Memory for serial order across domains: Three common principles

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Serial order in verbal short-term memory

- Serial order in verbal STM intensively studied and well-understood
- Abundance of data
  - serial position curves
  - transposition gradients
  - other error patterns (e.g., "omissions", "intrusions", "protrusions")
  - grouping effects
  - similarity effects
  - repetition effects
- Abundance of computational theories
  - Brown, Preece, & Hulme, 2000; Burgess & Hitch, 1999; Farrell & Lewandowsky, 2002; Henson, 1998; Lewandowsky & Farrell, 2008; Page & Norris, 1998

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Four principles

- Positional marking
- Primacy gradient
- Response suppression
- Output interference

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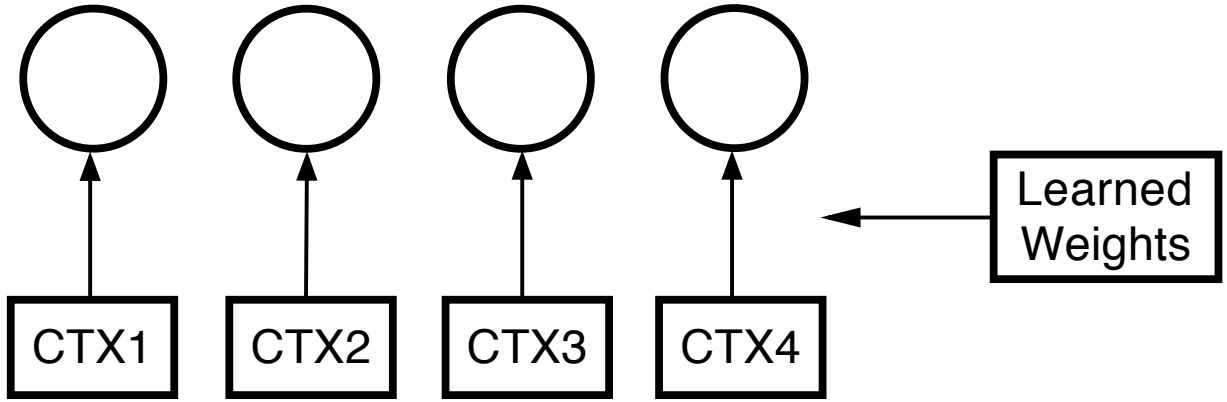
Positional marking



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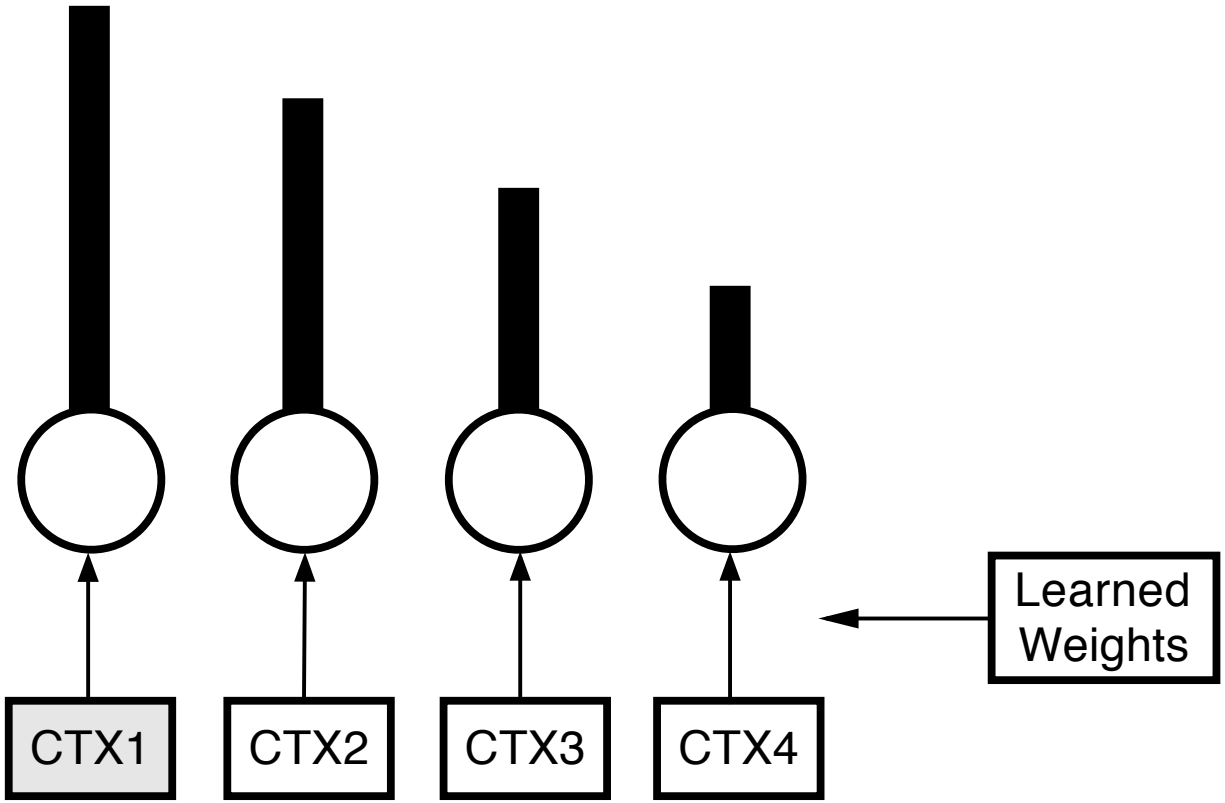

