Evidence for the representation of context in human parahippocampal cortex and retrosplenial cortex

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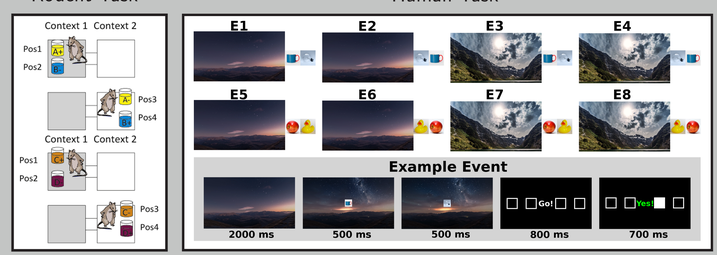
Motivating Question: What information is present in patterns of activity in retrosplenial cortex and parahippocampal cortex?

- Do RSC/PCC and PHC contain information about individual contexts [1-5]? Do they share that information [6]?
- Does RSC/PCC contain conjunctive representations of stimulus-stimulus associations [5]; e.g., *what-where*, *what-where-when*?
- Are RSC/PCC representations related to memory performance [1-5]?

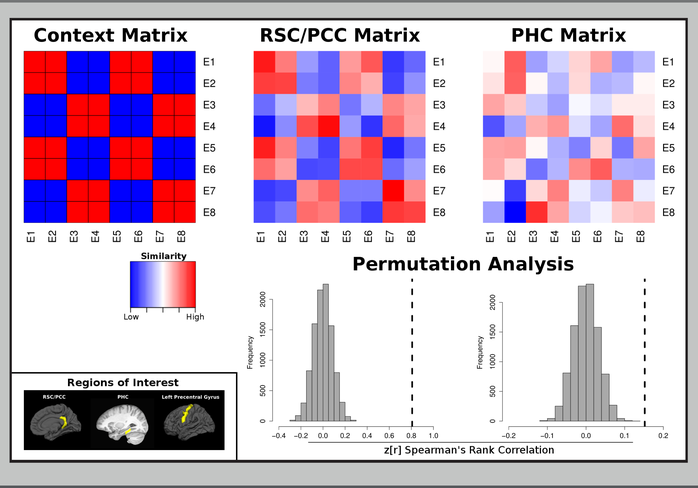
We extended the task created by McKenzie et al. in the Eichenbaum Lab [7] from the rodent to humans

Rodent Task | Human Task

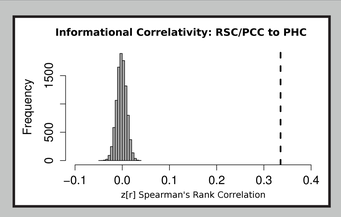


- McKenzie et al. [7] showed that patterns of activity in the hippocampus contain hierarchically-organized item-in-position-in-context representations

RSC/PCC and PHC contain contextual information



RSC/PCC and PHC contain similar representations of context on a trial-by-trial basis

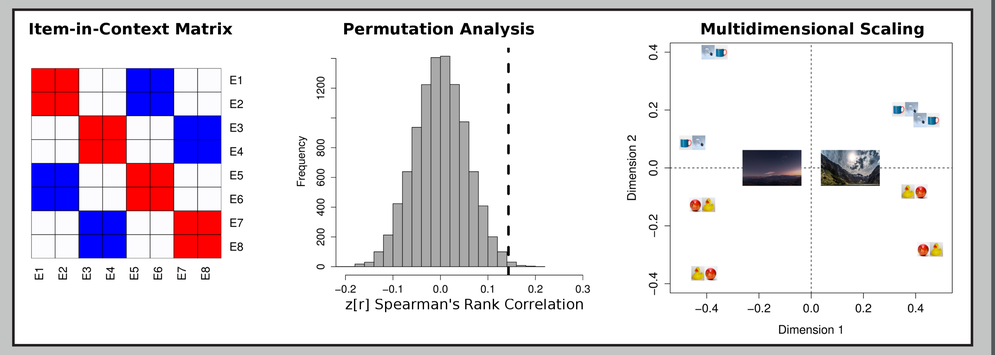


- These results extend our previous finding of stimulus-dependent informational correlativity between RSC/PCC and PHC [6; see 8]

