Cognitive decline may be detected using network analysis, according to researchers

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We all lose our car keys or our glasses from time to time. Most people would be correct to laugh it off as a normal part of aging. But for others, cognitive decline may start as a worrying but clinically unnoticeable step

toward cognitive impairment, be it relatively mild or as severe as Alzheimer's disease.

The vast complexity of the human brain makes early diagnosis of cognitive decline difficult to achieve, which has potentially important implications for treatment and prevention. This is especially true for subjective cognitive decline, in which an individual reports concerns about memory or cognitive ability but shows no deviation on cognitive tests administered by clinicians.

That's the focus of a paper in the journal *Cortex* by Concordia Ph.D. student Nicholas Grunden and Department of Psychology professor Natalie Phillips. In it they use a novel technique called network analysis to study whether it can reveal the subtle changes associated with subjective cognitive decline that cannot be detected through standard test analyses.

A network approach models cognitive performance as a web of intertwined cognitive abilities that reflects the relationships between a set of variables or nodes. The nodes here are the results of several neuropsychological tests, as well as participant characteristics like age, sex, and education.

By running a statistical analysis of data merged from two large Canadian data sets, the researchers were able to visualize the strength of relationships between the nodes among people who are classified as cognitively normal (CN), or who have diagnoses of subjective cognitive decline (SCD), mild cognitive impairment (MCI) or Alzheimer's disease (AD).

"The nodes are connected by edges, which are the conditional associations between them," Grunden says. "The edge reflects how those variables work together. Are they positively correlated or negatively

correlated? The network shows us how strong these associations are by how saturated the edges are. It's a built-in visual communication of findings."

Seeing the decline

After constructing the networks using the merged databases, the researchers identified two nodes that exert the strongest influence on the rest of the network: performance on tests of executive function and processing speed. Both are known to decline with age.

The strength of these two nodes, however, had marked decreases from the cognitively normal to the subjective cognitive decline to the mild cognitive impairment groups. This progressive gradient places SCD as an intermediate stage between CN and MCI.

"We found that very interesting because it uncovered something that speaks to individuals' subjective concerns that are invisible in normal statistical analyses," Grunden explains.

"Executive function and processing speed are important cognitive abilities in that they contribute to other abilities (e.g., language, attention) and are integral to supporting an individual's day-to-day functioning in their lives. We know efficiency decreases as we age but we also see them at the initial stages of some types of progressive cognitive decline."

Age limits

The researchers also noticed an important component to the role of age. While it is one of the strongest predictors of cognitive decline, and it exerted substantial influence on cognitive abilities among those

classified CN and SCD, that influence waned among those classified MCI or AD. For them, other nodes measuring cognitive ability take on more weight.

"In other words, all things considered, age will be the biggest influence on cognition for older adults who do not show signs of Alzheimer's disease," says Phillips, the Concordia University Research Chair in Sensory-Cognitive Health in Aging and Dementia.

"But that is not the case in those individuals who have a diagnosis of MCI or Alzheimer's disease. For them, cognitive function is more associated with how advanced their disease is, as indicated by general measures of clinical status on standardized cognition tests like the Montreal Cognitive Assessment Test."

Grunden says network analysis can help researchers examine brain function as a system rather than isolated variables acting upon each other.

"This helps us read between the lines because we can look at the interrelationships between all of the variables at the same time," he says. "You can pick up on indicators that are less apparent in single elements of data and instead focus on associations between them."

More information: Nicholas Grunden et al, A network approach to subjective cognitive decline: Exploring multivariate relationships in neuropsychological test performance across Alzheimer's disease risk states, *Cortex* (2024). DOI: 10.1016/j.cortex.2024.02.005

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