



NURTURING

RESEARCH ON
BRAIN DEVELOPMENT
IN BABIES REVEALS
MANY WONDERS
OF THEIR GROWTH.
THE FINDINGS ALSO
OFFER A KEY TO
ADDRESSING A
RANGE OF PUBLIC
POLICY ISSUES
AT THE EARLIEST
STAGE POSSIBLE.
BY CHRISTINE H.
O'TOOLE



Connecting neurons at amazing speed, an infant's brain is literally a thousand points of light. In the first months of life, a baby forms some 700 synapses per second, building the ability to recognize patterns of light and sound, bond with caregivers, and gradually regulate behavior.

For the next few years, the infant brain actually prunes away synapses. In adulthood, most humans will learn at a far slower rate. That means that investing in infant development may be far more urgent than addressing later deficits.

"Timing is everything," Nathan Fox, professor of human development at the University of Maryland, told a fall conference at Carnegie Mellon University. "Neurons to Neighborhoods" invited researchers, early education professionals and policymakers to consider the intersection of their fields at a first-of-its-kind meeting sponsored by Carnegie Mellon's BrainHub. The interdisciplinary research center uses technology to support those on the front lines of education and health science.

Executive Director Gerry Balbier called the conference "a rare opportunity. Our faculty wants to have an outlet, here and potentially nationally, to disseminate findings in a way that can be applied."

In the Pittsburgh region, brain research already has been used in the formation of early childhood education programs and family services initiatives. More recent research findings, like those presented at the conference, are attracting the interest of education and civic leaders who see potential in applying the work to efforts to push for more public policy addressing issues affecting children and families.

"We remind our representatives that families, particularly two-worker families, want their child care providers to apply the best possible practices to help babies thrive," said Patrick Dowd, executive director of Allies for Children, which integrates research into public debate on health and education priorities.

Mr. Dowd added that the conference presentations reinvigorated the arguments he presents to legislators on children's issues. The Heinz Endowments has made a \$48,500 grant to support a series of three gatherings addressing brain research across the lifespan. The first meeting attracted more than 50 professionals from across the United States.

"The Heinz Endowments is excited about these convenings, because they build from [Chair Emeritus] Teresa Heinz's initial idea of the first [early brain development] conference more than a decade ago, which provided an opportunity for science and practice to come together to create positive impact for our children, families and communities," said Michelle Figlar, the foundation's vice president of Learning. "This time we have the tremendous opportunity to utilize the resources of the BrainHub to go beyond early childhood and look at brain development through the lifespan, and intentionally connect this research to policy and practice. We also hope to incubate ideas of how multi-disciplinary teams can work together to influence public policy."

Over the past two decades, new imaging technologies developed at Carnegie Mellon and elsewhere allow researchers to observe the brain in action. The results emphasize that in babies' brains, emotional development is as important as meeting cognitive milestones. Stable, caring relationships and face-to-face interactions shape brain architecture in early years, supporting lifelong learning, behavior and even physical health. Conversely, neglect, abuse or poverty may send very young brains off the rails.

As research progresses, scientists are homing in on critical windows of times in brain development. Those "sensitive periods" are points when the effect of experience on brain development can be particularly strong—for example, when acquiring visual information or early language. Molecular biologists are racing to specifically

identify when such critical periods occur and how missed developmental opportunities can be remediated later in life.

Nearly a century ago, animal behavior specialist Konrad Lorenz conducted his study of attachment between newborn goslings and the first moving objects they saw. The famous image of the geese trailing him across a field proved his theory that the bond between infants and caregivers was instinctive and triggered through environmental stimuli. Conference presenters demonstrated how emotional attachment affects human brain development.

Dr. Fox discussed results of his comprehensive 18-year study of children in Bucharest, comparing the development of Romanian toddlers raised in large orphanages with those in birth or adoptive families. Electroencephalograms measured slower brain activity, or alpha waves, in institutionalized children. Gauges of cortisol, a stress-related hormone, showed that emotional neglect blunted their response to stress. But children adopted from orphanages showed the ability to rebound from adversity, especially before 24 months of age. While the children's ability to catch up declined after that point, the findings confirm that a caring environment can rescue and rebuild the brain.

Nim Tottenham, associate professor of psychology at Columbia University, reviewed research on the key role of early caregivers, when the baby's amygdala is highly sensitive to threats. She focuses on the amygdala, which creates the basic fight-or-flight response, and the prefrontal cortex, which governs cognition, personality and decision-making. The circuit between the two, developing slowly over time, regulates emotions.

Brain imaging shows that the presence of a stable caregiver decreases the reactivity of a young child's amygdala. "An infant can't fight or flee—because, let's face it, they wouldn't be good at either," she said. "Their survival mechanism is to attach. When the caregiver meets the needs of the child, the brain has the luxury of plasticity," the ability of the brain to reorganize and learn.

The amygdala's most sensitive developmental period appears to occur before age three; by contrast, mental illness, mood disorders and substance abuse, related to difficulties in emotion regulation, present much later in adolescence.

"That tells us we'd better pay attention to what happened during childhood, when the environment affects the architecture of the system," Dr. Tottenham insisted. "If we know why, we're better equipped to intervene later on."

The leader of a new national effort to provide brain science to parents and caregivers echoed Dr. Tottenham's remarks. "There is no early childhood learning without relationships," said Ellen Galinsky, author of "Mind in the Making: The Seven Essential Life Skills Every Child Needs."