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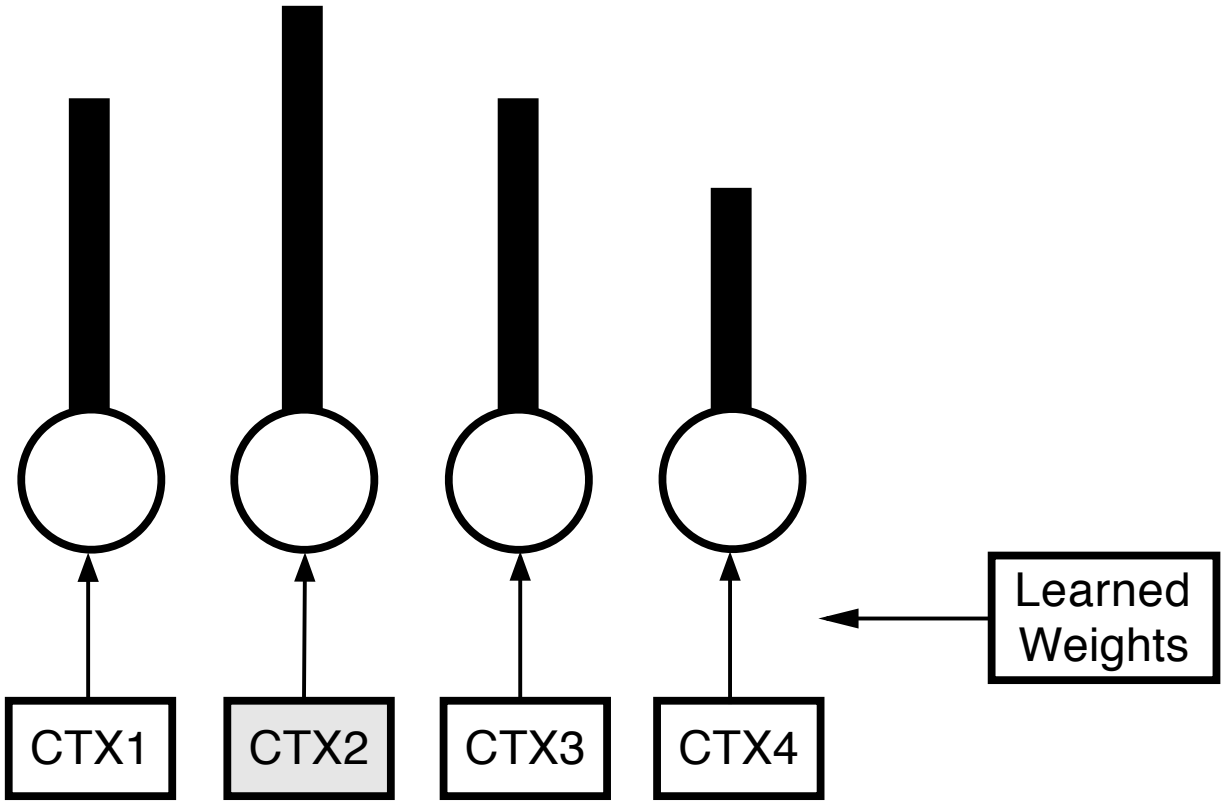

