

# Extending an Integrated Computational Model of the Time-Based Resource-Sharing Theory of Working Memory

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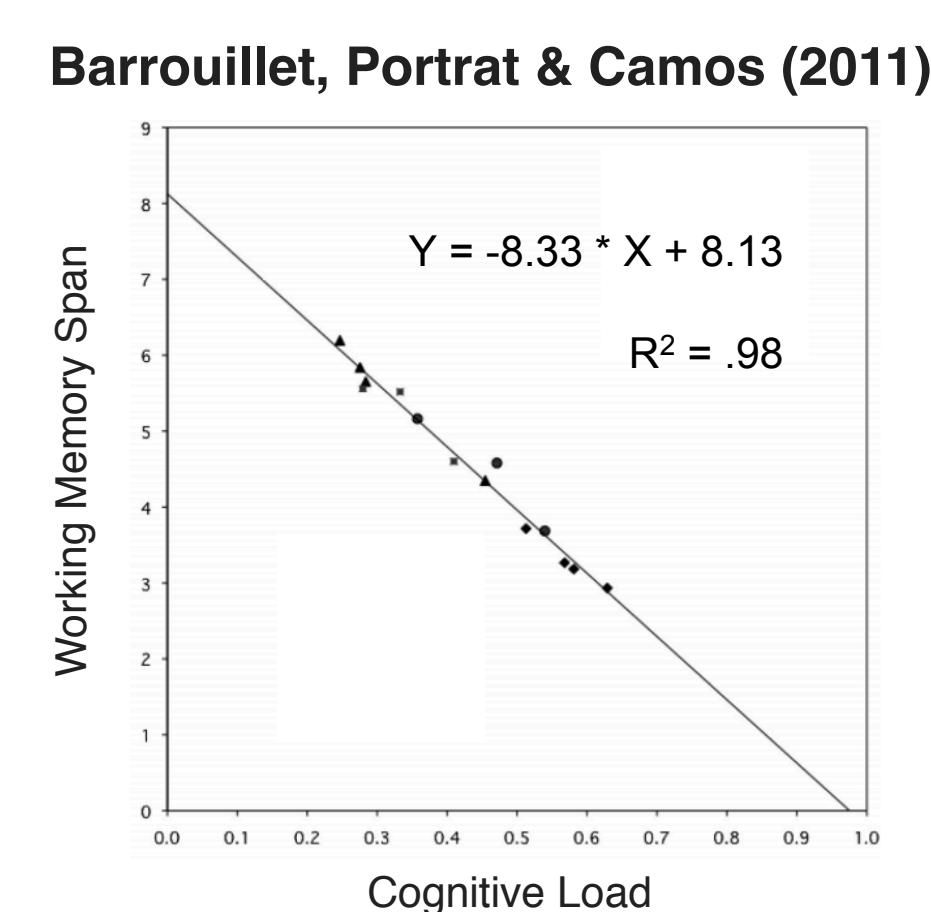
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## Time-Based Resource-Sharing

- Maintenance and processing require attention
- Attention can only be deployed to one thing at a time (central bottleneck)
- Items in the focus of attention gain activation, while all others decay with time

