

Babies and Mathematics



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Learning basic mathematical concepts is a complex business, but in trying to understand the world, babies naturally seek out problems to solve. The challenge for the parent or practitioner is to create an interesting and rich environment in which early math (and science) learning can occur.

The first year is one in which the baby's brain absorbs, processes and interprets information at a phenomenal rate. For example, the six-week-old baby can work out basic problems such as how to make the objects on a mobile move and the three month-old knows that a toy hidden under a cloth is still there, even though they cannot see it. The four-month-old baby can work out that two identical shapes presented side by side are separate objects and the five-month-old shows sensitivity to changes in the quantity of 'stuff' presented to them. The six-month-old baby can operate a musical toy by pressing buttons to make a sound and the eight-month-old can work out how to get to an enticing toy. The eleven-month-old baby can imitate a repetitive clapping and patting pattern and fit pegs in pegboard holes, and the twelve month-old knows that a large nesting cup is too big to fit inside a small one.

This article provides an overview of basic mathematical understanding in the first year and suggests ways in which parents and practitioners can encourage a love of math in babies that will stand them in good stead for the future.

Brain processing

Mammals, including humans, have a large neocortex (newer outer layer of the brain), which serves as the centre of higher order thinking and contains some

100 billion cells. The neocortex is divided into two halves which form the left and right brain hemispheres. The left hemisphere processes mathematical, analytical, and language orientated information.

Through the use of non-invasive techniques such as Event Related Potentials, which involve placing sensors on the baby's head, scientists can now measure the brain's electrical activity at different ages and stages of development. Analysis shows that babies have similar left brain activity to that of young children and adults in processing mathematical problems.

Number and science theory

Much of our understanding about how and when mathematical awareness takes place is based on the work of Jean Piaget, a Swiss psychologist (1896-1980), and his sensorimotor period from birth to age two. Piaget believed that during this period, information received through the senses was the major mode of learning for babies. He was not wrong! Although many of Piaget's proposals on early development have not held up under further enquiry, his work on the sensorimotor period continues to provide a useful outline on the early stages of math and science learning.

Piaget, and the work of others, has shown that very young babies instinctively understand the fundamental laws of physics. They know that an object cannot be in two places at once, that two objects cannot simultaneously occupy the same space and that an object cannot suddenly appear or disappear. For example, the six-month-old expresses surprise when a ball that has been dropped behind a screen appears suspended in mid air when the screen is lifted. Does this suggest that babies know something about gravity or is the original hypothesis maintained until something new comes along to replace it?

Estimating quantities

Throughout history, numerical knowledge has had a tremendous influence on our culture and on our language. It is an important and essential part of daily life for humans and also for many other mammals that need to keep track of mates, enemies and offspring. Experiments involving birds, rodents and horses have shown that they can tell when one pile of objects is bigger than another. For birds, the instinct is natural. Hens, for example, instinctively lay a clutch of eggs before sitting on them. However, mammals such as dogs, horses and human babies with higher brain functions, choose large containers of food over small ones. In an experiment involving human babies, jars which contained the most biscuits were always chosen in preference to containers with few biscuits. In another study, babies always selected large sets of toys in preference to small sets.

Counting

Most people think of counting as a verbal process in which a string of numbers is recited in a fixed order. Although counting in this sense cannot be present before the emergence of speech, there are many opportunities to introduce babies to the sounds of numbers from an early age. For example, putting pegs in their respective holes on a pegboard and counting each one in turn introduces babies to 'one to one correspondence' (matching a number to a specific object). Although one-to-one correspondence might not happen until the second year, giving babies the opportunity to see math through play helps them to build interest for future learning. They also gain an understanding of order, for example knowing that two comes after one and that four comes after three and so on.

Some researchers claim that six to eight months-old babies know something about numbers, although the evidence is controversial. In tests involving voices and images, they found that six to eight month-old babies responded to the sound of three voices by staring longer at images with three faces, than images with one or two faces. Previous research indicated that such connections were not possible until the age of two-and-a-half years.

Sorting and labeling objects

Sorting objects into categories is an important and very useful problem solving skill in both science and mathematics. Categorizing objects according to their texture, shape, colour, sound or movement means that the brain is processing, analyzing and memorizing information. Babies given different fruits to explore learn a great deal about colour, shape, size, texture, taste, weight and composition. Given several fruits of each type, they learn about classification and categorization.

