Modelling the effect of prioritisation on recall in visual working memory

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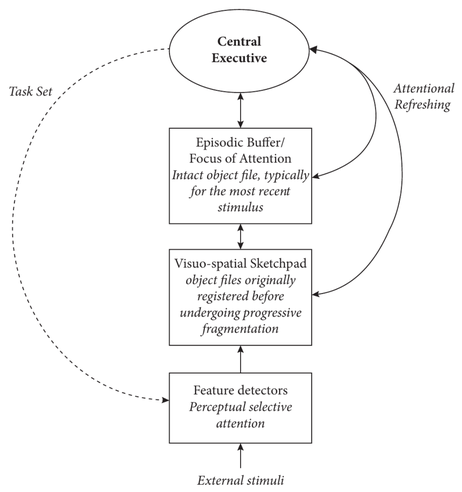
The focus of attention in visual working memory

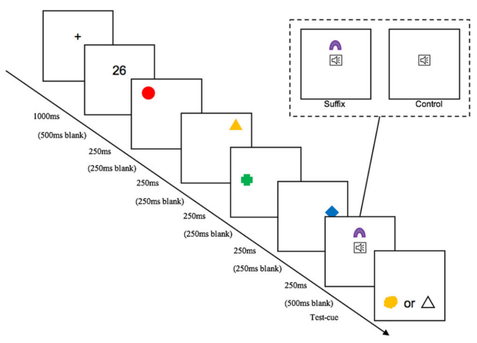
- Episodic buffer limited capacity store in visuo-spatial working memory (Baddeley, 2000)
- Identified with focus of attention
- Contents determined by:
  - Bottom-up perceptual processes
  - Top-down executive processes
- Attentional refreshing maintains items in the episodic buffer
- Executive process that can offset overwriting by new perceptions



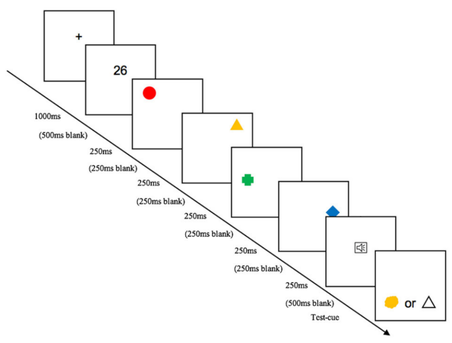
Visuo-spatial working memory (Baddeley, 2000)

Investigating the effect of prioritisation on recall

- Aim To study the interaction between executive and perceptual processes in determining the contents of the focus of attention (Hu et al., 2014; Hitch et al., 2018)
- Task Prioritise one or more items while memorising a sequence of visual stimuli
- Sequence sometimes followed by a *suffix* distractor stimulus
- Will prioritisation…
  - increase memory for prioritised items?
  - reduce the recency effect found in sequence learning tasks?
  - be affected by the suffix distractor?
- Independent variables
  - **Prioritised serial position**
    - Experiment 1: SP2 ∨ SP3
    - Experiment 2: None ∨ SP1 ∨ SP2 ∨ (SP1 ∧ SP2)
  - **Cue serial position** (Experiments 1 & 2: SP1 ∨ SP2 ∨ SP3 ∨ SP4)
  - **Suffix** (Experiment 1: Yes ∨ No)



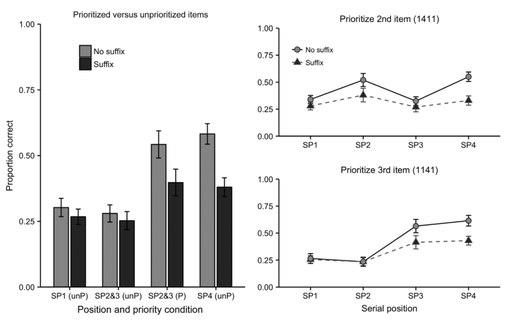
Experiment 1



Experiment 2

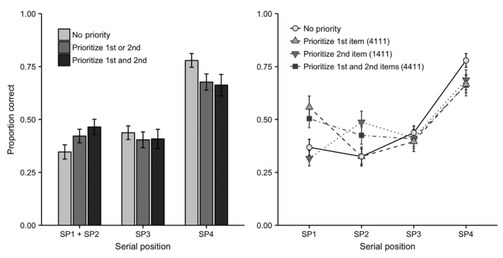
Results and interpretation

- Prioritising items improves recall
- Improvement reduced by suffix
- Recency effect reduced by suffix and SP2 prioritisation



