Researchers show brain's battle for attention

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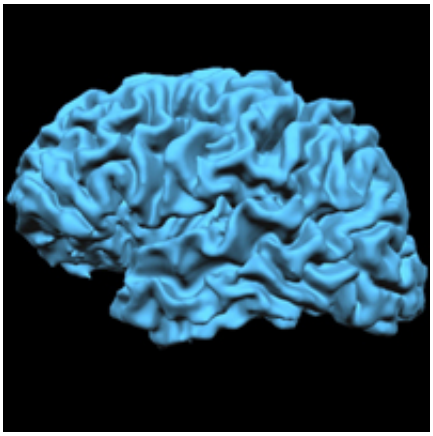

MRI brain scan

(Medical Xpress)—We've all been there: You're at work deeply immersed in a project when suddenly you start thinking about your weekend plans. It happens because behind the scenes, parts of your brain are battling for control.

Now, University of Florida researchers and their colleagues are using a new technique that allows them to examine how parts of the brain battle for dominance when a person tries to concentrate on a task. Addressing these fluctuations in attention may help scientists better understand many neurological disorders such as autism, depression and mild cognitive impairment.

Mingzhou Ding, a professor of biomedical engineering, and Xiaotong

Wen, an assistant research scientist of biomedical engineering, both of the University of Florida; Yijun Liu of the McKnight Brain Institute of the University of Florida and Peking University, Beijing; and Li Yao of Beijing Normal University, report their findings in the current issue of *The Journal of Neuroscience*.

Scientists know different networks within the brain have distinct functions. Ding, Wen and their colleagues used a brain imaging technique called functional magnetic resonance imaging and biostatistical methods to examine interactions between a set of areas they call the task control network and another set of areas known as the default mode network.

The task control network regulates attention to surroundings, controlling concentration on a task such as doing homework, or listening for emotional cues during a conversation. The default mode network is thought to regulate self-reflection and emotion, and often becomes active when a person seems to be doing nothing else.

"We knew that the default mode network decreases in activity when a task is being performed, but we didn't know why or how," said Ding, a professor of biomedical engineering in the J. Crayton Pruitt department of biomedical engineering. "We also wanted to know what is driving that activity decrease.

"For a long time, the questions we are asking could not be answered."

In the past, researchers could not distinguish between directions of interactions between regions of the brain, and could come up with only one number to represent an average of the back-and-forth interactions. Ding and his colleagues used a new technique to untangle the interactions in each direction to show how the different brain regions interact with one another.

In their study, the researchers used fMRI to examine the brains of people performing a task that required concentration. The scientists can see the activity in certain areas of the brain at the same time a person is performing a given task. They can see which parts of the brain are active and which are not and correlate this to how successful a person is at a given task. They then applied the Granger causality technique to look at the data they saw in the fMRI. Named for Nobel Prize-winning economist Clive Granger, this technique allows scientists to examine how one variable affects another variable; in this case, how one region of the brain influences another.

"People have hypothesized different functions for signals going in different directions," Ding said. "We show that when the task control network suppresses the default mode network, the person can do the task better and faster. The better the default mode network is shut down, the better a person performs."

However, when the default mode network is not sufficiently suppressed, it sends signals to the task control network that effectively distract the person, causing his or her performance to drop. So while the task control network suppresses the default mode network, the default mode network also interferes with the task control network.

"Your brain is a constant seesaw back and forth," even when trying to concentrate on a task, Ding said.

The Granger causality technique may help researchers learn more about how neurological disorders work. Researchers have found that the default mode network remains unchanged in people with autism whether they are performing a task or interacting with the environment, which could explain symptoms such as difficulty reading social cues or being easily overwhelmed by sensory stimulation. Scientists have made similar findings with depression and mild cognitive impairment. However, until

now no one has been able to address what areas of the brain might be regulating the default mode network and which might be interfering with that regulation.

"Now we are able to address these questions," Ding said.

Provided by University of Florida