using the visual cliff has turned up some fascinating findings.

One example is the work of Sorce et al. (1985), who put 1-year-old infants on a visual cliff for which the drop-off was neither shallow nor deep but in between (about 30 inches). As a baby crawled toward the "cliff," it would stop and look down. On the other side, as in the Gibson and Walk study, the mother was waiting. Sometimes the mother had been instructed to maintain an expression of fear on her face, while other times the mother looked happy and interested. When infants saw the expression of fear, they refused to crawl any farther. However, most of the infants who saw their mother looking happy checked the "cliff" again and crawled across. When the drop-off was made flat, the infants did not check with the mother before crawling across. This method of nonverbal communication used by infants in determining their behavior is called *social referencing*.

RECENT APPLICATIONS

Gibson and Walk's groundbreaking invention of the visual cliff still exerts a major influence on current studies of human development, perception, emotion, and even mental health. Following is a brief sample.

A study by Berger and Adolph (2003) cited Gibson and Walk's early study in their research on how toddlers analyze the characteristics of tasks involving heights, specifically crossing over a bridge. The researchers coaxed very young toddlers (16 months) to cross bridges of various widths, some with handrails, some without. They found that the children were significantly more likely to cross wider bridges than narrower ones (pretty smart for 16 months!). More interesting, however, was the finding that the toddlers were more likely to attempt the narrow bridge if it had handrails. "Infants who explored the bridge and handrail before stepping onto the bridge and devised alternative bridge-crossing strategies were more likely to cross successfully. [These] results challenge traditional conceptualizations of tools: babies used the handrail as a means for augmenting balance and for carrying out an otherwise impossible goal-directed task" (p. 594).

Another practical application of the visual cliff study looked at the possibilities for using virtual reality to help developmentally disabled children learn to deal safely with the physical environment around them. Strickland (1996) developed a system that incorporates virtual reality to help autistic children safely explore and interact with the world around them. Often these children pose a danger to themselves because their perceptions are either distorted or not fully developed. For example, an autistic child might not perceive drop-offs such as those represented by the visual cliff and would, therefore, be prone to dangerous falls. According to Strickland, however, virtual reality allows us to design custom programs so each individual child may gain valuable motor experience without danger of physical injury.

CONCLUSION

Through the inventiveness of Gibson and Walk, behavioral scientists have been able to study depth perception in a clear and systematic way. Behavioral scientists continue to debate the question of whether this and other perceptual abilities are innate or learned. The truth may lie in a compromise that proposes an interaction between nature and nurture. Perhaps, as various studies have indicated, depth perception is present at birth, but fear of falling and avoidance of danger are learned through experience, after the infant is old enough to crawl around enough to "get into trouble." But whatever the questions are, elegant methodological advances such as the visual cliff allow us to continue to search for answers.

Berger, S., & Adolph, K. (2003). Infants use handrails as tools in a locomotor task. *Developmental Psychology, 39,* 594–605.

Campos, J., Hiatt, S., Ramsay, D., Henderson, C., & Svejda, M. (1978). The emergence of fear on the visual cliff. In M. Lewis & L. A. Rosenblum (Eds.), *The development of affect.* New York: Plenum Press.

Sorce, J., Emde, R., Campos, J., & Klinnert, M. (1985). Maternal emotion signaling: Its effect on the visual cliff behavior of 1-year-olds. *Developmental Psychology, 21,* 195–200.

Strickland, D. (1996). A virtual-reality application with autistic children. *Presence: Teleoperators and Virtual Environments, 5*(3), 319–329.