Brain 'maps' reveal clue to mental decline

8 February 2011

(PhysOrg.com) -- The human brain operates as a highly interconnected small-world network, not as a collection of discrete regions as previously believed, with important implications for why many of us experience cognitive declines in old age, a new study shows.

Australian researchers have mapped the brain's neural networks and for the first time linked them with specific cognitive functions, such as information processing and language. Results from the study are published in the prestigious *Journal of Neuroscience*.

The researchers from the University of New South Wales are now examining what factors may influence the efficiency of these networks in the hope they can be manipulated to reduce age-related decline.

"While particular brain regions are important for specific functions, the capacity of information flow within and between regions is also crucial," said study leader Scientia Professor Perminder Sachdev from UNSW's School of Psychiatry.

"We all know what happens when road or phone networks get clogged or interrupted. It's much the same in the brain.

"With age, the brain network deteriorates and this leads to slowing of the speed of information processing, which has the potential to impact on other cognitive functions."

The advent of new MRI technology and increased computational power had allowed the development of the neural maps, resulting in a paradigm shift in the way scientists view the brain, Professor Sachdev said.

"In the past when people looked at the brain they focused on the grey matter in specific regions because they thought that was where the activity was. White matter was the poor cousin. But white matter is what connects one brain region to another and without the connections grey matter is useless," he said.

In the study, the researchers performed magnetic resonance imaging (MRI) scans on 342 healthy individuals aged 72 to 92, using a new imaging technique called diffusion tensor imaging (DTI).

Using a mathematical technique called graph theory, they plotted and measured the properties of the neural connectivity they observed.

"We found that the efficiency of the whole brain network of cortical fibre connections had an influence on processing speed, visuospatial function - the ability to navigate in space - and executive function," said study first author Dr Wei Wen.

"In particular greater processing speed was significantly correlated with better connectivity of nearly all the cortical regions of the brain."

Professor Sachdev said the findings help explain how cognitive functions are organised in the brain, and the more highly distributed nature of some functions over others.

"We are now examining the factors that affect age-related changes in brain network efficiency - whether they are genetic or environmental - with the hope that we can influence them to reduce age-related decline," Professor Sachdev said.

"We know the brain is not immutable; that if we work on the plasticity in these networks we may be able to improve the efficiency of the connections and therefore cognitive functions."

Provided by University of New South Wales