Relating resting state brain connectivity in hippocampal regions to individual differences in topographical navigation and semantic cognition

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Background: Resting state scanning and the accompanying functional connectivity analysis have gained immense popularity since their initial characterisations. However, the exact cognitive profile of this unconstrained state remains to be elucidated. This method allows us to profile the connectivity of seeded hippocampal sub regions to test whether they show strong patterns of functional connectivity to brain regions that are specific to either navigational or semantic function. Evidence for these function based hippocampal subdivisions has been provided by Nadel et al (2012). To this end, the main objective of this study was to reveal the relationship between fMRI-based resting state brain connectivity in anterior and posterior hippocampus regions across 3 cohorts.

Methods: A total of 165 participants underwent resting state scanning (3T GE HDx Excite, TR = 3000 ms, 180 volumes), and were independently tested on a range of semantic and navigational tasks. All fMRI data was preprocessed following a standard procedure. Two further sets of resting state data collected in different sets of subjects (N=141 and N=75) were analysed to test the consistency of group resting state patterns across all three cohorts. Subsequently, the patterns across the three independant data sets were entered into separate functional connectivity analyses and conjunctions between the patterns were calculated based on bihemisphere anterior and posterior anatomical hippocampal masks as seed regions. Functional connectivity contrasts were then calculated between to compare anterior and posterior hippocampal seed regions. Conjunction analyses were then calculated across all the data sets to find common functional connectivity patterns across all three cohorts. All results were cluster corrected for multiple comparisons at the FWE 0.05 level of significance.

Results: The functional resting state results indicated that across all 3 cohorts the anterior hippocampus showed greater connectivity to anterior and medial brain structures related to semantic processing (e.g. Superior Temporal Gyrus and Frontal Medial Cortex). In contrast the posterior hippocampus showed greater connectivity with posterior brain regions (e.g. Lingual Gyrus and Precuneus). These findings demonstrate that resting state connectivity in anterior and posterior hippocampus regions is related to brain regions with segregated functions.

Conclusions: The connectivity differences between anterior and posterior hippocampus suggests clear functional subdivisions and potential function based organisation of the hippocampus. Anterior hippocampus shows greater connectivity to semantic regions and posterior hippocampus shows greater connectivity to navigational regions. Further task-based studies will be necessary to understand functional organisation of the hippocampus.