Exploring Infant Cognition

November 25, 2014

Many of today's developmental psychologists defend the hypothesis that "babies are smarter than we think" — a *lot* smarter than we think, explained Nora Newcombe of Temple University during her APS William James Fellow Award Address at the 2014 APS Convention in San Francisco. But Newcombe's work on mental rotation and human spatial perception has made her question the complex cognitive abilities that many researchers ascribe to infants.

"They're smarter than you think if you think they don't know *anything*," she said, noting that no serious contemporary scientist sees babies as "blank slates" devoid of mental ability. Referencing the concept of "experience expectancy" proposed by neuroscientist William Greenough, also an APS William James Fellow, Newcombe acknowledged that human infants benefit from "strong starting points" — brains capable of learning from the physical world. The empirical questions that remain, then — questions that science has yet to answer — are whether babies are also born with strong representational knowledge of the world and, if so, how much knowledge they are born with.

Infants can't tell scientists what they think or understand. So developmental psychologists have long relied on "looking time" as a clue in the study of infant cognition. In 1997, for example, Sue Hespos and Philippe Rochat designed a study in which 2- to 8-month-old infants were shown a two-dimensional animation of an object (shaped more or less like a two-tined fork) turning as it fell behind a larger occluding square.

Then, the "fork" was either removed from behind the occluder in the position in which it would be expected to have fallen considering its trajectory, or it was removed from the occluder in a position that would be totally unexpected considering the trajectory the babies witnessed. Seeing the second, physically improbable scenario caused infants to look longer at the object. Apparently, Hespos and Rochat concluded, these infants understood that something about the animation didn't mesh with the way the physical world works. Subsequent studies have used looking time to suggest that babies as young as 3 to 4 months can distinguish between pairs of objects that mirror each other and pairs of objects that do not mirror each other.

Newcombe urges developmental psychologists to think twice about interpreting such results as evidence of incredible spatial insight in babies. Work conducted in her own lab and by Wenke Möhring and Andrea Frick used looking time to examine how well infants could predict the position of a *p*-shaped object that was completely blue on one side and yellow with a red bull's-eye shape on the opposite side. Infants watched the *p* fall straight down behind an occluder (blue side facing forward and with no rotation at all).

Only when 6-month-old infants had been allowed to handle the *p* before watching it fall (as opposed to just being shown both sides of the shape) did they stare (i.e., display an "elevated looking time") when the *p* emerged from behind an occluder with the yellow side facing forward — a surprising event considering the *p*'s trajectory. Ten-month-olds seemed puzzled by unexplained object rotation even without having handled the *p* figure; however, this effect was carried by the 10-month-olds in the study who had learned to walk. Ten-month-olds who had not yet learned to walk showed shorter looking times than their mobile age-mates when the *p* shape was pulled from behind the occluder in what should have seemed like an "impossible" position.

These results contradict the dominant "nativist" view of development, which attributes spatial learning to innate intellectual abilities: *Experiential* learning — exploring and learning from one's environment as the babies did when they handled the *p* shape — may be much more important than many researchers acknowledge.

Even mobile 10-month-olds like the ones from Möhring and Frick's study, who seemed capable of making predictions about a simple object rotation task, have a very limited understanding of the geometry of their surroundings, Newcombe said. The scientists who design object-rotation tasks may get infants to stare longer at "impossible" scenarios. However, Newcombe warned, the babies "don't think, 'That's impossible.' They just think it looks a little weird; that's all it takes to drive a looking-time finding."

"As you interact [with your environment] through grasping and crawling," she asserted, "*that* propels developmental change."

According to the evidence that Newcombe and her colleagues have gathered from their work with older children, it takes years of interactive experience before children develop truly complex spatial reasoning capacities. A 2013 study led by Andrea Frick tested 4- and 5-year-olds' ability to play a simplified version of the game *Tetris*, which required the player to look at a figure and determine how it could fit into a larger puzzle. The team asked only that the children *touch* the place where the blocks would fit; they didn't actually have to rotate the blocks or fit them into the puzzle. Four-year-olds struggled with the activity; many 5-year-olds could do it.

When these results were combined with those from an experiment that tested how well children ages 3–5 could fit various ghost-shaped pieces into a puzzle board, the researchers concluded that it isn't until about 4.5 years of age that most children are able to make accurate, active predictions about object rotation.

"I think a lot of cognitive development needs to be rethought … in light of these doubts about what looking time is telling us," Newcombe said. She hopes her work will challenge researchers convinced that "babies are smarter than we think" to embrace a different point of view. Newcombe believes that babies are "really *not* so smart, and that there's a lot of change that occurs during development, and that our task is indeed to embrace this change and to think about what creates this change."

Right now, Newcombe sees child cognitive development between infancy and 4 years of age as *terra incognita*. Infants, she argues, must learn many of the skills scientists previously assumed they were born with; mapping that learning process should be a new priority for developmental researchers.