The strategic allocation of working memory and episodic memory in prospective remembering: A neural network model

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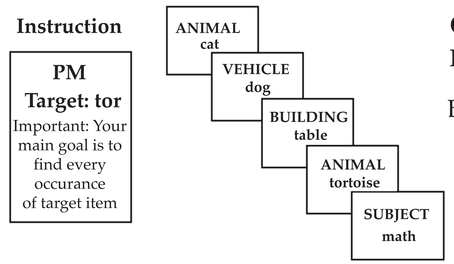
I. Background

Prospective memory (PM) is our capacity to maintain & retrieve a delayed plan for execution at a future time. PM poses a memory problem for periods in which an agent is occupied with other ongoing tasks (OG), while being responsive to target events that trigger plan execution. We construe PM mechanistically as the strategic integration of working memory (WM) & episodic memory (EM) strategies to strike the right balance between maintenance & retrieval. We propose a neural network model for the theoretical account. The model simulate seminal PM findings in humans.

II. Behavioral paradigm

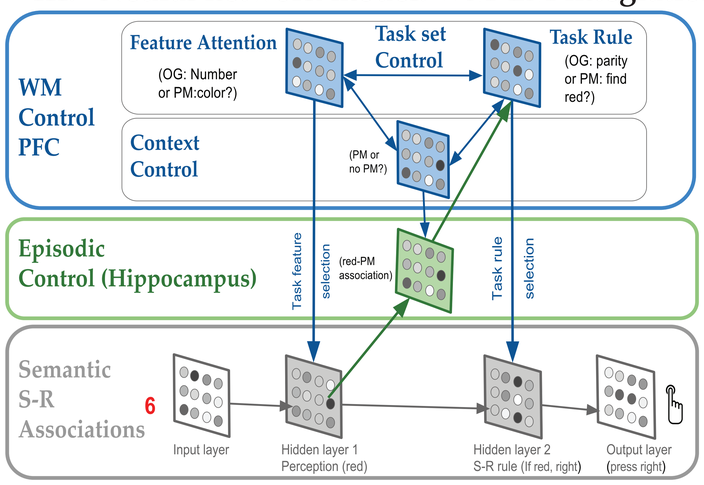


OG task : Category match
PM task : Syllable match ('tor')

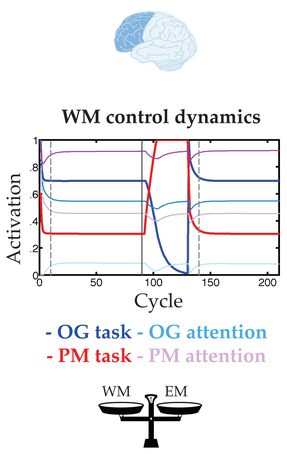
Block order:
* no-PM (baseline OG)
* PM
* non-PM (aftereffects)

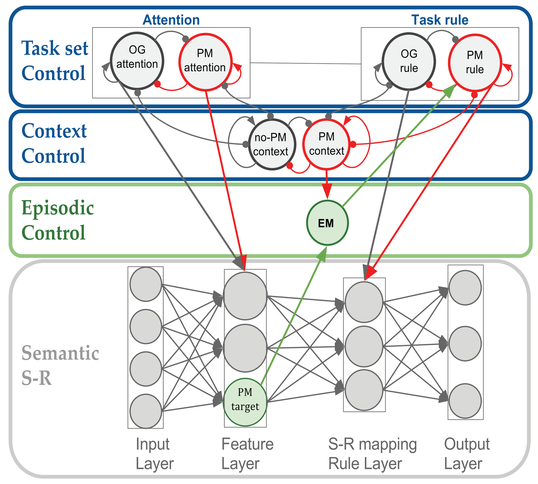
Einstein et al. 2005

III. Neural network model: WM-EM integration in cognitive control



Schematic neural network architecture





Present implementaiton of architecture

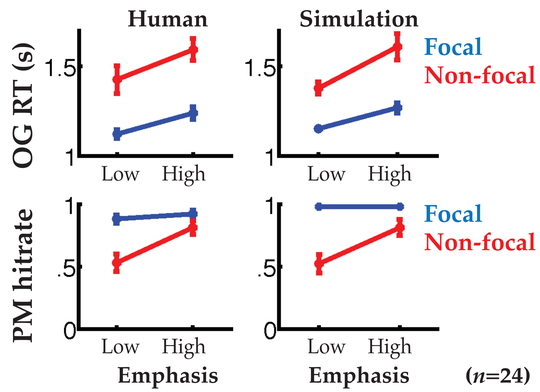
IV. The cost of prospective memory in human & model

