WSU neuroscientists capture brain connectivity in human fetuses

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Research could lead to new insight into the early origins of autism, ADHD and dyslexia

Wayne State University School of Medicine researchers have shown for the first time that brain connectivity in human fetuses can be measured, which could translate into new ways to diagnose, prevent and treat brain disorders like autism, attention deficit hyperactivity disorder, dyslexia and cognitive impairments in early life.

A collaborative project between Wayne State University and the Perinatology Research Branch of the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the National Institutes of Health led to this major discovery. The team, led by neuroscientist Moriah Thomason, Ph.D., assistant professor of Pediatrics at the WSU School of Medicine and director of the Perinatal Neural Connectivity Unit of the PRB, applied functional magnetic resonance imaging to study when communication or connectivity between areas of the brain emerge during human fetal life. Extremely challenging to perform, the research discovered that connectivity is already present during fetal life and becomes stronger during fetal development.

“Many brain disorders are thought to arise from disrupted communication in brain networks,” Dr. Thomason said. “Autism, ADHD and dyslexia, for example, have all been associated with disrupted brain connections. Therefore, it is of great importance to understand how these networks form and what events can impact the formation of networks and their connectivity.”

The study, “Cross-Hemispheric Functional Connectivity in the Human Fetal Brain,” was published in the Feb. 20 issue of Science Translational Medicine, a journal of the American Association for the Advancement of Science. The key findings of this study are:

• Connections between the right and left sides of the brain became stronger as fetuses matured.

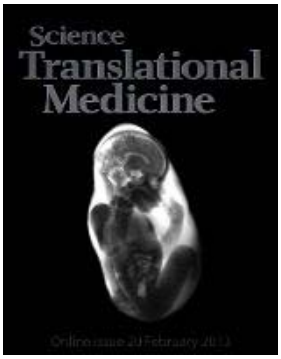
• Short distance connections were more strongly connected than long-range connections in brain networks.

“By studying communication signals of the brain in healthy human fetuses, we are able, for the first time, to observe and measure the formation of these networks at the beginning of life,” Dr. Thomason said. While network connections in adults are well-established, in children, the networks are still developing.

Dr. Thomason’s team pioneered several techniques to overcome the challenges of scanning fetuses without compromising the health and safety of the mother or her child. Researchers obtained functional MRI connectivity diagrams for more than 80 regions in the fetal brain.

Moriah Thomason, Ph.D., prepares pregnant study volunteer Porsha Crudup for her pregnancy fMRI scan at the MR Research Facility at Wayne State University.

Dr. Thomason points to 31-week female fetus, named Avery by expecting parents.



The Feb. 20 issue of Science Translational Medicine features

an MRI of a fetus by Dr. Thomason.

“When we began (in November 2012), we did not even know if these communication signals could be measured in the human fetus,” Dr. Thomason said.

The study reveals fetuses are forming connections before they’re born, and that these span shorter distances before they expand to connect widely distributed brain areas.

The team will now work to further define the order and timing of how brain networks are formed in utero, and compare the development of these brain networks in fetuses with disease, illness or unwanted exposures during pregnancy to determine how neural connection development is disrupted.

“A major motivation for this study was to understand the reasons why premature babies are at risk for cerebral palsy and other neurologic disorders,” said Roberto Romero, M.D., D.Med.Sci., chief of the Perinatology Research Branch, which focuses on the prevention of preterm birth and its long-term consequences. “More than half of preterm children require special assistance in the classroom: 20 percent are in special education and 50 percent repeat at least one grade in high school. We believe that insults (such as “silent” intrauterine infection or fetal oxygen deficiency) can affect the development of brain connectivity in utero, and this accounts for many of these disorders. The study published today is part of ongoing research to determine whether insults during fetal life have an effect on the brain, and how we can prevent long-term consequences.”

The MRI examinations were performed at WSU’s Vainutis Vaitkevicius, M.D. Magnetic Resonance Research Facility, located at Harper University Hospital in Detroit, under the direction of E. Mark Haacke, Ph.D., a WSU professor of Radiology and Biomedical Engineering. The research was supported in part by the Merrill Palmer Skillman Institute for Child and Family Development, the Kellogg Foundation, the WSU Department of Pediatrics and the NICHD.