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Math not wasted on the young; As early as four months, children can tell the difference between 1, 2 and 3

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You may be surprised to learn it's never too early to sharpen your child's mathematical mind.

I don't necessarily advocate reading the digits of Pi to your baby in utero, (at least not for mathematical reasons -- if you find it soothing, then go for it), but there are plenty of ways that you can help your baby or toddler explore the mathematics inherent in the world around them.

Years before children understand the symbols of language or written numbers, they are actively engaged in making sense and order out of everything they encounter.

Researchers of infant cognition have discovered that very young children can tell the difference between quantities of one, two and three. Recent studies of brain activity show that at four to five months, babies can detect arithmetical errors such as $1+1=3$, and can perform the equivalent of $2-1=1$. By six to nine months, babies can distinguish between quantities with high ratios, such as groups of eight and 16.

And we know that babies and young children perceive their environments numerically, and also through other aspects of mathematics such as shape, space, motion and change. They use the patterns they find in things they touch, see and hear to learn the boundaries and the possibilities present in their environments. The message here: Children are natural mathematicians.

As kids continue to grow and develop, however, improvement in their mathematical ability is not as consistent. For instance, when they learn to speak around age two, they start verbalizing numbers and making computations with words, not just basic concepts, and begin making errors such as $1+1=3$. As they learn to count, kids naturally use their fingers to add and subtract.

This is something adults might discourage, but studies show that we should do just the opposite. When children use their fingers to count, they are developing their ability to calculate and to think with a level of abstraction that allows them to perform more complex operations.

Until about age five, kids have more difficulty performing arithmetical operations when done verbally, while they are able to perform arithmetic non-verbally with a high degree of accuracy.

What I take away from this research on mathematical cognition in young children is a great respect for the processes of mathematical discovery that babies and toddlers are already engaged in without any instruction or intervention from adults.

Their natural curiosity and imagination will lead them through what child psychologist David Elkind calls the "fundamental curriculum," or "our knowledge of things, their sensory properties, their spatial relations and their temporal sequencing."

We can provide toys and experiences that give them material to explore, but they will do most of the work of educating themselves as they play.

Babies and toddlers also respond to social motivation, so as parents we can support our children's development by exploring math through shared play, reading and family activities. This can be as simple as sorting socks, or figuring out how many spoons should go on the breakfast table.

As we look for ways to help our young children learn, it is important to remember the learning that goes on before a child reaches kindergarten is markedly different from the learning that older children and adults engage in. Follow your child's natural motivation for cues on what he or she is interested in exploring.

Dr. Arvind Gupta is a father of three, a mathematician at Simon Fraser University and scientific director of MITACS.

Illustration:

- Colour Photo: Jana Chytilova, Ottawa Citizen, Canwest News Service, File / Even babies perceive their environments numerically and through other aspects of math such as shape, space and change.

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