MIND Matters

Your Baby's Brain is Built to Achieve in STEM—An Expert Explains Why!

By Moira R. Dillon, Ph.D.

Our babies amaze us daily with how quickly and deeply they learn about the people, objects, and places around them. But what can be even more amazing is what babies seem to know already, without having to learn at all! For example, newborns no more than two days old will look longer at a group of 12 shapes versus four shapes after hearing repeated sets of 12 tones (infants who hear sets of four tones look longer at four shapes). This means that newborns can already match numbers across shapes and sounds![1]

Young babies can even do small-number addition and subtraction: They are surprised and look longer when, after two dolls are sequentially hidden, only one doll is revealed.[2] Indeed, it doesn't end at baby arithmetic; they can also do geometry: Young babies notice and are interested in looking at two differently shaped triangles versus two same-shaped triangles, even if the triangles vary in their sizes, orientations, and directions.[3] Even physics: When young babies see an object appear to move through a solid wall or hover in mid-air after rolling off a table, they will look longer at these outcomes in surprise.

And what's more, they are curious scientists who do experiments: Babies who saw the ball go through the wall will be more likely to bang it on the table, while babies who saw the ball hover in mid-air will be more likely to hold it up and drop it.[4] Babies are natural mathematicians, geometers, physicists, and scientists!

How did we find out that babies are so smart?

You might be saying to yourself: "Didn't I learn that babies think that an object no longer exists when it disappears from view (i.e., they don't have, what Jean Piaget referred to as object permanence)? If this is true, how could babies *add* hidden objects!?" We have learned a lot since Piaget, and contemporary research in cognitive science and developmental psychology, which happens in laboratories like mine at NYU, aims to nuance our understanding of what babies know. So, while babies won't reach for a hidden object until after about 9 months of age, they will look longer if the object is shown to have actually disappeared, much earlier than 9 months of age. In today's labs, researchers like me are studying babies' implicit knowledge about numbers, shapes, and objects by showing them puppet displays and animated vignettes with potentially interesting, preferable, or surprising outcomes. If babies have those interests, preferences, or don't expect those outcomes, then they will look longer. Older babies will even choose or act on objects based on what they saw. Over the past 50 years, new methods and research questions have completely revolutionized our understanding of what babies already know about math and science.

How does this research relate to STEM learning?

Universal preschool is becoming available across the globe, from developing countries like India to our own New York City. Most preschool curricula are founded on the idea that children are best ready to learn math and science in school after experience with adult-led activities that exercise their intuitive cognitive abilities. While labs like mine might aim to identify such intuitive abilities, the lab is much dif-

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ferent from the classroom: Lab studies alone do not reveal the causal factors that produce knowledge on the long run or enhance knowledge in school. And so, my collaborators and I have put our findings to the test by seeing whether a game-based curriculum, focusing on numerical and spatial abilities that emerge in infancy and function throughout life, can promote school learning in thousands of preschool children in poor areas of New Delhi, India.[5]

Our study yielded three important findings: 1. It is possible to translate the careful manipulations of the lab into implementable interventions in the real world; 2. Children's intuitive numerical and spatial abilities can improve with practice, and those improvements have an impact on simultaneous learning of formal math; 3. Such improvements in formal math disappear on the long term when primary school curricula focus only on number and spatial symbols.

So how do you best foster your own baby's STEM learning?

While we don't have a full answer to this question yet, many researchers, practitioners, and policy makers agree that young children build a foundation for learning math and science in school best through early and frequent social interactions that exercise their numerical, spatial, and physical intuitions. One of the best things you can do is to spend time enjoying math and science together with your child!

[1]Izard, V., Sann, C., Spelke, E. S., & Streri, A. (2009). Newborn infants perceive abstract numbers. Proceedings of the National Academy of Sciences, 106(25), 10382-10385.

[2]Wynn, K. (1992). Addition and subtraction by human infants. Nature, 358(6389), 749-750.

[3]Dillon, M. R., Izard, V., & Spelke, E. S. (in preparation). Infants' sensitivity to shape changes in 2D visual forms.

[4]Stahl, A. E., & Feigenson, L. (2015). Observing the unexpected enhances infants' learning and exploration. Science, 348(6230), 91-94.

[5]Dillon, M. R., Kannan, H., Dean, J. T., Spelke, E. S., & Duflo, E. (2017). Cognitive science in the field: A preschool intervention durably enhances intuitive but not formal mathematics. Science, 357(6346), 47-55.

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