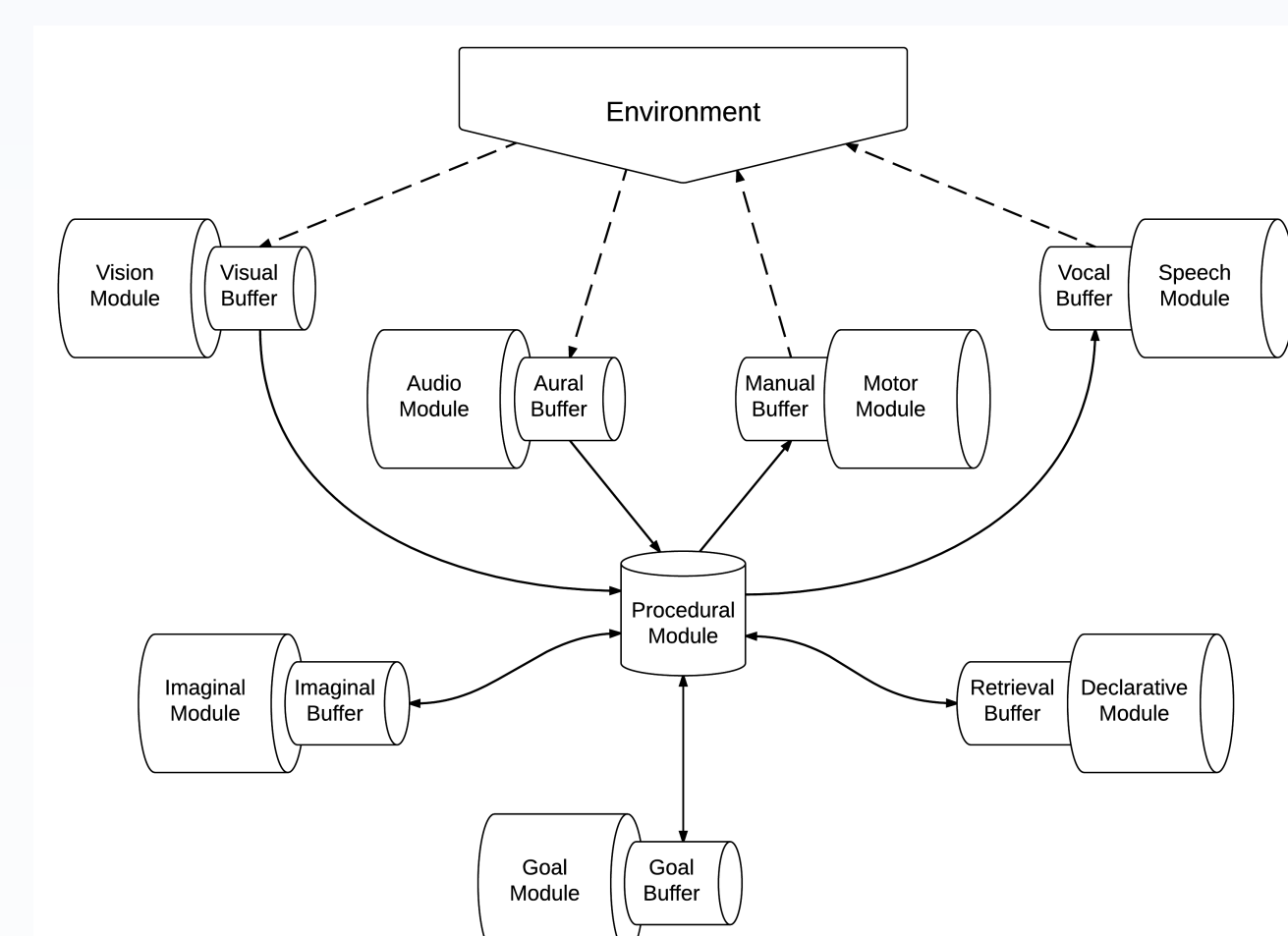
## Research Questions

- Is working memory (WM) span really a linear function of cognitive load?
- Can we formally specify how articulatory rehearsal works with attentional refreshing?

