Poverty influences children's early brain development

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Poverty may have direct implications for important, early steps in the development of the brain, saddling children of low-income families with slower rates of growth in two key brain structures, according to researchers from the University of Wisconsin–Madison.

By age 4, children in families living with incomes under 200 percent of the federal poverty line have less gray matter—brain tissue critical for processing of information and execution of actions—than kids growing up in families with higher incomes.

"This is an important link between poverty and biology. We're watching how poverty gets under the skin," says Barbara Wolfe, professor of economics, population health sciences and public affairs and one of the authors of the study, published today in the journal *PLOS ONE*.

The differences among children of the poor became apparent through analysis of hundreds of brain scans from children beginning soon after birth and repeated every few months until 4 years of age.

Children in poor families lagged behind in the development of the parietal and frontal regions of the brain—deficits that help explain behavioral, learning and attention problems more common among disadvantaged children.

The parietal lobe works as the network hub of the brain, connecting disparate parts to make use of stored or incoming information. The

frontal lobe, according to UW–Madison psychology professor Seth Pollak, is one of the last parts of the brain to develop.

"It's the executive. It's the part of the brain we use to control our attention and regulate our behavior," Pollak says. "Those are difficulties children have when transitioning to kindergarten, when educational disparities begin: Are you able to pay attention? Can you avoid a tantrum and stay in your seat? Can you make yourself work on a project?"

The maturation gap of children in poor families is more startling for the lack of difference at birth among the children studied.

"One of the things that is important here is that the infants' brains look very similar at birth," says Pollak, whose work is funded by the National Institutes of Health. "You start seeing the separation in brain growth between the children living in poverty and the more affluent children increase over time, which really implicates the postnatal environment."

The study used brain scans provided by the NIH's MRI Study of Normal Brain Development, data that excludes children whose brain development may have been altered by a number of factors: mothers who smoke or drank during pregnancy, birth complications, head injuries, family psychiatric history and other issues. As a result, the findings may underestimate the actual deficit developed by a more representative sample of children from poor families.

The study found no meaningful difference in gray matter between children of middle-income families and those from relatively wealthy ones.

For poor families—who ranged from extremely poor with almost no cash income to a few tens of thousands of dollars per year—the list of potential environmental factors is lengthy. Poor nutrition and lack of

sleep, lack of books and educational toys, parental stress, an unsafe environment, and limited enriching conversation are just a few of the potential contributors, according to Wolfe.

"All of these may play a role," Wolfe says. "We don't really know their individual contribution or the combined effect. But we do know we observed no apparent structural differences very early in life. This might be viewed as very good news, as it suggests that public policy can reduce the gap."

Pollak expects the absence of enriching activities and interactions are of particular importance.

"We know from nonhuman animal studies that being left in cages without toys and exercise, without stimulation and opportunities to explore, can cause a decrease in the generation of neurons and synapses in the brain," he says.

If lack of enrichment is a major cause of delayed human brain growth, there is good news. Less gray matter at age 4 is not necessarily a permanent problem.

"These people are not doomed, and can hopefully fully recoup if they are appropriately stimulated," Wolfe says. "It means that we as a society need to find ways to help provide an enriched, stimulating and safe environment for these young children."

As many as 16 million children are living below the poverty line in the United States, making interventions a daunting task. But this suggests a great opportunity for these children and for society, and one that is not necessarily expensive.

"When we say enrichment, we're not talking about flashcards or special

software," says graduate student Jamie Hanson, the study's lead author. "We're talking about providing normal interactions: talking to and comforting your child, giving children time to play and explore with you out in a park without stress."

"Still," Wolfe points out, "those are hard things to provide for a poor family working multiple jobs, often working the hours when their children are home, taking long commutes, often looking for safe and affordable places to live."

The researchers are enthusiastic about their collaboration, joining social science (adept at describing family and economic conditions) with psychology and neuroscience (better at testing individuals' biological responses). The UW–Madison group partnered with a team at the University of North Carolina at Chapel Hill who developed a method for measuring children's brain volumes, an especially remarkable technological feat when performed on tiny infant brains.

Provided by University of Wisconsin-Madison