Medical Xpress

Decision-making is shaped by individual differences in the functional brain connectome

March 19 2018, by Liz Ahlberg Touchstone

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Each day brings with it a host of decisions to be made, and each person approaches those decisions differently. A new study by University of Illinois researchers found that these individual differences are associated with variation in specific brain networks – particularly those related to executive, social and perceptual processes.

A group of researchers at the Beckman Institute for Advanced Science and Technology at Illinois, led by psychology professor Aron Barbey and postdoctoral researcher Tanveer Talukdar, investigated whether individual differences in brain connectivity were associated with decision-making, using functional MRI and a comprehensive test of decision-making. While prior studies of decision-making have focused on group effects, or the ways everyone's brains are similar, the new study focused on individual differences.

"People often take different approaches to decision-making. They might apply different strategies, consider different elements of the problem or assign value to the options differently," Barbey said. "Our research suggests that neurobiological differences appear to be important when accounting for one's susceptibility to biases in judgment and for understanding their competence in decision-making."

The study, published in the journal *Human Brain Mapping*, is one of the largest and most comprehensive experiments of individual differences in decision-making conducted to date, the researchers said, with 304 healthy adult participants.

Study participants were administered the Adult Decision-Making Competence test, a comprehensive psychological evaluation tool that measures six well-established facets of decision-making – for example, "resistance to framing" and "risk perception."

"When making everyday decisions, we may be vulnerable to specific types of errors and biases in judgment. The Adult Decision-Making Competence test allows us to characterize the extent to which people are susceptible to specific types of biases that have been studied in the literature on human judgment and decision-making," Barbey said. "A person is thought to be competent in decision-making to the extent that they are able to resist these biases and to make accurate decisions."

The researchers also administered resting-state functional MRI to assess functional brain connectivity within each study participant. They didn't focus merely on individual regions, but assessed the entire functional brain connectome – which represents how each region is functionally connected to every other region of the brain.

"We conducted an analysis of the whole brain, examining the connections among all regions," Talukdar said. "We examined the functional brain connectome of each individual and then investigated how each individual's connectome differed from every other individual in the sample."

Next, the researchers analyzed how the individual differences they saw in the brain were associated with performance on the Adult Decision-Making Competence test.

They found that functional connectivity within specific brain regions was associated with individual differences in decision-making. As expected, brain regions within the frontal lobe were involved, which are known to support executive functions such as reasoning and problem-solving. In addition, regions within the temporal and parietal cortex, which support memory and attention, as well as brain structures within the occipital lobe, which process visual and spatial information, were engaged.

The researchers then performed an analysis to further characterize the role of these regions by examining their contributions to specific intrinsic connectivity networks.

"Research indicates that the brain is functionally organized according to intrinsic connectivity networks, which are known to play a central role in specific facets of intelligence. For example, the fronto-parietal network regulates executive functions, the ventral attention network supports

attention, and the limbic network underlies emotional and social processing," Talukdar said.

The researchers found that individual differences in functional brain connectivity reflected differences in how certain intrinsic connectivity networks were engaged. For example, the measure of "resistance to framing," which assesses whether individuals' choices are susceptible to irrelevant variations in a problem description, was associated with the ventral attention network. The researchers hypothesized that this network directs attention to essential aspects of the problem, which serves to attenuate the framing bias.

Barbey's group is further studying how individual differences in functional brain connectivity are shaped by learning and experience. Their next study investigates whether decision-making competence can be improved by specific interventions – ranging from cognitive training, noninvasive brain stimulation, physical fitness training and nutrition – to target the brain networks identified in the current study.

"Decision-making competence is known to be influenced by lifestyle factors, such as social engagement, diet and physical activity," Talukdar said. "Now we can design interventions that take into account an individual's functional brain connectivity and the respects in which people differ in their approach to decision-making."

More information: Tanveer Talukdar et al. Individual differences in decision making competence revealed by multivariate fMRI, *Human Brain Mapping* (2018). DOI: 10.1002/hbm.24032

Provided by University of Illinois at Urbana-Champaign