Decreased Dynamic Flexibility of Brain Functional Connectivity in Prodromal Alzheimer's Disease

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Background and Hypothesis:

In neuroimaging, functional connectivity (FC), defined as the correlation between the functional MRI signals of two brain grey matter regions of interest (ROIs), is thought to reflect communication between ROIs. Changes in whole brain FC networks have been detected in Alzheimer's disease (AD); however, traditional FC networks generated using the entire length of an fMRI scan could miss cognitively relevant fluctuations in FC. Analyzing dynamic patterns of FC within subsets of fMRI scans is hypothesized to enable greater sensitivity to deficits of information transfer and processing in AD compared to static FC.

Project Methods:

Functional MRI data of 58 participants with either subjective cognitive decline (SCD), mild cognitive impairment (MCI), AD, or controls were divided into time windows; the FC within each window provides sequential dynamic FC networks (dFC). Each dFC network was partitioned into subnetworks, e.g. visual or motor, whose member ROIs are strongly interconnected, and the functional flexibility of an ROI was estimated by the number of times it switches subnetworks in a scan.

Results:

The flexibility of the left inferior parietal lobule, right rostral lateral orbitofrontal cortex, and right amyglada/parahippocampal gyrus showed the highest correlations with Montreal Cognitive Assessment scores: $r = 0.2516$, 0.2480, and 2421, respectively. Although no correlations reached conventional significance ($p = 0.0568$, 0.0605, and 0.0671, uncorrected), this may reflect low power that should be increased with a planned larger sample.

Potential Impact:

Dynamic FC analyses may help clarify the neurophysiological mechanisms underlying cognitive decline, but methodological refinements and higher resolution data are likely needed to realize this potential.