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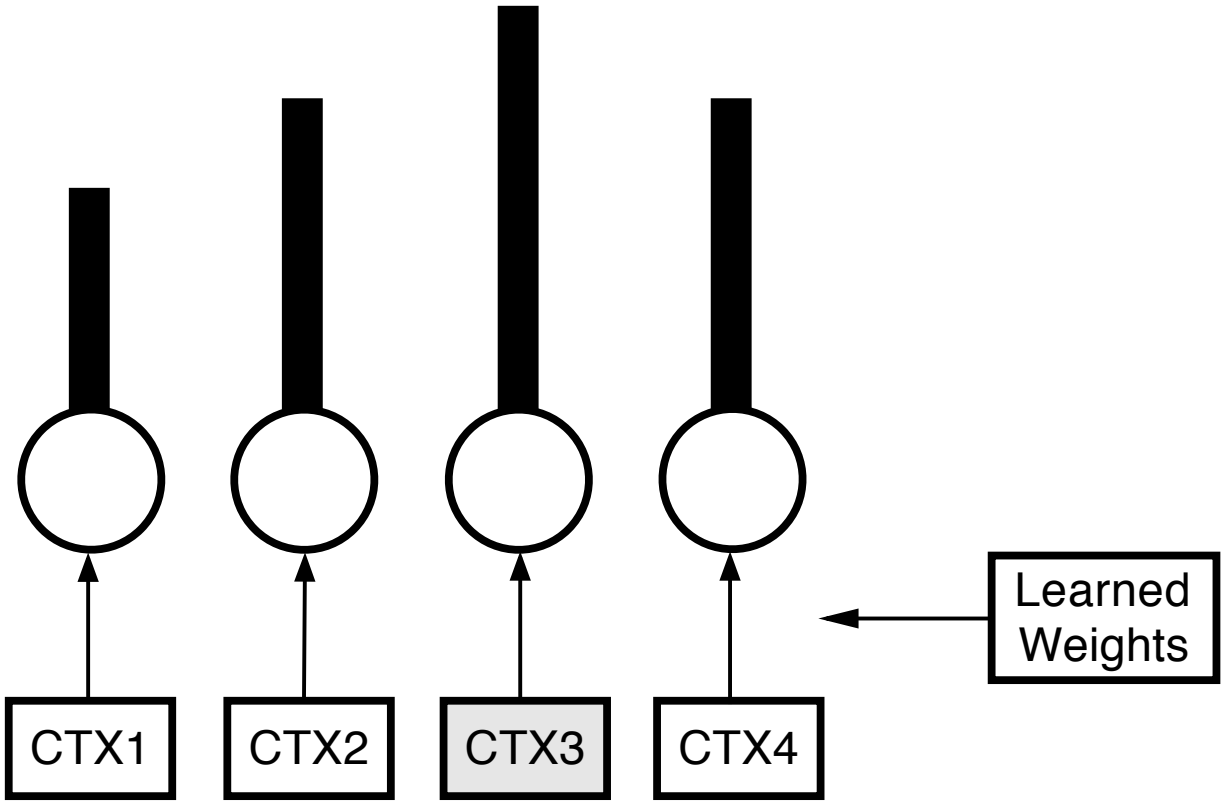

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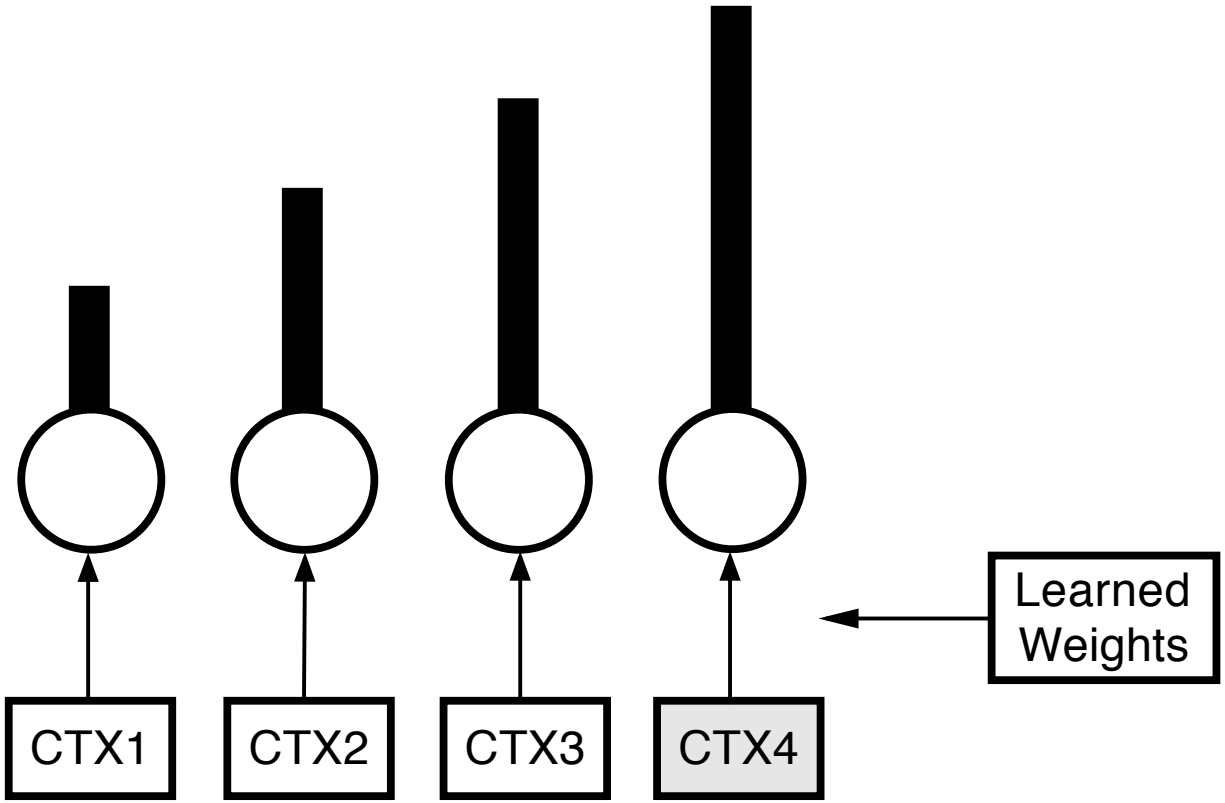