Young children instinctively demand interaction with caregivers through rhythmic babbling, facial expressions and gestures. Adults respond with "baby talk" or "parentese"—the same kind of vocalizing and gesturing back at them. The back-and-forth process, called "serve and return," connects all regions of the brain: Babies visualize the actions they will need to speak.

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Pittsburgh City Councilwoman

Ms. Galinsky is the chief science officer at the Bezos Family Foundation, which is supporting new public outreach efforts through the Vroom campaign. Created in conjunction with Harvard University's Center on the Developing Child, Vroom's website, www.joinvroom.org, and free mobile app suggest quick, simple interactions that build young brains. The program now reaches 100,000 users.

Examples of successfully applied developmental research on attachment include the Allegheny County Department of Human Services' prevention and intervention programs. Erin Dalton, who directs research and evaluation activities for DHS, told the audience at the conference that DHS policy now avoids traumatic out-of-home placements in its Children, Youth and Families programs whenever possible, reducing such cases from 3,500 to 1,200 over the past 20 years. Recognizing that children placed with relatives fare better than those in foster care, it works to find family members to become caregivers.

"Over 60 percent of our foster placements are now with kin," she noted. "But we recognize that often our families have multiple generations with trauma. We need to support all of them."

DHS has documented that services at its regional Family Support Centers help reduce child abuse and neglect. It has coordinated enrollment for home visits for new mothers so that parenting skills and developmental concerns can be addressed promptly. The agency is now studying how predictive risk modeling could identify pregnant clients for intervention from the delivery room onward, to ensure healthy infant growth and brain development.

Despite such success cases, however, governmental restrictions can thwart efforts to apply better brain research.

Ms. Dalton cited interagency pitfalls that hamper interventions. "The federal structure gives [the county] funds only for children removed from the home, not in-home intervention," which comprises 95 percent of DHS's practice. Pennsylvania data could illuminate Allegheny County's incidence of children with numerous adverse childhood experiences (see sidebar), but some of the state's PeopleStat statistics are not yet shared with counties.

"We need help to translate research into interventions that work," she said. "We need to support our workforce in the difficult decisions they're forced to make."

Quality standards for early education programs, like the Keystone STARS program in Pennsylvania, have helped working families find safe and stimulating settings for their preschoolers. The system has recently reemphasized the importance of "serve and return" activity.

Professional training helps early education staff understand their charges' developmental milestones; in turn, a well-qualified staff allows centers to qualify for increased per-child subsidies. But the demand

for those programs far exceeds the supply. At present, there is a waiting list of 400 for spots in Pittsburgh Public Schools' existing pre-K classrooms. The city has established an Office of Early Childhood to work toward universal pre-kindergarten programs for children ages 3 and 4, with additional support for caregivers of babies and toddlers.

City Councilwoman Natalia Rudiak, who has spearheaded the drive for better early education and child care options for Pittsburgh's working families, told the audience that the cost of enrolling all preschoolers not eligible for other subsidies in quality programs would cost the city \$36.2 million. But she also cited well-known work by James Heckman, a Nobel Prize-winning economist; he has estimated the long-term return on public investment in early childhood programs at 7 to 10 percent.

Working with the Women's Caucus of City Council, Ms. Rudiak has redirected \$250,000 in city economic development funds to help child care providers improve safety and quality.

"We now direct more public spending as the brain becomes more stable, but we are lacking the public investment when the brain is developing the fastest. How do we increase that?" she asked. Her answer: political science, rather than neuroscience.

"We need to elect more women advocates," she said.

As BrainHub prepares for a follow-up conference on adolescent brain research this spring, the center's executive director expects that the research presented will provide additional ammunition for farsighted policy decisions.

"We know scientific breakthroughs have served public education," Mr. Balbier said. "We've opened a door to keep on doing this and make it broader, engaging parents more." **h**

ADVERSE IMPACT

Research on children's earliest social and emotional encounters shows that abuse and neglect harm children's cognitive development. At Carnegie Mellon University's BrainHub conference, several scientists cited new data from the Adverse Childhood Experiences (ACE) study, which has been championed by nationally recognized San Francisco pediatrician Dr. Nadine Burke Harris. The study found that the more toxic experiences children face, the more likely they are to suffer chronic illnesses like heart disease and diabetes in adulthood. These results prove that emotional trauma actually changes chemicals in both the brain and the body.

Dr. Burke Harris, who was in Pittsburgh in October to receive the 2016 Heinz Award for the Human Condition, has effectively used ACE data to illuminate health disparities, explaining that children are especially sensitive to repeated stresses at home.

"High doses of adversity not only affect brain structure and function, they affect the developing immune system, developing hormonal systems, and even the way our DNA

is read and transcribed," she told a recent TED audience.

Using a simple 10-question quiz, the survey assigns one point to each experience. The higher the score, the more challenged the child is likely to be as an adult.

"If my patient has an ACE score of 4, she's two and a half times as likely to develop hepatitis or chronic pulmonary disease, she's four and half times as likely to become depressed, and she's 12 times as likely to attempt to take her own life as my patient with zero ACEs," Dr. Burke Harris said.

Research she and others have conducted reveals that when children are exposed to four or more ACEs, they are twice as likely to be overweight or obese, and 32 times as likely to have learning or behavior problems as compared to children of the same income and ethnicity with zero ACEs.

Poor minority children are not the only ones at risk from ACEs, Dr. Burke Harris noted. The original ACE study was done in a population that was 70 percent Caucasian and 70 percent college-educated.