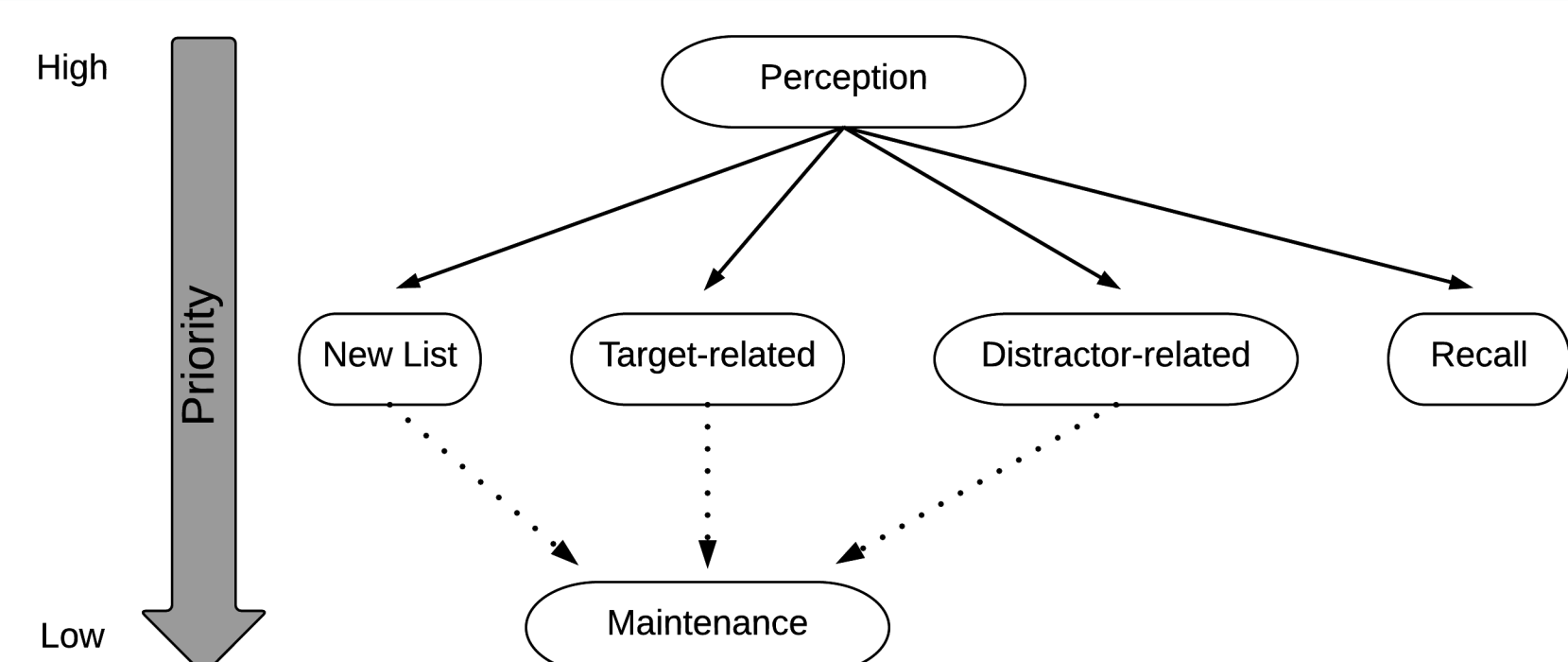


## Compatibility with ACT-R

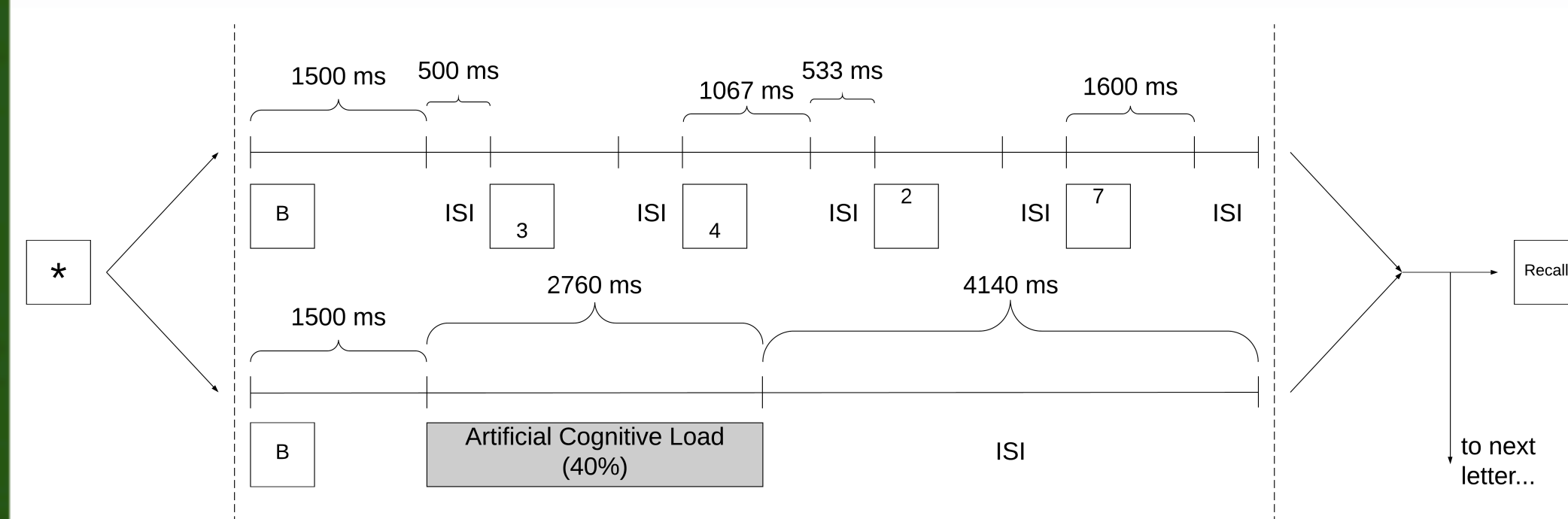
- Specialized modules & limited capacity buffers
- Only one production can fire at a time
- Power law learning and forgetting