Experiment 1

- Prioritising single and multiple items improves recall
- No difference between prioritising one or two items
- Recency effect reduced by all priority conditions

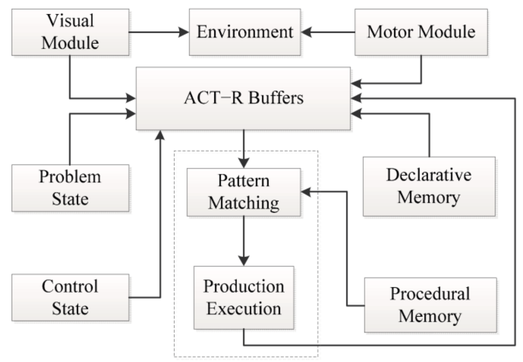


Experiment 2

- Limited capacity FoA filled by perceptual recency and top-down internal control
  - Executive process of attentional refreshing maintains items in the FoA to offset overwriting by new perceptions (e.g., later items and suffix)
  - Prioritised information competes with recent information to occupy FoA
- Experimental effects related to probability of items occupying the FoA at test
  - Reduced recall for SP4 due to maintenance of prioritised items in FoA
- Experiment 2, no significant difference in effects of prioritising one or two items
  - Attentional refreshing alternates between two prioritised items, moving them in turn to the episodic buffer (and the FoA)

The ACT-R cognitive architecture

- Computational "unified theory of cognition" (Anderson, 2007)
- Procedural memory (production rules representing actions)
- Declarative memory (network of "chunks" representing facts)
- Modules with buffers, including "imaginal", vision, motor control