Babies aged seven months know that vehicles and animals are from different categories, but are unable to separate cars and lorries or dogs and horses into more defined groups. Through repeated observation, the baby learns that vehicles have wheels, that they are made of metal and that they make a particular sound when moving. They also learn that animals have a face, different body coverings and eat, sleep and move in a certain way. However, it is not until the second year that the infant is capable of subdividing vehicles into groups of cars and lorries and animals into groups of dogs and horses and so on.

Size estimation

Nine-month-old babies are very accomplished at estimating the size and shape of an enticing object held out in front of them. If the object is big, they extend both arms. If the object is small, they extend a single hand. This shows that the baby has used a series of intellectual acts to work out size and distance. Younger babies, however, shape their hands according to the size, shape and texture of an object.

Logical thinking

Problem-solving and logical thinking skills are linked to emotional development, which depend on positive interactions with a loving, caring adult. A happy contented baby with a predictable daily routine learns easily and quickly and develops the skills that lead to mathematical thinking. A regular routine gives order to everyday events, helps babies make logical sense of the world, and sets the stage for an understanding of patterns and sequences. Skills such as calculation, reasoning, sequencing, number and pattern recognition depend on logical thinking. It's also the type of intelligence that school children who are very successful in math use frequently!

Ideas for developing math skills

There are many enjoyable songs, games and other activities that can help babies learn mathematical concepts. However, hearing, feeling and seeing mathematics in action is the key. Parents and practitioners may find the following suggestions helpful in providing meaningful and relevant experiences.

Pointing out numbers on doors, on the telephone and on the clock face help babies understand how numbers can be used practically. Counting and touching fruit, toys, shapes and pegs helps babies see that you are counting one thing at a

time. Using words such as 'big' and 'small', 'long' and 'short', 'heavy' and 'light' encourages comparison. Babies can also be shown how to make sets of colours, shapes, farm animals and cars.

As well as being fun, number rhymes introduce babies to the sounds of numbers from an early age. They also enable babies to learn patterns and sequences. Examples include:

- 1, 2, 3, 4, 5 once I caught a fish alive.
- Five currant buns in the baker's shop
- Ten fat sausages

The following books reinforce number sounds and introduce the idea that numbers relate to different amounts.

- The Three Little Pigs
- The Very Hungry Caterpillar
- Five Little Ducks

Babies love activities that offer opportunities for exploration, discovery and problem-solving. Materials such as sand (or a suitable substitute), water and dough offer endless opportunities for finding out about the special properties of each material. Other examples include:

- Boxes with lids to open and close
- Containers of different size and shape
- Coloured bricks to stack or knock down
- Nesting cups to build and nest

Games that enhance awareness of spatial relationships and object constancy include:

- Cardboard boxes or tunnels to crawl through
- Bean bags or balls to throw in a laundry basket
- Peek-a-boo

Engaging in musical experiences together creates connections in the brain that help children solve math problems in later life. The beat (timed interval) of a musical piece also relates to number concepts. Examples include:

- Clapping and patting to a beat
- Banging on a pot or drum
- Bouncing to a beat (even 8-month-old babies can predict when to bounce!)

Action songs that introduce a pattern or sequence might include:

- Pat-a-cake
- If you're happy and you know it
- Head and shoulders, knees and toes

Towards the end of the first year, babies enjoy activities that encourage use of the pincer grip. The following examples encourage babies to explore spatial relationships, and form the foundation for geometry and numbers. However, spatial awareness is still developing, which is why babies find it hard to post a shape in the respective hole or put a jigsaw piece in the correct place.

- Peg boards
- Shape sorters
- Simple peg puzzles with two or three shapes

- Stacking towers
- Scribbling crayons and paper

As babies look, hear, touch, taste and smell, concepts used in math and science grow and develop over the first year. When babies grasp things, they discover that some objects fit in their hands, and that others do not. When they mouth objects, they find out about weight, size, shape and texture. When they stack one brick on top of another and see them fall and become small parts again, they become engaged in math observation. When they blow out the candle on their first birthday cake, they acquire a sense of number. All these skills have a special value in stimulating the brain and in developing processes that enable them to understand more complex concepts in mathematics such as multiplication, division, and the use of standard units of measurement in later life.

Key points:

- Babies have an innate driving force to learn
- Babies use their senses to find out about the world
- Early experiences play an important role in later math and science learning in school
- Incorporating math in everyday activities in a fun way is the key to effective learning