## Overview of the Model

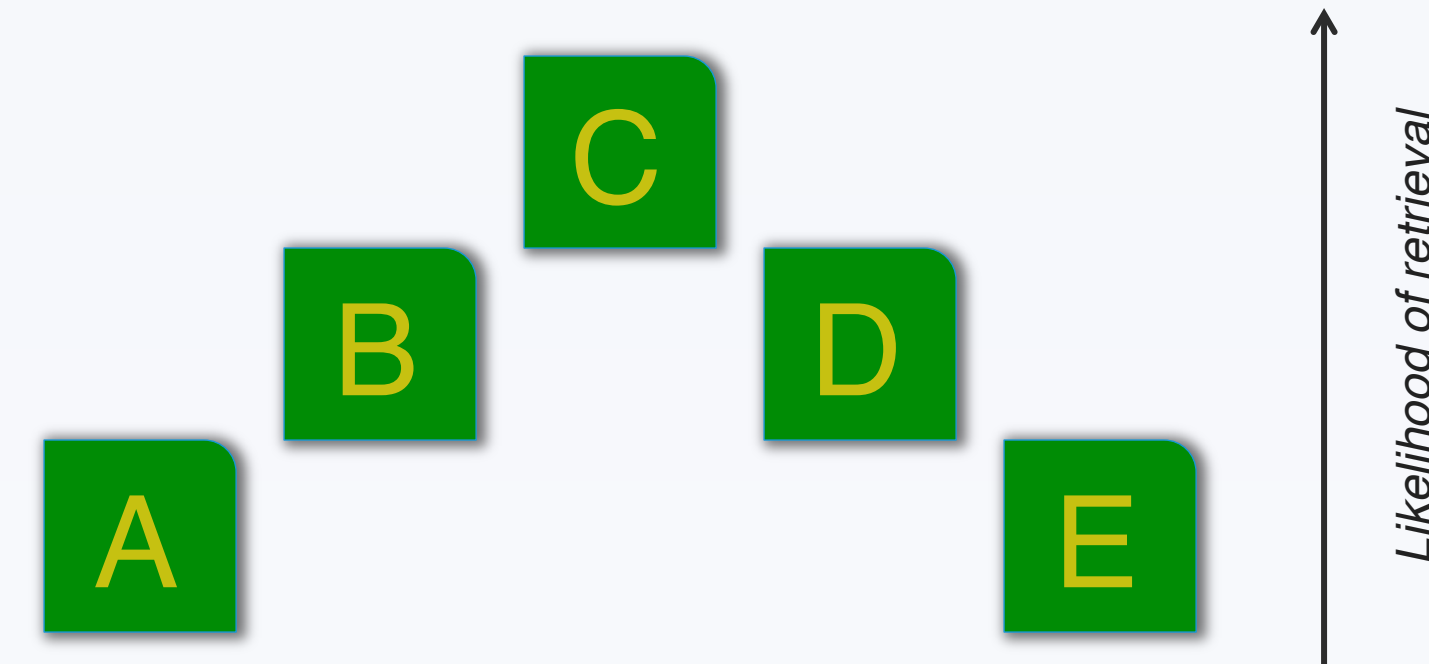


## Simulation

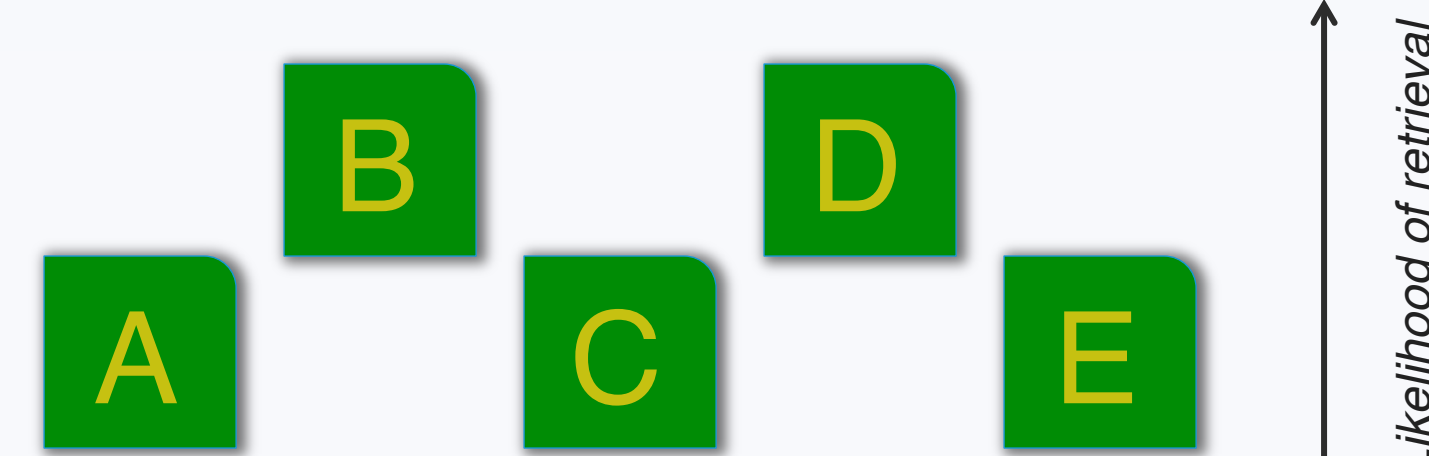


