The aging brain: Failure to communicate

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A team of Howard Hughes Medical Institute researchers has shown that normal aging disrupts communication between different regions of the brain. The new research, which used advanced medical imaging techniques to look at the brain function of 93 healthy individuals from 18 to 93 years old, shows that this decline happens even in the absence of serious pathologies like Alzheimer's disease.

Researchers have known for quite some time that normal aging slowly degrades bundles of axons in the central nervous system that transmit critical signals. “Our study now shows that cognitive decline in aging may be linked to disruption of communication between different regions of the brain,” said Buckner, who is a Howard Hughes Medical Institute investigator at Harvard University.

The new research, published December 6, 2007, in the journal *Neuron*, begins to reveal how simply growing old can affect the higher-level brain systems that govern cognition. “We may have caught the failure of communication in the act,” said Buckner.

The human brain can be divided into major functional regions, each responsible for different kinds of “applications,” such as memory, sensory input and processing, executive function or even one’s own internal musing. The functional regions of the brain are linked by a network of white matter conduits. These communication channels help the brain coordinate and share information from the brain’s different regions. White matter is the tissue through which messages pass from different regions of the brain.

Scientists have known that white matter degrades with age, but they did not understand how that decline contributes to the degradation of the large-scale systems that govern cognition.

“The crosstalk between the different parts of the brain is like a conference call,” said Jessica Andrews-Hanna, a graduate student in Buckner's lab and the lead author of the study. “We were eavesdropping on this crosstalk and we looked at how activity in one region of the brain correlates with another.”

Buckner, Andrews-Hanna, and their colleagues looked at crosstalk in the brains of 93 people aged 18 to 93, divided roughly into a young adult group (18-34 years old) and an old adult group (60-93 years old). The older participants were given a battery of tests to measure their cognitive abilities -- including memory, executive function and processing speed. Each person was studied using functional magnetic resonance imaging (fMRI) exams to measure activity in different parts of the brain. fMRI can precisely map enhanced blood flow in specific regions of the brain. Increased blood flow reflects greater activity in regions of the brain that are utilized during mental tasks.

For the task used in the Neuron study, subjects were presented words and were asked to decide whether each word represented a living (e.g., dog) or nonliving (e.g., house) object. “Such a task requires the participants to meaningfully process the words,” said Buckner.

Buckner's group explored whether aging in the older group caused a loss of correlation between the regions of the brain that -- at least in young adults -- engage in robust neural crosstalk.

They focused on the links within two critical networks, one responsible for processing information from the outside world and one, known as the default network, which is more internal and kicks in when we muse to

ourselves. For example, the default network is presumed to depend on two regions of the brain linked by long-range white matter pathways. The new study revealed a dramatic difference in these regions between young and old subjects. “We found that in young adults, the front of the brain was pretty well in sync with the back of the brain,” said Andrews-Hanna. “In older adults this was not the case. The regions became out of sync and they were less correlated with each other.” Interestingly, the older adults with normal, high correlations performed better on cognitive tests.

According to Buckner, it is inferred that in a young, healthy brain, signals are readily transmitted by white-matter conduits. As we age, those conduits are compromised. “Measures of white matter integrity in the older adults point to decline,” he said. Depending on the networks at play, the result may be impaired memory, reasoning or other important cognitive functions.

Buckner and Andrews-Hanna emphasized that other changes in the aging brain may contribute to cognitive decline. For example, cells’ ability to express chemical neurotransmitters may also be compromised.

In general, the new work promises a better physiological understanding of cognitive decline in the elderly and may help explain differences among individuals. “It may help explain why some people are just as sharp in their 90s as they were in their 40s,” noted Andrews-Hanna. “We all age differently and cognitive abilities vary considerably among individuals.”

Typically, said Buckner, as individuals get into their 70s and 80s, you see some degree of change. “We can use this new approach (correlating the activities of different regions of the brain) as a tool to understand variation between individuals. We can also explore risk factors for breakdowns (in these pathways) like cardiovascular health.”

Source: Howard Hughes Medical Institute