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The Goldilocks effect: Babies learn from experiences that are 'just right'

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Long before babies understand the story of Goldilocks, they have more than mastered the fairy tale heroine's method of decision-making. Infants ignore information that is too simple or too complex, focusing instead on situations that are "just right," according to a new study to be published in the journal *PLoS ONE* on May 23.

Dubbed the "Goldilocks effect" by the University of Rochester team that discovered it, the attention pattern sheds light on how babies learn to make sense of a world full of complex sights, sounds, and movements. The findings could have broad implications for human learning at all ages and could lead to tools for earlier diagnosis of attention-related disabilities such as ADHD or autism, says Celeste Kidd, lead author on the paper and a doctoral candidate in brain and cognitive sciences at the University.

With the aid of eye-tracking devices and statistical modeling, the research is the first to provide both a theory and quantifiable measures of what keeps a baby's attention, says coauthor Richard Aslin, the William R. Kenan Professor of brain and cognitive sciences at the University.

For years, researchers have explored what types of events most effectively capture babies' attention. In some situations, infants reliably prefer familiar items, such as a favorite toy; in others, they favor novel objects. The new study resolves such seeming contradictions. Instead of novelty or familiarity per se, the research shows that babies seek out

situations with just the right amount of surprise or complexity.

To measure complexity, the Rochester team developed a test based on the probability of surprising events in a video. Unlike hard-to-quantify concepts such as novelty or unlimited dimensions such as size, probability exists in a well-defined range from 0 (never happens) to 1 (always happens). Probability provides a continuous measure and is often employed by computer scientists and engineers to describe complexity, says Aslin.

In the study, researchers measured the attention patterns of 72 seven- and eight-month-old infants in two separate experiments. The babies watched video animations of fun items, such as a pacifier or ball, being revealed from behind a set of colorful boxes. The researchers varied where and when the objects would appear across dozens of short trials.

To measure attention, an eye-tracking device located below the computer screen followed the infants' gaze. As long as they looked at the screen, the events continued; as soon as they looked away, the trial ended. Babies quickly learned that they were in control. If they wanted to continue watching they just needed to keep their eyes on the screen. To reduce distractions, infants sat in a darkened space on the lap of their parent, who wore headphones playing music and a visor to prevent them from biasing their infant's performance.

Using a specialized statistical model, the researchers were able to calculate and predict how likely infants were to lose interest based on the complexity of each event depicted in the video. Complexity was defined as how surprising each event was in light of the previous events an infant had observed in the video.

Across both experiments, babies reliably lost interest when the video became too predictable – when the probability of a subsequent event was

very high. "But here's the counterintuitive part," says Aslin. "You would think that the more complex something is, the more interesting it would be. That's not the case with babies." They drifted away from the screen when the sequence of events also became too surprising – when the pattern seemed random and unpredictable because the probability of something happening was very low.

"The study suggests that babies are not only attracted by what is happening, but they are able to predict what happens next based on what they have already observed," says Kidd. "They are not passive sponges. They are active information seekers looking for the best information they can find."

Although the experiments were limited to infants, the results provide a window into the way the brain works in general. "If you are interested in human nature, then babies are the place to look," because their reactions are less complicated by cultural filters and learned responses, says Steven Piantadosi, a coauthor and post-doctoral fellow in brain and cognitive sciences.

For example, the "Goldilocks" attention pattern supports other theories of adult learning, the authors note. Cognitive scientists have proposed that learners direct their attention to material that contains just the right amount of challenge, because this optimal complexity triggers the right amount of stimulation in learners.

In real life, babies are also attracted to faces, voices, foods, and other aspects of their world that are key to survival. These "special" stimuli may trigger attention in a different way, the authors acknowledge. But complexity does help to explain how infants gather information about the rest of their environment, they write.

Does this mean that parents should worry about providing material that

is "just right" for their little ones? Not really, says Aslin. "Infants are learning all the time, as long as they have reasonably stimulating environments. They focus in on what they can handle and filter out the rest," he says.

Kidd agrees: "Parents don't need to buy fancy toys to help their children learn. They make the best use of their environment. They are going to look around for what fits their attention level." And even though the experiment employed an animated video, the scientists emphasize that human interactions are the most critical for development. "Kids learn best from social interaction," reminds Kidd.

The study's insights into attention patterns may help to explain why children ask to hear the same story over and over. For an adult, the repetition can be mind numbing, says Kidd, "but for a child, they are likely getting something new out of the story every time. Because adults know so much, we often take for granted how many new things an infant needs to learn."

Provided by University of Rochester