## Attentional Refreshing

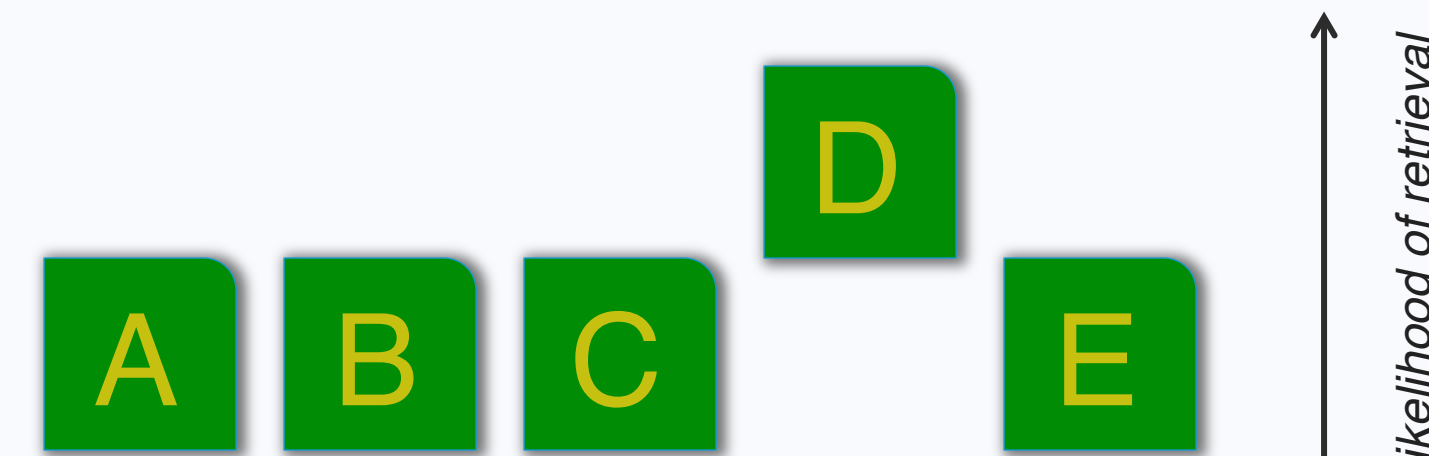
Episodic similarity gradient applied using "C" as the cue



