Little thinkers

Judy Siegel-Itzkovich, THE JERUSALEM POST Aug. 21, 2005

Babies are more than demanding creatures that have to be fed, burped, bathed, diapered and put to sleep until they develop a personality. Researchers in the brain development and cognitive behavior of infants believe infants acquire many sophisticated perceptual abilities, can detect errors, process quantitative information and feel emotions as complicated as jealousy, frustration and empathy.

In a number of labs around the world, parents are bringing in their babies and allowing caps of electrodes to be placed on their heads to record electrical signals beamed from different parts of the brain while they watch specially made films or real-time situations.

Although much still has to be learned, researchers already insist that pediatricians and parents should pay attention not only to physical development – when infants first roll over or sit up – but also their social skills and emotional and cognitive development. They also suggest that certain early signs could have predicative value for language development, social skills and cognitive disabilities.

Exploring the infant mind is a hot subject. Newsweek, which devoted its August 15 cover story to "Reading Your Baby's Mind," described experiments at Texas Tech University in which a mother holds her six-month-old baby girl on her lap. The baby soon has a bored expression. A professor of human development, who led the study, tells the mother to read a children's book, have a conversation with her and "ignore" her baby. The researcher then brings in a life-size baby doll. She places it in the mother's arm and asks her to cuddle, hug, rock and coo it while continuing to ignore Victoria.

The baby no longer shows ennui. First she smiles at her mother, as if to steal her attention. When this fails, she seems to lose patience, crying so hard that her face turns as red as a beet and she nearly spits up. The experiment ends, and the mother is then permitted to comfort Victoria. The Texas researcher is not surprised, as she has seen this scene repeated hundreds of times, and in nearly every case, the baby turns into a jealous, green-eyed "monster."

Initially, the researcher could hardly believe that a very young child could display such complex emotions.

Newsweek also reported that until the age of three months, babies are able to recognize scrambled photos of their mothers as easily as a lifelike photograph of them; they lose this ability after that. Facial recognition appears after four months, and this is fortunate because being able to distinguish caregivers from complete strangers is naturally beneficial for babies. When infants hear recordings of other babies crying, they start crying themselves, but rarely react that way to recordings of their own bawling. This ability apparently fades as they get older, but between 13 and 15 months, if their playmate begins to cry, they are likely to go over and try to comfort him and even bring over their own mother to assist.

Israel has not been left out of this basic scientific research: Dr. Andrea Berger of Ben-Gurion University of the Negev is now conducting an analysis, with colleague Prof. Michael Posner of the University of Oregon, of more than 50 babies aged five to nine months that she and her students tested at her electro-physiology lab in the behavioral sciences department in Beersheba.
study, funded by the prestigious US-Israel Binational Science Foundation, is examining the differentiation by babies between basic quantities and their initial understanding of simple arithmetical concepts such as addition and subtraction.

"We are in the last phase of data collection and the beginning of analysis," says Berger. "We are looking at not only mathematical thinking but also more complex things such as executive attention, error detection and specific brain areas."

Berger, her students and lab staffers started their work about three years ago, based on a method used a decade ago by Dr. Karen Wynn of the psychology department at the University of Arizona, who reported on her work in a letter to the journal Nature. Wynn, basing her hypotheses on much experimentation, reported that infants can discriminate among different small numbers of items and quantify small numbers of items without consciously counting them.

Wynn studied 32 normal, full-term infants, divided into two groups and ranging in age from four months and 19 days to five months and 16 days. One group were shown a Mickey Mouse doll in an empty display area. Then a small screen rotated up, hiding the item from view. The tester brought a second identical doll into the display area so the baby could see it clearly.

The second group were shown a sequence of events depicting a subtraction of one item from two items. For both groups, at the end of this presentation, the screen was rotated downward to reveal either one or two dolls. The researchers recorded how much time each infant spent looking at the display.