Exp1. Focality X Priority

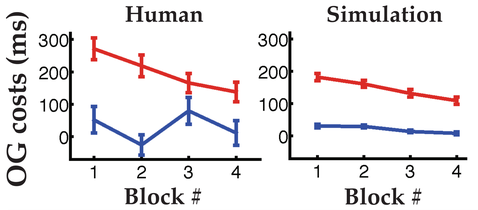
Focal PM
OG task's stimulus features are same as PM target's

Non-focal PM
Attention to different features for OG stimuli vs. PM target

PM Priority (emphasis)
Priority of PM vs. OG (e.g. PM more rewarding)

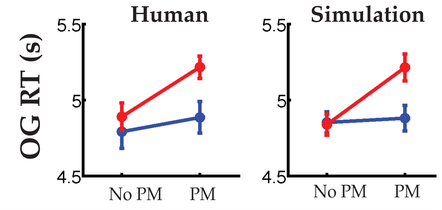


Exp 2. Monitoring, hence non-focal costs, decrease over time



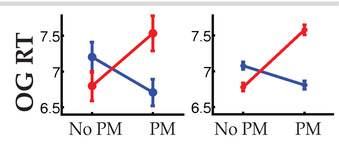
Exp 3. PM load exerts costs

1 target vs. 6 targets



Exp 4. Individual differences in OG RT costs reflect low cost vs. high cost strategies

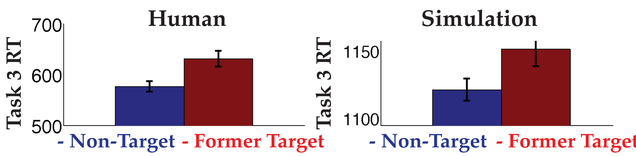
(*n*=104)



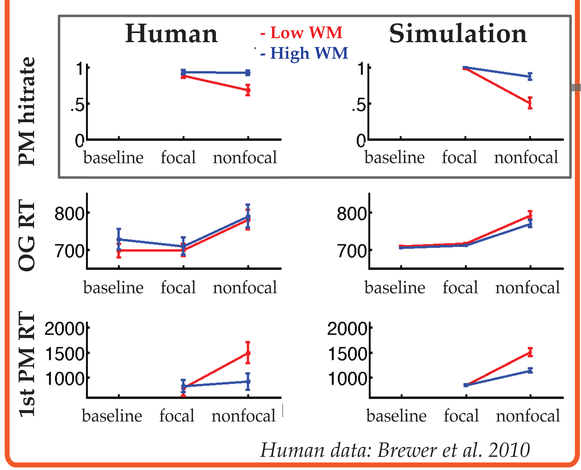
Exp 5. RT after-effects

After PM task is over, slower RT to a **former target** while performing a 3rd task

Einstein et al. 2005

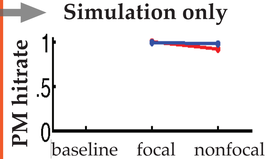


V. Low WM capacity: low PM



Human data: Brewer et al. 2010

VI. High EM rescues PM



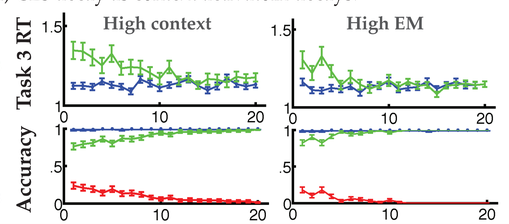
Strengthening EM compensates low WM deficit

Suggests mechanistic account of **implementation intentions**

VII. Commission errors

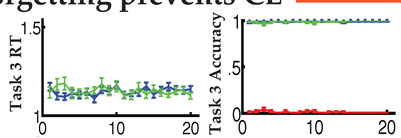
Commission errors (CE): Untimely PM response, after PM finished
Predictions: (i) Strong context activatoin, (ii) strong EM association trigger CE. (iii) CEs decay as context activatoin decays.

- Target: correct task 3
- Target: commission error
- Non-Target: correct task 3



VIII. Directed forgetting prevents CE

Prediction:
Directed forgetting (lowering context & EM after PM) can avoid CE.



IX. Discussion

- We propose a mechanistic account of PM as strategic integration of WM & EM strategies.
- Simulations show human-like regulation of planned action in PM while performing OG tasks.
- Model's representation & dynamics can be used to analyze patterns & time course of fMRI.
- The model based approach to fMRI pattern analysis can help empirically compare theoretical models of WM-EM interaction more broadly in cognition, e.g. in task switching.

1- Einstein, G. O., McDaniel, M. A. et al. (2005). Multiple processes in prospective memory retrieval: factors determining monitoring versus spontaneous retrieval. JEPG.
2- Brewer et al. (2010). Individual differences in PM: Evidence for multiple processes supporting cue detection. Memory and Cognition.

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