

'Brain road maps' reflect behavior differences between males and females

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Credit: George Hodan/public domain

Differences in the neural wiring across development of men and women across ages, matched behavioral differences commonly associated with each of the sexes, according to an imaging-based study from researchers at the Perelman School of Medicine at the University of Pennsylvania published February 1 in *Philosophical Transactions of the Royal Society B*.

The Penn team, including senior author Ragini Verma, PhD, an associate professor in the Center for Biomedical Image Computing and Analytics (CBICA), department of Radiology, performed [diffusion tensor imaging](#) (DTI) brain scans and administered a computerized neurocognitive battery (CNB) of tests on 900 randomly selected healthy and unmedicated Philadelphian children and young adults, ages 8 to 22 years, to find how structural [differences](#) in the brain may relate to male and female behavior differences such as men being more likely to be better at learning and performing a single task at hand and women being more likely to exhibit superior memory and [social cognition](#) skills. These methods allowed the team, including lead authors Birkan Tunc, PhD, a research associate, and Berkan Solmaz, PhD, a postdoctoral researcher in Radiology, CBICA, and co-authors Ruben C. Gur, PhD, a professor of psychology in the department of Psychiatry, and Raquel E. Gur, MD, PhD, professor of Psychiatry, Neurology and Radiology, to develop a structural connectome, akin to a road map of each subject's brain.

As a natural gateway to fathom the human mind and behavior, studies concentrating on the human structural connectome are an important part of efforts to investigate [sex differences](#). Insight into [brain differences](#) between men and women offers important considerations for the growing field of personalized medicine, which U.S. President Barack Obama announced \$215 million in support for in his recent State of the Union address. The findings also have potential implications for treatment of a variety of conditions.

Differences in the cause and progression of some diseases and disorders according to sex sometimes influence treatment of those conditions. For instance, men are far more likely to get autism than women are. And in schizophrenia, which is also more frequent in males, the onset and severity of the disease differ between the sexes.

"Links between brain and behavior possibly rely on a complex interplay

among multiple features of the neurobiological mechanism," Verma said. "Network theoretical studies pertaining to the properties of the structural connectome may provide pioneering insights into these links."

Her team studied sex related differences in the connectivity of the subnetworks that were defined based on structural characteristics, functional systems, and finally, behavioral domains. Subnetworks are clusters of brain regions and their connectivity, which are associated with functionality or behavioral domains such as motor abilities, social motivation or cognitive control.

The team's [findings build on a 2013 *Proceedings of the National Academy of Sciences \(PNAS\)* study](#) in which they found, on average, differences in the neural wiring of men and women. This latest study delves deeper, reporting that differences in the behaviors of men and women are accompanied by related differences in the brain subnetworks. According to findings of the team, stronger structural connectivity in motor, sensory, and executive functions matched higher motor and spatial skills in males. In females, subnetworks associated with social cognition, attention and memory tasks had higher connectivity and matched improved memory and social cognition skills.

"On a macro level, behavior-related disorders manifest and progress differently based on sex, and these findings should advance conversations about how we manage some of those conditions," Verma said. "Our results suggest a synchrony between sex-related differences in the brain network and behavior. Thus, in a near future, we may be able to pinpoint precisely at the subnetwork level what we know about an individual's brain and how to manage care of whatever disorders or ailments they are facing."

More information: Birkan Tunç et al. Establishing a link between sex-related differences in the structural connectome and behaviour,

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