Activity within the default mode network predicts the organization of human memory.

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Introduction

- The default mode network can be fractionated into sub-networks that support specific cognitive functions including memory retrieval.¹
- A posterior medial subsystem has been proposed to support context-based representations fundamental to episodic memory.²
- Despite evidence linking these cortical networks to mnemonic functions, it is unclear how they influence memory search.
- We developed a family of neurally informed computational models to test the relationship between functional network activity and cognitive mechanisms that predict the organization of memory search.

Experimental Methods

Experiment 1: DMN Informed Model

Encoding: Informed Context
- Fill Delay: Informed Context
- Unfilled Delay: Uninformed Context
- Free Recall: Informed Context

Experiment 2: PM Informed Model

Encoding: Informed Context
- Fill Delay: Informed Context
- Unfilled Delay: Uninformed Context
- Free Recall: Informed Context

Computational Framework

Verbal Recall
Baseline Model
Prediction
BOLD Response
Neural Model
Prediction

Linking Hypotheses:

- Activity in components of interest during recall reflects the integration of contextual information into a recall cue that is influence memory search.

Modeling Results:

- Increased PM activity reflects increased context retrieval, improving prediction (D = 0.16, P < 0.001).
- Two independent components from Kragel and Polyn¹ that demonstrate spatial correspondence to the default mode network, PM, posterior medial; FC, posterior cingulate; MP, medial prefrontal.

Postero medial network activity informs context maintenance

Behavioral Results:

- Increased activity in the DMN reflects an increase in context retrieval, leading to improved prediction of recall sequence (D = 0.16, P < 0.001).
- Increased COP activity during the delay period in post-task context retrieval, allowing for improved prediction of behavioral (D = 0.28, P < 0.001).

Linking Hypotheses:

- Delay period activity in networks of interest reflects the disruption of a current contextual state.
- Delay period activity reflects the integration of contextual information following distraction, allowing access to the list.

Modeling Results:

- Neural signal reflects end-of-list context retrieval.
- Neural signal reflects retrieval of spatial context.

Default mode network activity informs context maintenance

Behavioral Results:

- Distraction during the delay conditions caused a decrease in recall of memory (t = -1.94, P = 0.056) and a shift in recall order (F(1,7) = 9.33, P = 0.036).

Linking Hypotheses:

- Using ICA, we identified multiple functional networks that exhibit delay-period sensitive activity. RFP (right frontopolar); LFP, left frontopolar; COP, cingulo-opercular network; DMN, default mode network.

Model Performance

Experiment 1: DMN Informed Model

Unfilled Condition
Filled Condition

Experiment 2: PM Informed Model

Conclusions

- Deactivation in the default mode network predicts the disruption of memory effects during recall initiation. These findings link activity in this network to the maintenance of internal contextual states.
- Increased activity within a postero medial network increases the likelihood that episodic associations are utilized during memory search. This links activity in this network to contextual retrieval processes that guide free recall behavior.
- Neurally informed computational models provide a means to identify explicit cognitive mechanisms supported by neural systems, and constrain formal models of human memory.

References


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