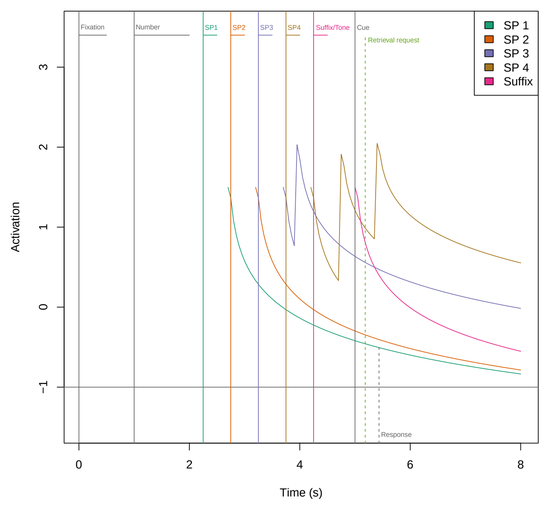


Working memory in ACT-R

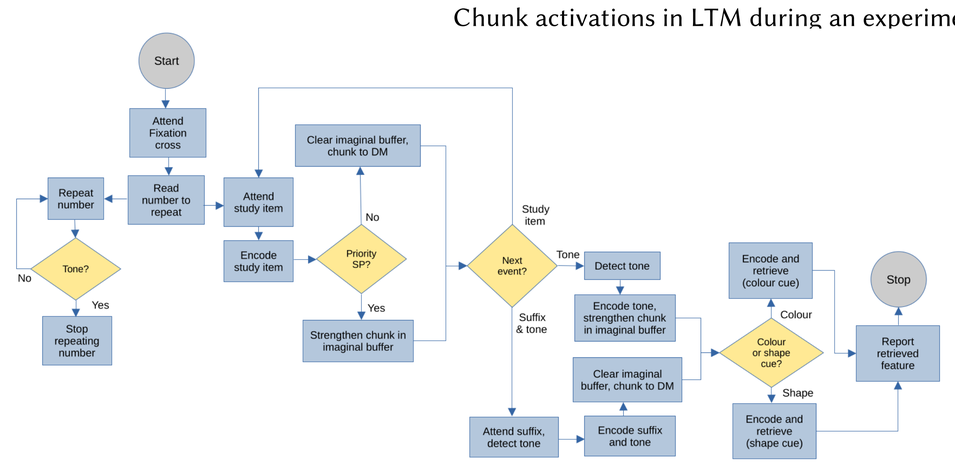
- ACT-R's conception of working memory
  - Contents of buffers, in particular retrieval and imaginal
  - Chunks in declarative memory above retrieval threshold
  - Imaginal buffer represents the focus of attention
- Limited capacity system with procedural bottleneck
  - Each buffer holds only one chunk at a time
  - Only one production can fire at a time

Key features of the model

- For all stimuli, a chunk representing shape and colour created in imaginal buffer then placed in LTM
- Chunk activations decay over time
- Effects of prioritisation and suffix due to chunk activations at retrieval
- Prioritised items Refresh chunk in imaginal buffer to boost activation
- After last study item (SP4)
  - Suffix Encode suffix
  - Tone Refresh in imaginal buffer

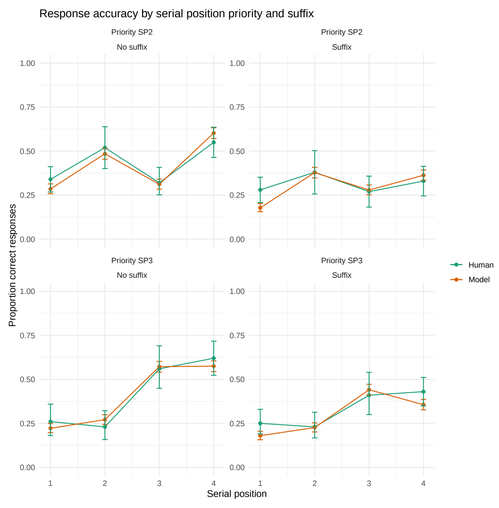


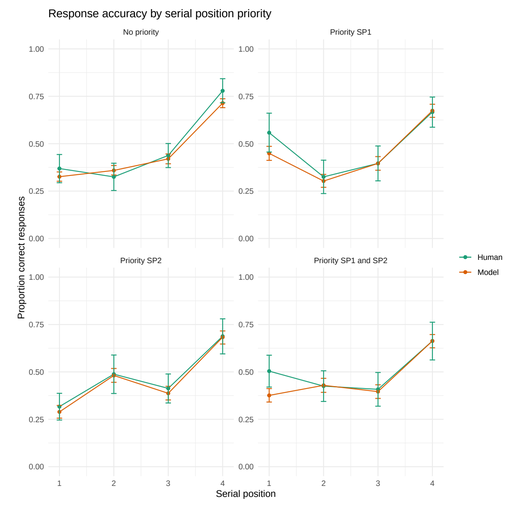
Chunk activations in LTM during an experiment trial



Control structure for an experiment trial

Model performance in the two experiments





Summary of the ACT-R account

- FoA is identified with the imaginal module and limited to one chunk
- Items can be maintained in FoA and activation boosted by executive process
- Effects of prioritisation and suffix due to relative chunk activations at retrieval **NOT** competition for space in FoA during trial or at test

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- Baddeley, A. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences*, 4(11), 417—423.
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- Hu, Y., Hitch, G. J., Baddeley, A. D., Zhang, M., & Allen, R. J. (2014). Executive and perceptual attention play different roles in visual working memory: Evidence from suffix and strategy effects. *Journal of Experimental Psychology: Human Perception and Performance*, 40(4), 665–1678.