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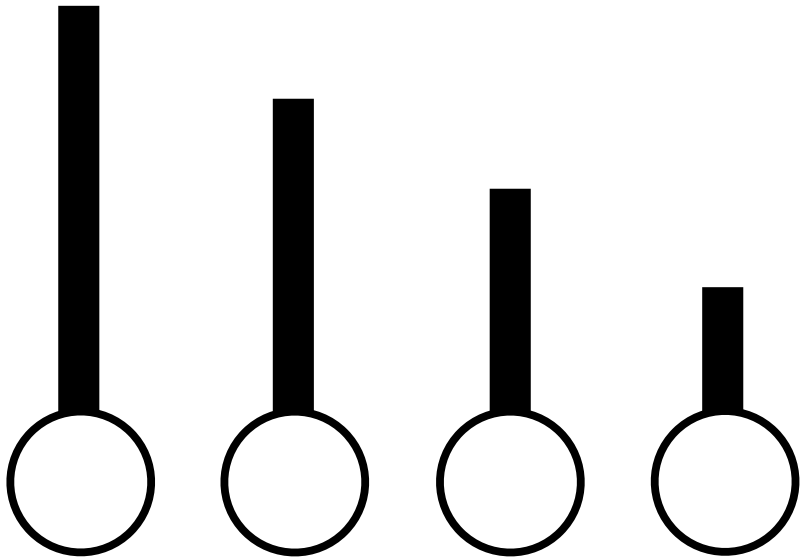

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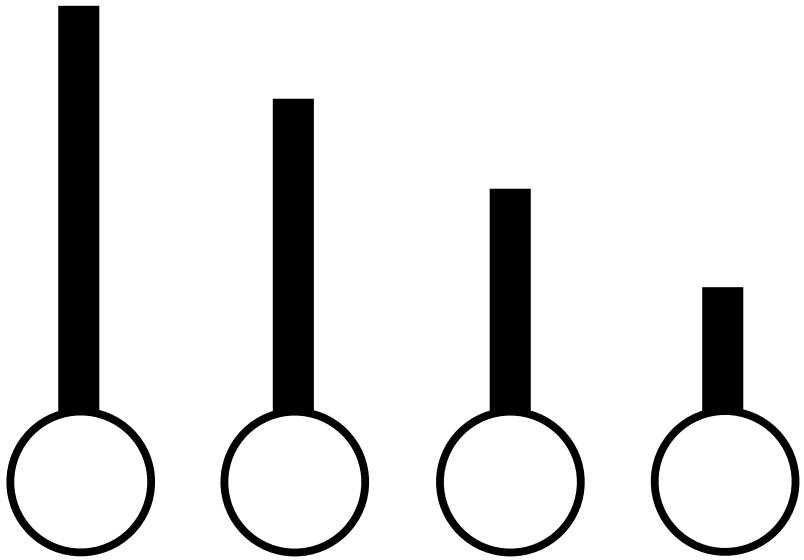

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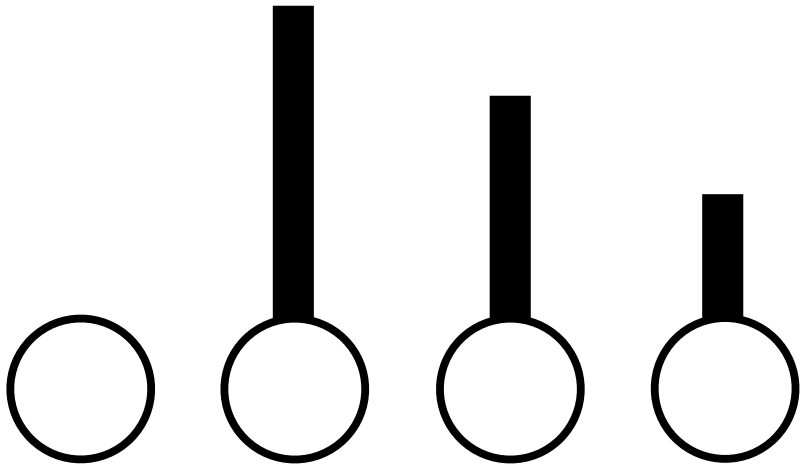

