SCIENCE NEWS of the week

Babies Add Up Basic Arithmetic Skills

Babies possess many obvious aptitudes – drooling, crying, soiling diapers, and evoking unbounded love from their parents. You can now append a more surprising talent to that list, according to a report in the Aug. 27 NATURE: Infants as young as 5 months of age can add and subtract small numbers of items.

"My working theory is that humans are innately endowed with a mental mechanism devoted to quantifying discrete entities, and this mechanism is already operating unconsciously in infants," asserts psychologist Karen Wynn of the University of Arizona in Tucson.

In a commentary accompanying Wynn's report, psychologist Peter E. Bryant of the University of Oxford in England calls her paper "a notable event in the history of developmental psychology" that presents "apparently cast-iron evidence" for rudimentary mathematical reasoning by infants.

Research exploring babies' perceptual and mental capacities has ballooned in the past 20 years. Studies indicate that babies see individual objects within an array of items, visually track moving objects, and know that an object exists when it moves behind a barrier. Investigators have also found that infants realize when a small number of drumbeats matches an equal number of objects shown on a slide. Babies also respond to changes in the number of a set of objects.

The perception of a small number of items in the absence of explicit counting, referred to as subitization, may stem from either numerical calculations or a general quantity judgment unrelated to mathematical reasoning.

Most studies of how infants think – including Wynn's – rely on a "looking-time procedure": Babies tend to look markedly longer at new or unexpected stimuli than at recently presented or familiar stimuli.

Wynn first studied 32 baby boys and girls, all around 5 months of age. A "1 + 1" group saw a rubber Mickey Mouse doll placed on a table and then obscured by a screen. Next an experimenter placed a second doll behind the screen, in full view of each infant. A "2 – 1" group saw two dolls placed on a table and then obscured by a screen, followed by an experimenter removing one doll. At that point, the screen was lowered for both groups.

Each infant viewed the addition or subtraction six times. In half the instances, an incorrect number of dolls appeared upon removal of the screen, corresponding to "1 + 1 = 1" or "2 – 1 = 2." The other trials presented the correct number of dolls. Before the trials began, Wynn also established the baseline amount of time each baby spent looking at one doll and at two dolls.

Both groups looked significantly longer at the incorrect number of dolls in test trials, and allotted less, roughly equal time to looking at one or two dolls in baseline tests. The same pattern held for another 16 infants, also around 5 months old, tested in the same way, Wynn says.

Infants apparently expected the correct number of dolls to emerge from behind the screen and experienced surprise when they saw a different number, she argues. However, since the number of dolls in incorrect trials equaled the number shown before addition or subtraction, infants may only have noticed an unspecified numerical change with no expectations about the size or direction of the change.

A third study suggested that infants can indeed add up small numbers. Wynn exposed 16 infants between 4 and 5 months of age to the "1 + 1" trials, but the final number of dolls revealed behind the screen was either two or three. Both results differed from the initially presented number of dolls. Infants looked substantially longer at three dolls in test trials, but not in baseline tests with two and three dolls, Wynn says.

Several unpublished studies directed by Renee L. Baillargeon, a psychologist with the University of Illinois at Urbana-Champaign, find comparable calculation skills among 10-month-olds.

Both sets of results also suggest that subitization involves a counting process, supporting contentions that some animals, including birds and apes, calculate small quantities in a way linked to human counting (SN: 5/23/87, p.334), Wynn adds.

Infants' limited short-term memory undoubtedly restricts their counting ability, she notes. Wynn is now testing 5-month-olds on "3 + 1" and "3 – 1."

Wynn's third experiment convincingly demonstrates addition by infants, but she needs to conduct the same control for subtraction, Bryant asserts.

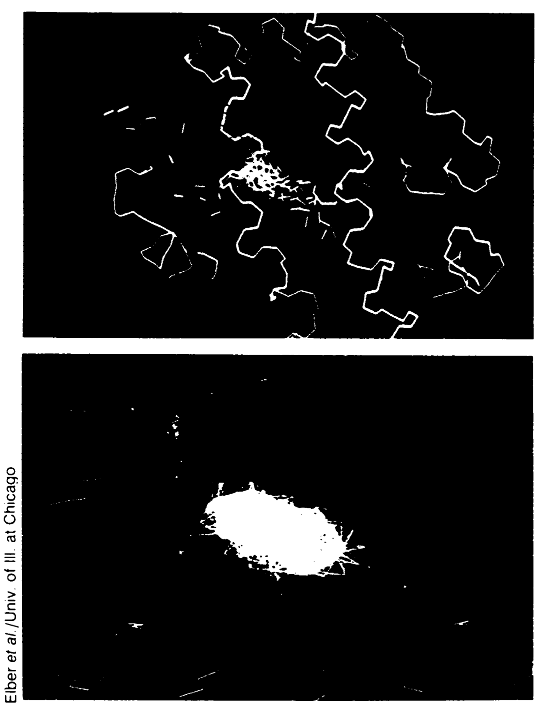
Infants probably do not understand that if, for instance, $3 + 2 = 5$, then $5 - 3 = 2$, he holds. But Wynn's work opens the way to investigating this assumption, Bryant adds. *– B. Bower*

Computer charts path of diffusing molecules

Computer simulations have given chemists a sneak preview of how small molecules worm their way into and out of larger ones. That preview, especially when combined with genetic engineering techniques, can guide researchers in attaining proteins for specific uses.

Two computational chemists have modeled carbon monoxide molecules exiting leghemoglobin, a plant protein that resembles human hemoglobin but which acts to trap rather than transport oxygen. Leghemoglobin has mystified researchers for years because the sites where oxygen or carbon monoxide bind to heme proteins lie deeply buried and seem inaccessible.

The simulations rely on new techniques that simplify the task of tracking the movements of the thousands of atoms that make up proteins, says Ron Elber of the University of Illinois at Chicago. He and Illinois colleague Gennady Verkhivker calculate that it takes just a few nanoseconds for two-atom molecules to escape from this protein. That's at least 10 times faster than those molecules can get out of similar proteins such as myoglobin, Elber says.



Elber et al./Univ. of Ill. at Chicago

Top: Simulation creates 80 molecules (orange) that try to escape from the heme core (red) of the protein (blue). Bottom: Time-lapse image traces one molecule's path (yellow) away from the heme (red) and out of the protein (green).