Mapping the Effects of Cognitive Load and Delay on Serial Recall

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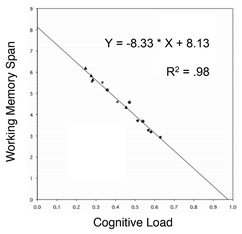
Simulation Study Goals

- Use a computational process model to explore how the temporal dynamics of a complex span task affect the observed WM capacity.
  - Increasing the Post-Target Delay (PTD) should increase time for consolidation and thus mean WM span.[1]
  - Increasing the Post-Distraction Delay (PDD) should also increase WM spans but maybe less effective than increasing PTD.
  - Adding a one-time Pre-Recall Delay (PRD) should increase WM spans if free but decrease them if filled by cognitive load.
  - Clustering cognitive load should affect WM spans differently than when evenly spaced.[2]
- Identify which task conditions are most promising for testing in human participants.

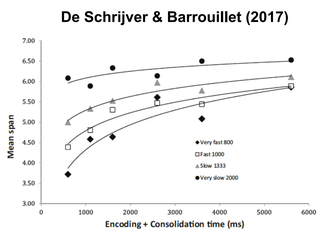
Time-Based Resource-Sharing[3]

- 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.

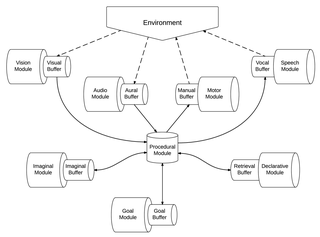
Barrouillet, Portrat & Camos (2011)



De Schrijver & Barrouillet (2017)

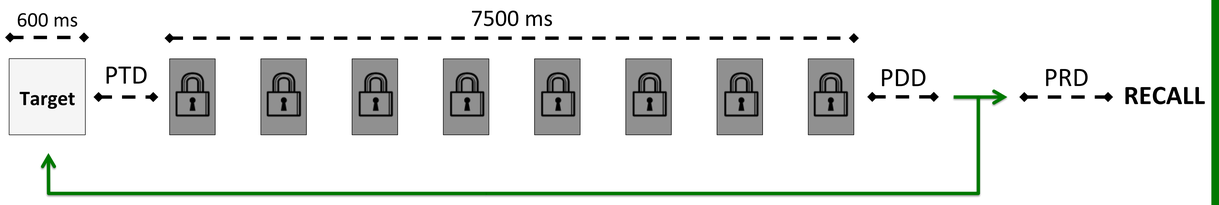


Computational Process Model[4,5]



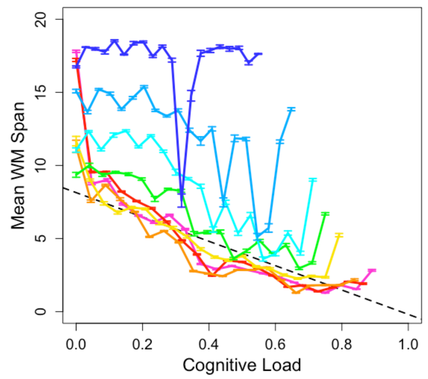
- ACT-R[6] model that uses declarative memory retrievals to perform attentional refreshing whenever the central bottleneck is free.

Task and Variables



Effects of Repeated Free Time

Post-Target Delay

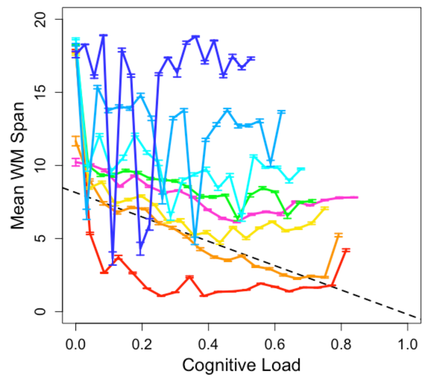


PTD / PDD (ms)

0
250
500
1000
1500
2000
3000
5000

PTD = 1000, PDD = 500
used to fit Barrouillet et al. (2011)

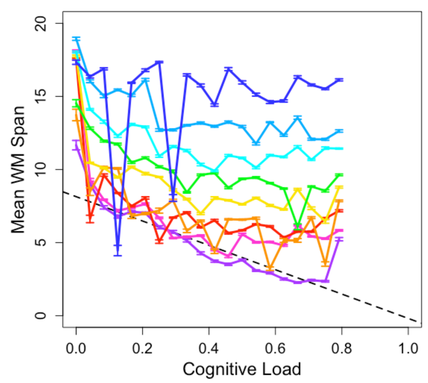
Post-Distraction Delay



- WM spans monotonically increase with more consolidation time (PTD).
- WM spans non-monotonically increase with PDD.
- Apparent benefit for load immediately before recall.

Effects of Delayed Recall

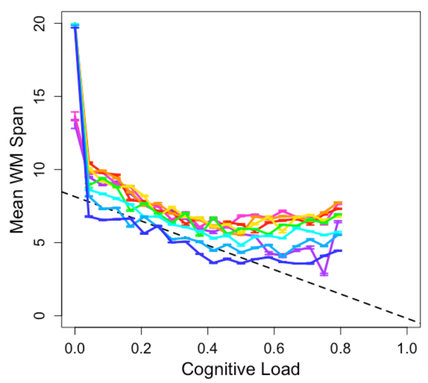
Unfilled Delay



PRD (ms)

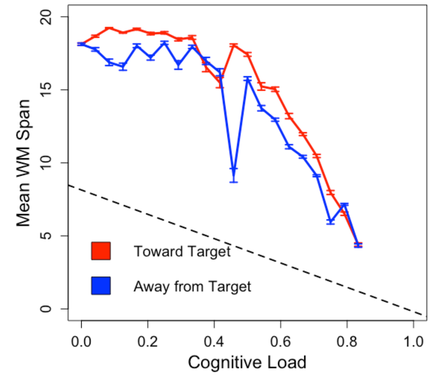
0
500
1000
2000
4000
8000
16000
32000
64000

Filled Delay



- Monotonically increasing benefit of one-time free delay before recall.
- Increasing a one-time filled delay before recall reduces WM spans.
- Positive effect of load immediately before recall.

Cognitive Load Effects



- Continuous block of load improves WM spans over multiple, evenly spaced episodes.
- Slight advantage for earlier block of load.
  - Present in intermediate conditions.

Discussion

- Model parameters are under-constrained but the qualitative patterns help us to understand the effects of delay and cognitive load on recall.
- As expected,[1] free delays improve WM spans.
- In contrast to the standard TBRS theory,[3,4] the model predicts asymmetric effects on WM spans from clustering cognitive load.
- Model favors initiating recall immediately following a period of load.
  - Gives temporal inhibition time to relax.
- There are potentially many interactions among these task variables so in the future we will use the model to identify when they tradeoff and which combinations mimic others in order to maximize the power of our human studies.

References

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