Temporal inhibition applied to "C"

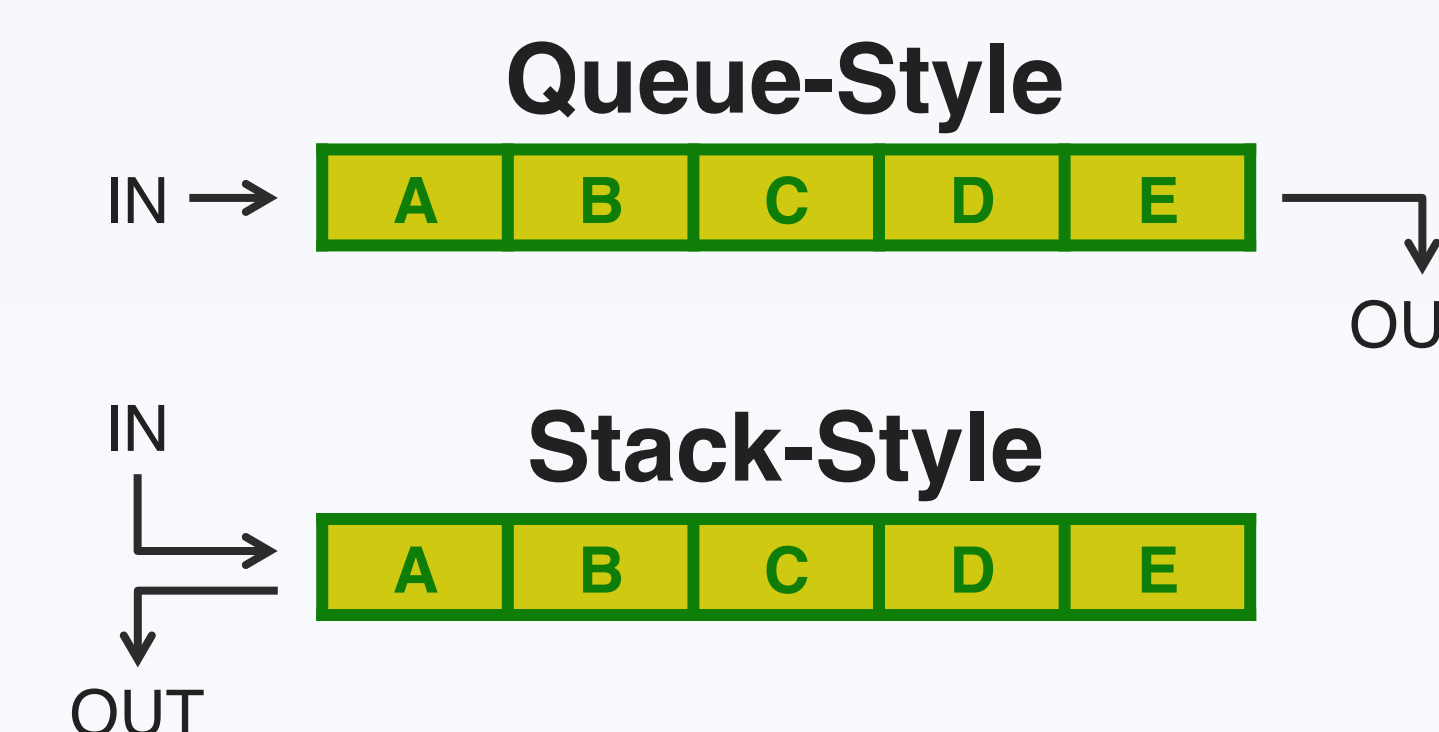


Temporal inhibition applied to "B"