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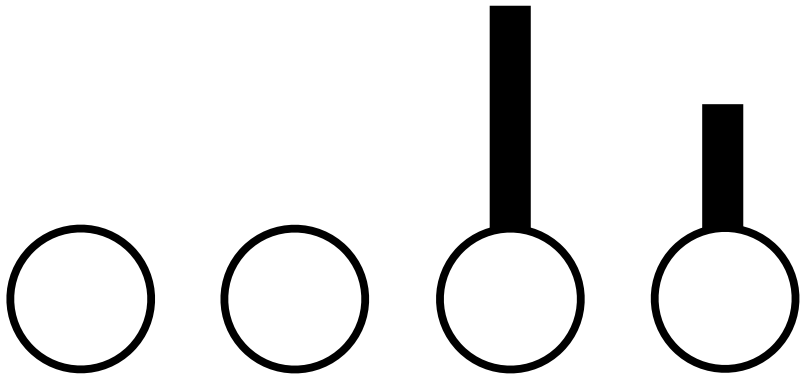

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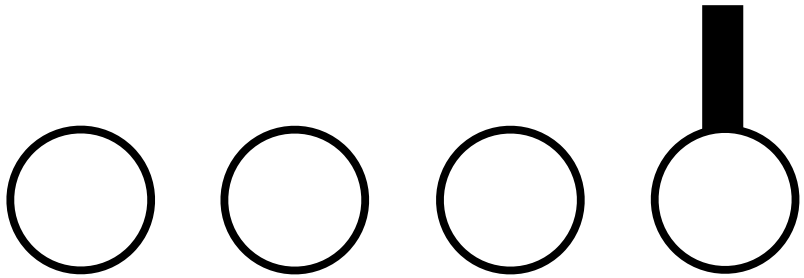

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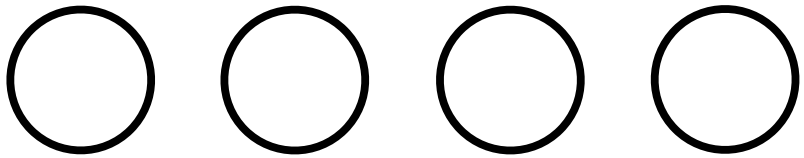

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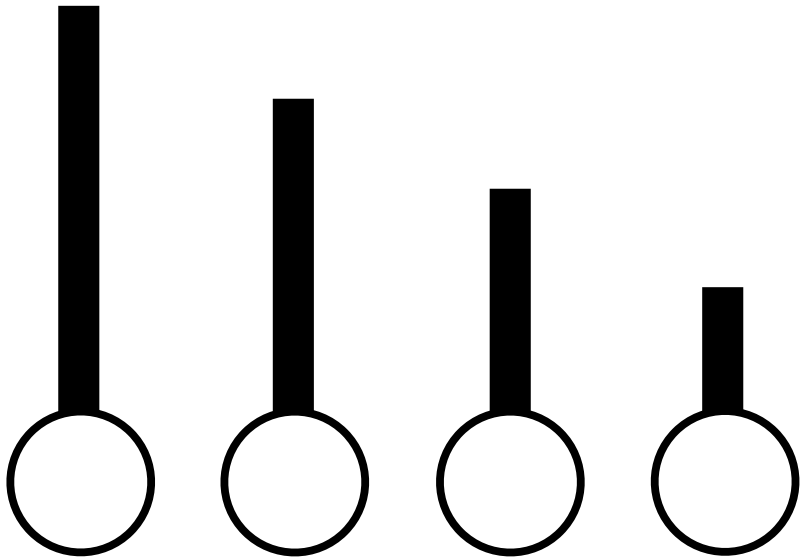

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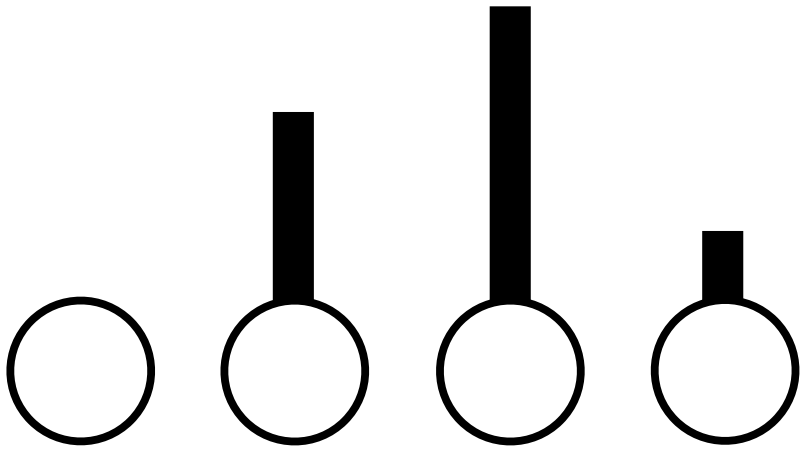

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  - visual (sequences of novel visual patterns)
  - spatial (sequences of locations / spatial movements)
- Numerous empirical similarities with verbal STM e.g.,
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Serial order in nonverbal short-term memory