Thus, she wrote, if they are able to compute the numerical results of arithmetical operations, they should look longer at the unexpected situation than at the expected one. The two minus-one group should look longer when the result is two than when the result is one item, and the one-plus one group should look longer when the result is one than when it is two – which is what was found in experiments. Babies know that an addition or subtraction results in a change in the number of items.

"Infants are sensitive to small numerical changes. They have the abilities that allow them to track distinct entities over time and space." She concluded that babies "can compute the results of simple arithmetical operations." The layman might think that researchers are making assumptions about babies who can't tell them what they are thinking, but by using harmless electrodes that measure electricity, scientists are now able to document the electrical activity taking place in a baby's brain when he is looking at mathematical equations, says Berger.

"We have received official Helsinki Committee approval for our experiments," she continues. "Parents get full explanations and give their written consent. We attach 128 electrodes woven together in a cap to the babies' heads, using saline [salt water] solution warmed to body temperature. The electrodes are not attached using gel, as in a medical electroencephalogram. "It might look uncomfortable, but it is not. The net is placed on the head of the baby as easily as a bathing cap. Before placing the net, we find the approximate vertex, or center, to ensure that the electrodes are placed in a specific location over the skull. They transmit electrical potentials to a computer, which shows brain activity. There are nets to suit different head sizes; we have three sizes for babies."

Berger's team has included only healthy boys and girls born to Hebrew-speaking mothers after 40 weeks of pregnancy, drafted in tipat halav (family health) centers in Beersheba.

While mothers hold the babies on their laps, they watch a film specially produced by the lab for 15 to 20 minutes. To catch the babies' attention, the film includes a sound track designed by professional composer Yossi Yampel. Still, some babies get tired, cry, or pull the caps off because they don't like
things on their heads; such babies are not included in the final analysis of the data.

While positron emission tomography (PET) and functional magnetic resonance imaging (MRI) scans – which show changes in blood flow in the brain – would offer higher-resolution images, Berger says they do not produce immediate, real-time results linking reactions with stimulation, as the event-related potential (ERP) studies do. Moreover, this technology is absolutely non-intrusive, which makes it more suitable for studying young infants. Before launching her study, Berger visited a lab in Kentucky where newborns are tested just after delivery.

Jean Piaget, the noted 20th-century Swiss developmental psychologist, believed that infants up to eight months old have no concept of objects. Recent studies suggest that this is not so. “If you cover a toy, the baby forgets it. He doesn’t look for it, as for him, it has disappeared – “out of sight is out of mind.” But when you present “impossible conditions” that violate physical laws, “babies look longer at them, as if they have an expectation of what the physical law should be,” Berger continues. Research using this technique shows now that Piaget’s conclusions were erroneous. Babies do have a sense of physical objects and expect them to continue existing after they go out of sight. Moreover, Wynn’s studies and others indicate that to some extent, babies track the number of objects being hidden.

“We don’t know for sure whether this talent is innate, acquired in the womb or from experience during their first months of life.” Berger says that while the ERP methodology is not new, it is becoming more common for studying babies. Her specific research on the development of error detection and numerical expectations is unique, and her findings will have implications regarding the development of attention during infancy.

When adults make an error, there is a change in the electrical signal recorded at the scalp, which seems to signal the person’s awareness of making the mistake. It was recently discovered in her lab that the same signal can be detected in adults not only when they make an error, but when they are shown an error they previously made, such as an erroneous numerical calculation. Finding evidence of error detection in babies when they observe erroneous numerical information would be a sign of the development of an “executive attention” system at this early age, which in turn is related to the development of empathy and self-regulation.

“We look for patterns in all babies of the same age. Our experiments include only normative groups and not comparisons between different ethnic or religious groups, or between full-term and premature babies. Maybe we will go on to do this in the future,” says the BGU researcher. Berger is reluctant to speak about eventual applications of her findings, but others in the field believe that babies could eventually be screened before they can walk for language deficit and even dyslexia, and that training and treatment could then be offered to minimize or even head off such handicaps. The findings might one day even help the Education Ministry devise ways to teach children mathematics more effectively.

In the meantime, pay attention to infants. You never know what they may be thinking about you.