Take Home Messages #1

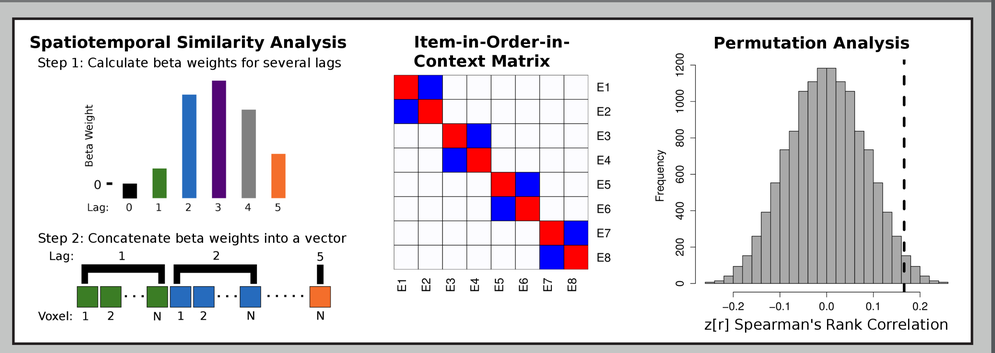
- **Our results suggest that RSC/PCC and PHC contain information about individual contexts and they share that information on a trial-by-trial basis**

RSC/PCC contains item-in-context information



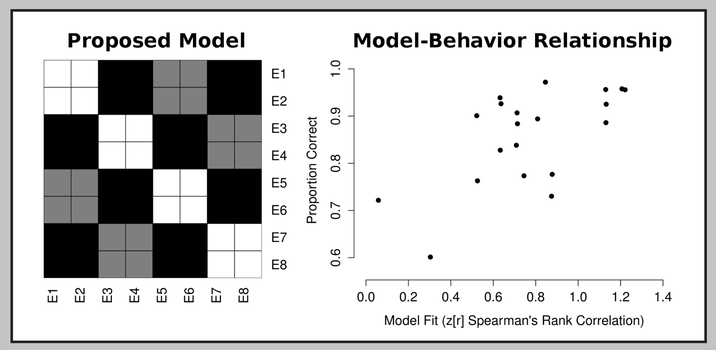
- White entries were excluded from analysis

RSC/PCC contains item-in-order-in-context information



- See [9] for a related approach to classification analysis
- White entries were excluded from analysis

RSC/PCC representations are related to associative memory performance



- Significant Spearman's rank correlation between model fit and performance on our associative memory task ($\rho = 0.51$, $t_{18} = 2.51$, $p < 0.05$)

Take Home Messages #2

- **RSC/PCC contains "item-in-context" and "item-in-order-in-context" representations**
  - Our results extend findings from the rodent hippocampus [7] to human RSC/PCC
- **Our results support the hypothesis that RSC/PCC is involved in memory performance** [1-5]
- **We should expand our view of the medial temporal lobe/declarative memory system**

Methods

- 20 participants
- Event-related design (6 second trials)
- 3T; 32 channel SENSE coil; 2.5 mm isotropic
- 64 presentations of each event across 16 runs
- Preprocessing: quadratically detrended, high pass filtered
- Framewise displacement threshold = 0.5 mm
- Split-halves representational similarity analysis
- **Permutation analysis for significance testing**
  - Randomize the model matrix and calculate z[r] Spearman's rank correlation to each subject's similarity matrix
  - Average across subjects, using the same randomization (more conservative)
  - Perform the above steps 10,000 times
  - Calculate the group-level two-tailed nonparametric p value [6,10]:

$$p = \frac{1 + \sum_{i=1}^{10,000} I(|t_i - \bar{t}| \geq |t^* - \bar{t}|)}{1 + 10,000}$$

  - For the item-in-order-in-context analysis, the full permutation was tractable (12,870 combinations)

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Poster created using LaTeX beamerposter.

References

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