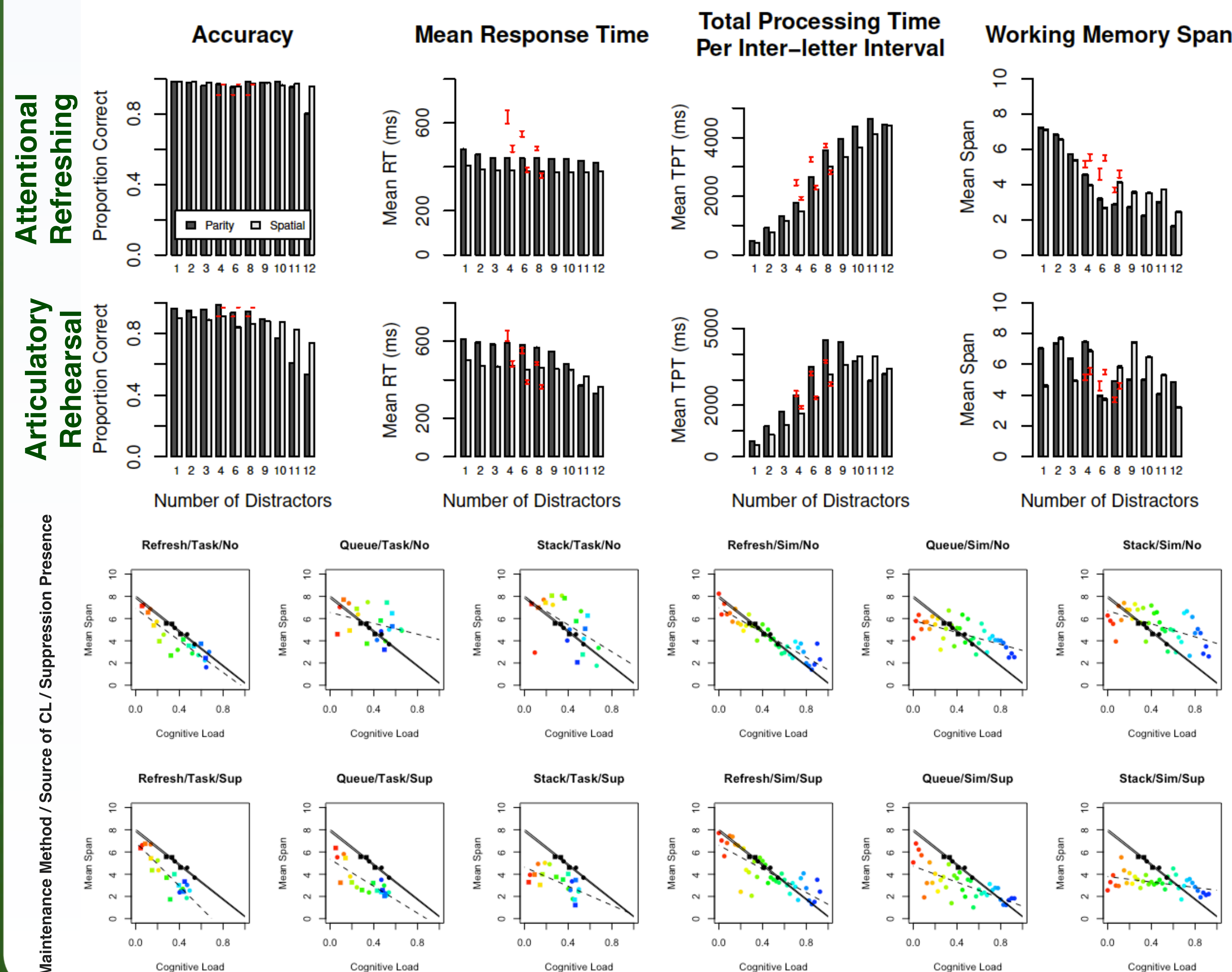
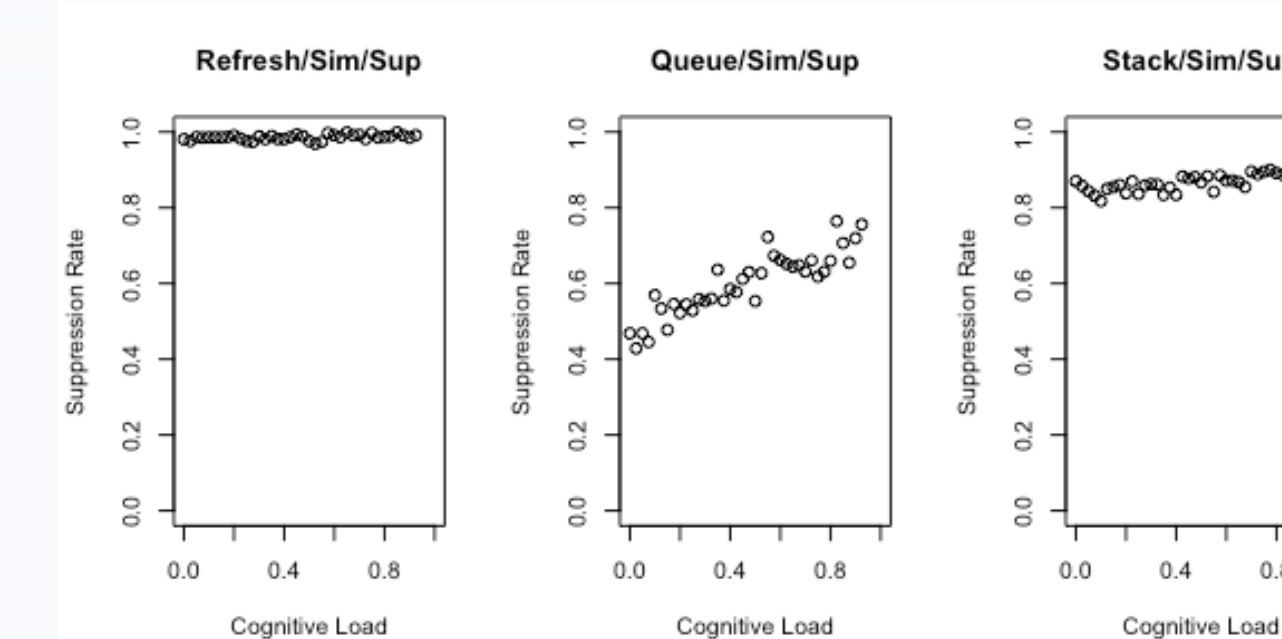
## Articulatory Rehearsal

