Title: Investigating how the spontaneous reactivation of behaviorally relevant neural ensembles influences specific resting-state networks

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Background: The behavioral relevance of resting-state networks (RSNs) and neural ensembles are both popular areas of investigation, yet how these local and global dynamics might interact has remained relatively unexplored. An ideal opportunity to connect these two areas might come from investigating the default mode network’s (DMN) role in memory consolidation. Specifically, changes in DMN fluctuations related to memory consolidation might occur during large deflections (sharp-waves) in the hippocampal local field potential (LFP) that co-occur with high-frequency (>80 Hz) oscillations called ripples, both during sleep and awake deliberative periods. Ripples are ideally suited for memory consolidation, since the reactivation of hippocampal place cell ensembles occurs during ripples. Notably, a recent study in macaques has shown diffuse fMRI neocortical activation and subcortical deactivation specifically after ripples. Yet it is unclear how these ripples can propagate and selectively influence endogenous fluctuations in specific RSNs—like the DMN—unitarily.

Methods: Here, we examine fMRI datasets from anesthetized monkeys with simultaneous hippocampal electrophysiology recordings. Using spatial independent component analysis (ICA), we isolate several prominent RSNs, including the DMN. We then use structural network analysis from diffusion tensor imaging (DTI) datasets to see how high-amplitude neural events like ripples might propagate from the hippocampus and influence separate neocortical regions differently.

Results: We observe a dramatic increase in the DMN fMRI signal following ripples, but not other hippocampal electrophysiological events. Crucially, we find increases in ongoing DMN activity after ripples, but not other RSNs. Using computational modeling informed by structural connectivity measures, we show that this effect is not exclusively explained by anatomical distance or direct projections from the hippocampus, but also by the ongoing functional connectivity in the DMN.

Conclusions: Our results relate endogenous fluctuations in the DMN to hippocampal ripples, thereby linking network-level fMRI fluctuations with behaviorally relevant circuit-level neural dynamics. Additionally, we present preliminary computational modeling evidence showing how this propagation might occur and that it cannot purely be explained by having the most regions with direct anatomical connections to the hippocampus. Taken together, our computational and experimental evidence suggests that high-amplitude neural events can propagate to disparate brain regions and selectively engage different RSNs.