Memory-task activation and resting-state connectivity measured by functional MRI are correlated in subjects with normal aging and mild cognitive impairment

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Background: Alzheimer’s disease (AD) is characterized by changes in multiple biomarkers; however, each of these alterations has mostly been investigated independently. Recently, there has been increasing interest in fusing information originating from different modalities (Calhoun, NeuroImage 2014). Indeed, the use of multiple sources of information could depict a more accurate multidimensional view of brain mechanisms by integrating several complementary representations. Here, we fuse two functional magnetic resonance imaging (fMRI) measures, namely task-based activity and resting-state (RS) functional connectivity, to examine their relationship across the spectrum from normal aging to amnestic mild cognitive impairment (aMCI), the prodromal stage of AD.

Methods: Task-based and RS fMRI were acquired in 22 aMCI patients (of which 12 converted to AD at follow-up) and 22 age-and education-matched elderly controls (EC). We used an associative memory task (van der Meulen, Cogn Behav Neurol 2012) to investigate associative recollection versus familiarity-based recognition. Task-based functional images were preprocessed using a standard procedure with SPM12, while RS fMRI data were preprocessed following the methodology described in previous work (Richiardi, NeuroImage 2011, 2012). We applied partial least squares correlation, a powerful multivariate data-driven technique that maximizes the covariance between two modalities in terms of latent variables (LVs).

Results: We obtained strong correlations in terms of 10 significant LVs, of which two were associated with subjects’ diagnosis. Interestingly, the first LV links activity in a pattern of memory-related regions during task, with the connectivity strength of the default-mode network during rest. In addition, both task and rest scores for this LV were significantly different between MCI converters and non-converters. The second LV relates task activations in regions more generally involved in memory processes and error detection, with RS connectivity in the salience network. For this LV, both task and rest scores could distinguish EC from aMCI.

Conclusions: We revealed a strong relationship between task activity and RS connectivity across normal aging and aMCI. These findings provide direct evidence and enrich previous reports about qualitative correspondence between for instance ICA maps from task- and RS fMRI data (Smith, PNAS 2009).