- Operates in parallel with retrieval loop
- Use aural representation as cue when available



## Articulatory Suppression

- A metronome plays a tone every 1 second.
- Say "ba" when you hear the tone.



## Discussion

- Support for TBRS's prediction of a linear relationship between WM span and cognitive load in a more complex model and environment
  - Tails still need to be tested in human subjects
  - Model suggests that we may be unable to measure the tails of this function in humans
  - Some suggestion of non-linearity at high load, but this may be moderated by spacing
- Exact nature of the coordination between attentional refreshing and articulatory rehearsal mechanisms remains uncertain
  - Rehearsal itself induces some cognitive load
  - Model suggests rehearsal reduces effect of cognitive load
  - Rehearsal improves recall overall
- Articulatory suppression strongly constrains models of articulatory rehearsal
  - Possible challenger to the traditional queue-like interpretation of the articulatory loop
  - Requires further development of perceptual attention in ACT-R

## Future Work

- Continue exploring temporal dynamics of WM
  - Delay and spacing effects
  - Complex interactions between consolidation, decay, refreshing, and rehearsal
  - Applications to problem solving in real world work environments (Human Factors)
- More sophisticated representations of the list
  - Grouping effects
  - Serial position effects and other errors
- Associative learning
- Structural additions (new module) to the ACT-R architecture

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