- Similarities across domains suggest that principles of serial order in the verbal domain are extensible to the nonverbal domain
- The question is which ones?
  - non-trivial, because many different combinations of the principles can explain existing data patterns
  - direct evidence required to select preferred principles
- One approach
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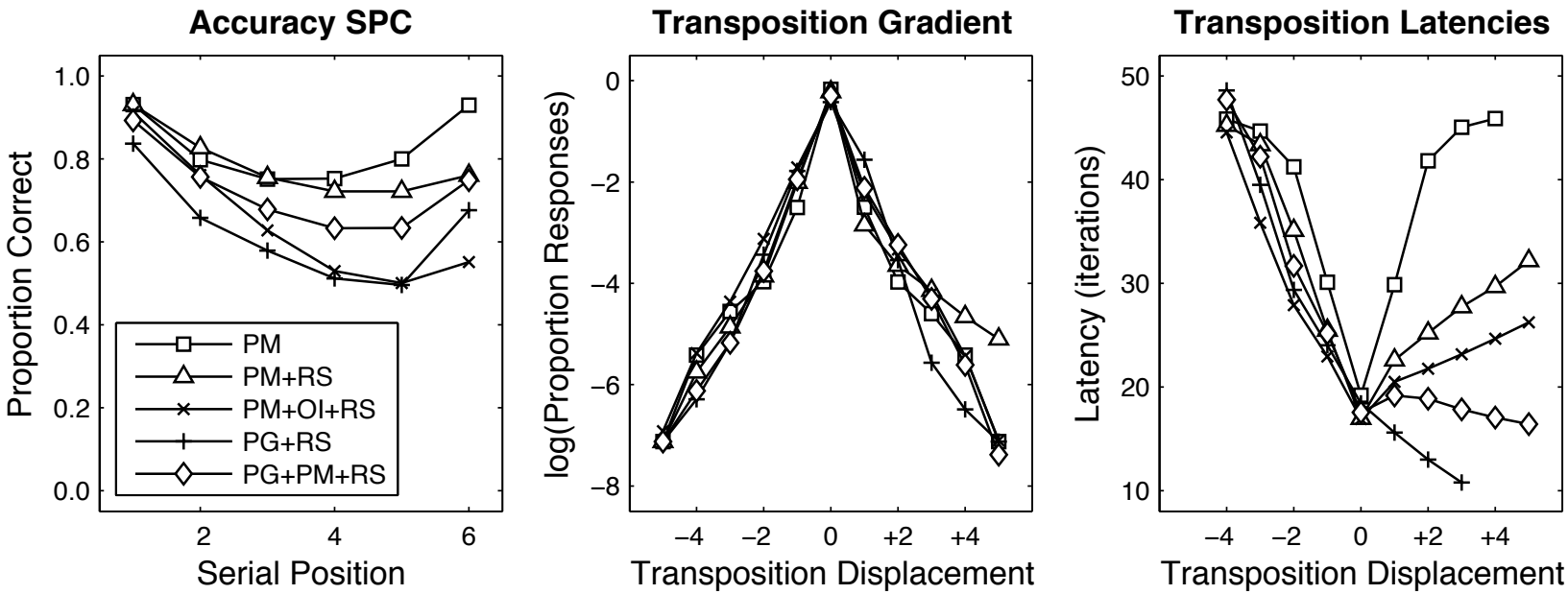
Modelling transposition latencies (Farrell & Lewandowsky, 2004; Hurlstone, 2010)



PM = Position Marking
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Empirical & modelling studies

