Medical Xpress

Scientists adapt economics theory to trace brain's information flow

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Scientists have used a technique originally developed for economic study to become the first to overcome a significant challenge in brain research: determining the flow of information from one part of the brain to another.

Researchers at Washington University School of Medicine in St. Louis and Florida Atlantic University report the new capability in *The Journal of Neuroscience*. It will provide important insights into brain organization and function, advancing efforts to help patients recover from brain injuries and mental disorders.

For years, scientists have used scanners to identify the brain regions involved in particular mental tasks. But they cannot get that data fast enough to trace the flow of information from one area of the brain to another.

"It's been like getting a picture of the members of an orchestra but not knowing the sequence in which each instrument was playing," says senior author Maurizio Corbetta, M.D., the Norman J. Stupp Professor of Neurology. "Now, for the first time, we can look at the questions of who's talking to whom in the brain, and what directions the activations of brain areas are flowing in."

The economic technique they used, called Granger causality, was developed by Sir Clive Granger, a co-recipient of the 2003 Nobel Memorial Prize in Economic Sciences who is now an emeritus economics professor at the University of California, San Diego.

The approach involves comparisons of streams of data known as time series, such as fluctuations in the stock market index and changes in employment levels. Because they consist of many pictures of the rise and fall of a value taken at regular time intervals, time series are comparable to movies. Given two movies, the comparison starts with frames from each of the movies taken at the same point in time. The second movie is then backed up one frame or more. Changes in those earlier frames in the second movie may predict changes that show up in a later frame of the first movie. Granger causality helps determine whether this link is coincidence or results from one process influencing another process.

Granger's original objective was to see if links could be established that allowed economists to use current economic data to forecast changes in the economy in the near future. But first author Steven L. Bressler, Ph.D., professor of psychology at Florida Atlantic University, suspected the technique might help reveal if one brain area was passing data to or influencing another brain area.

Chad Sylvester, an M.D./Ph.D. student at Washington University, gathered the data for the analysis. Researchers gave volunteers a cue that a visual stimulus would be appearing soon in a portion of a computer display screen, and asked them to report when the stimulus appeared and what they saw. Corbetta's group previously revealed that this task activated two brain areas: the frontoparietal cortex, which is involved in the direction of the attention, and the visual cortex, which became more active in the area where volunteers were cued to expect the stimulus to appear.

Scientists believed the frontoparietal cortex was influencing the visual cortex, but the brain scanning approach they were using, functional magnetic resonance imaging (fMRI), can only complete scans about once every two seconds, which was much too slow to catch that influence in action. When researchers applied Granger causality, though, they were able to show conclusively that as volunteers waited for the stimulus to appear, the frontoparietal cortex was influencing the visual cortex, not the reverse.

"Once the visual stimulus appears, we expect that the direction of influence between the frontoparietal cortex and the visual cortex will be less asymmetric, but this remains to be proven," notes co-author Gordon L. Shulman, Ph.D., research professor of neurology at Washington University.

Corbetta wants to apply Granger causality to a number of important questions about relationships in the brain, including attention's interactions with vision and memory. He will also use it to learn more about the extent to which the brain can adapt to injury by examining whether lesions in one area affect the flow of information processing in another area.

Source: Washington University School of Medicine