- Verbal STM
- Visual STM
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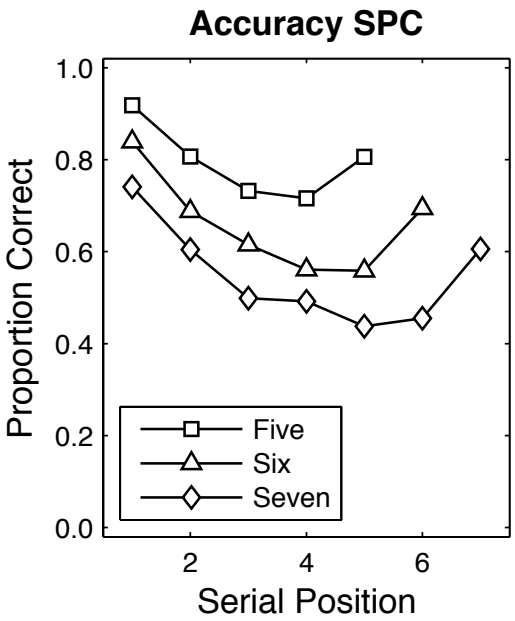
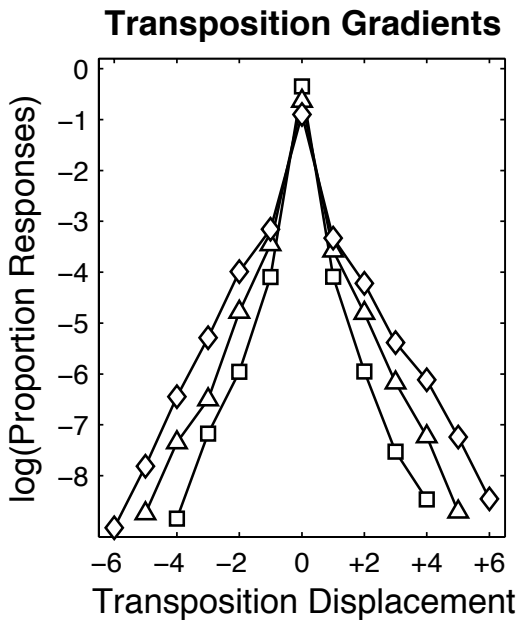
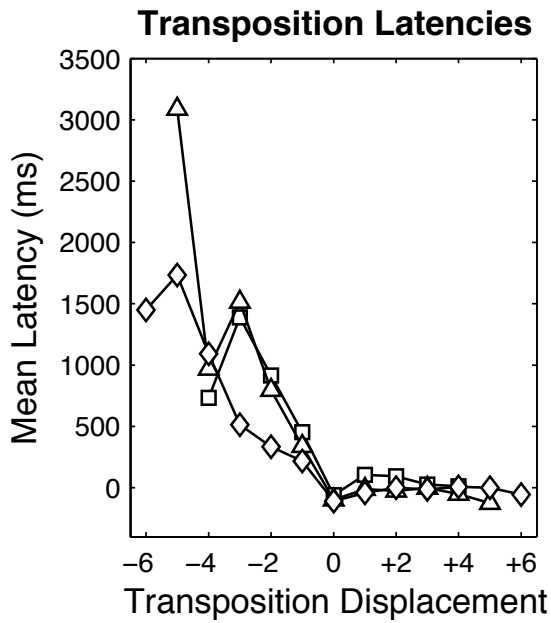
Experiment 1: Verbal STM

- *Forward serial order reconstruction* of sequences of familiar words
- $N = 18$
- Sequence length (within-participants): 5- / 6- / 7-items
- 100 trials per sequence length (2 x 150 trial sessions)

Data







- *Consistent with Farrell & Lewandowsky (2004)*

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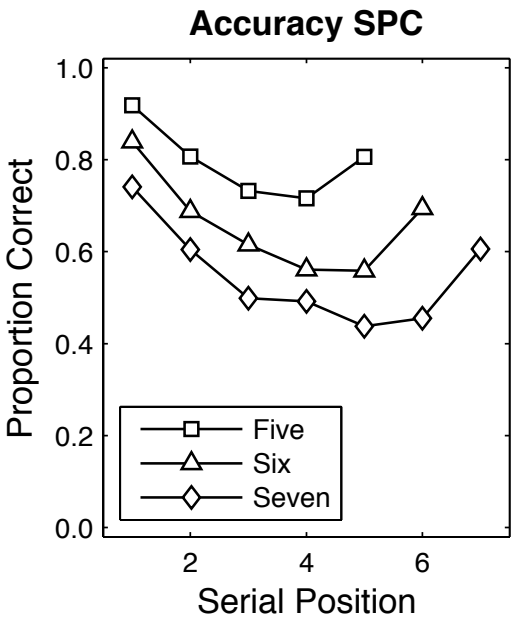

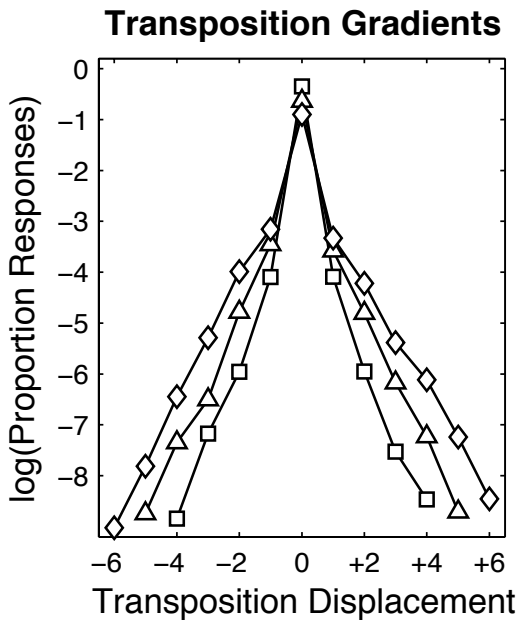

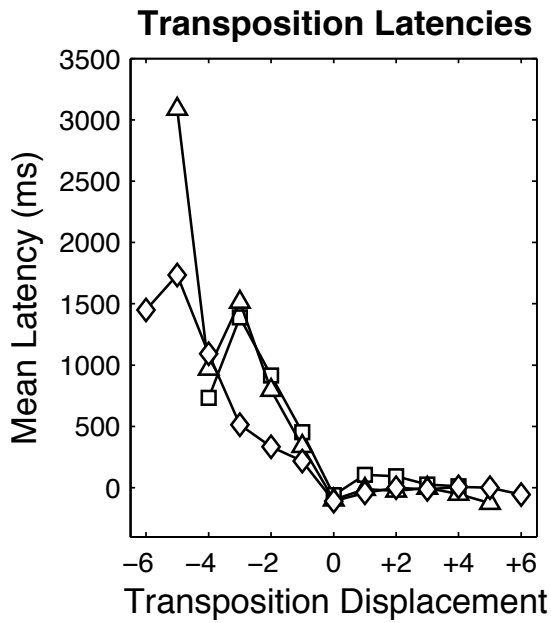

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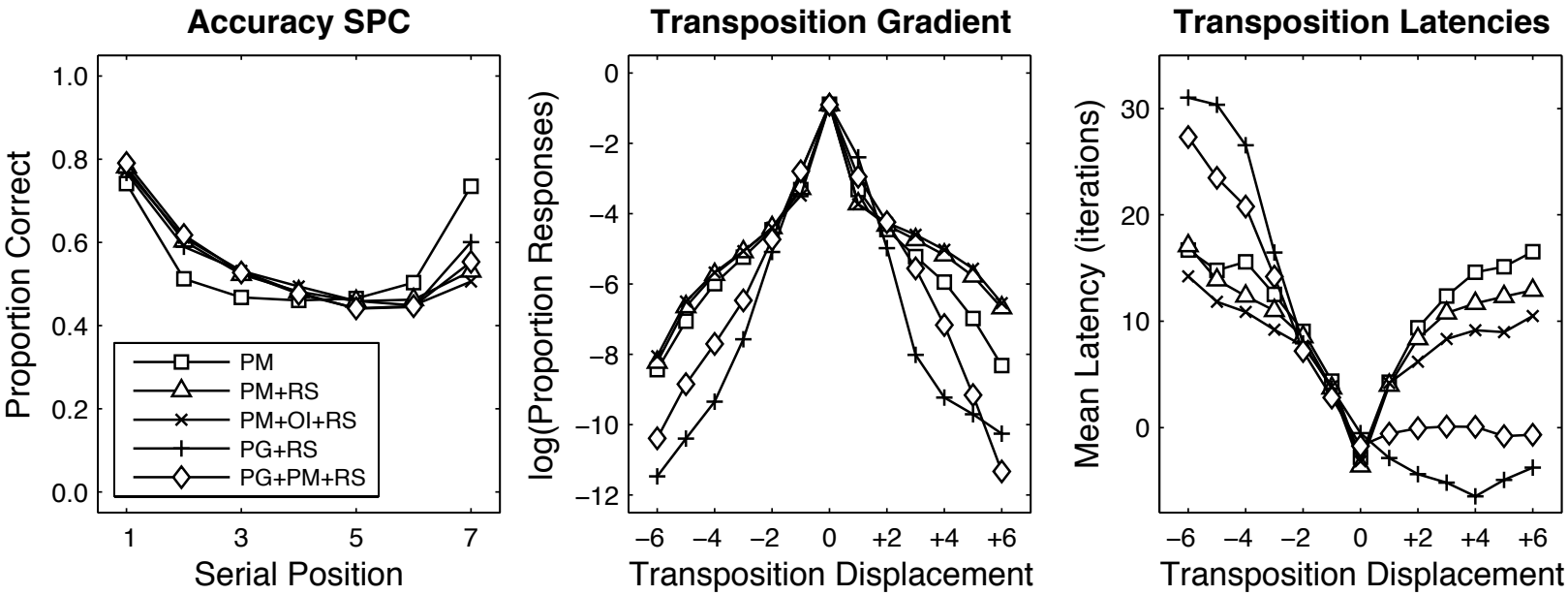
Quantitative model fits



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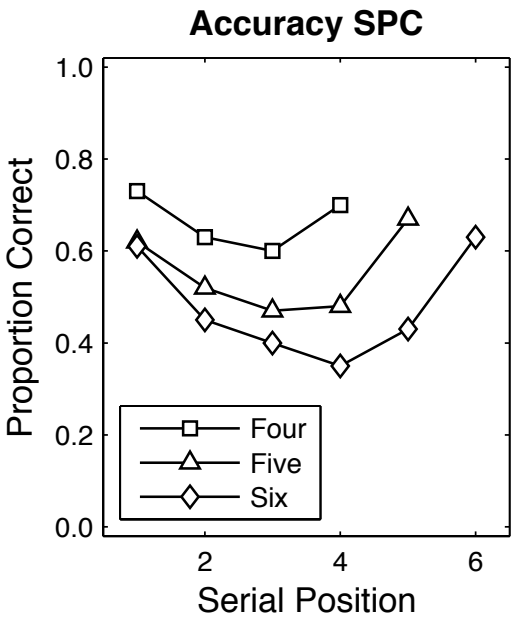
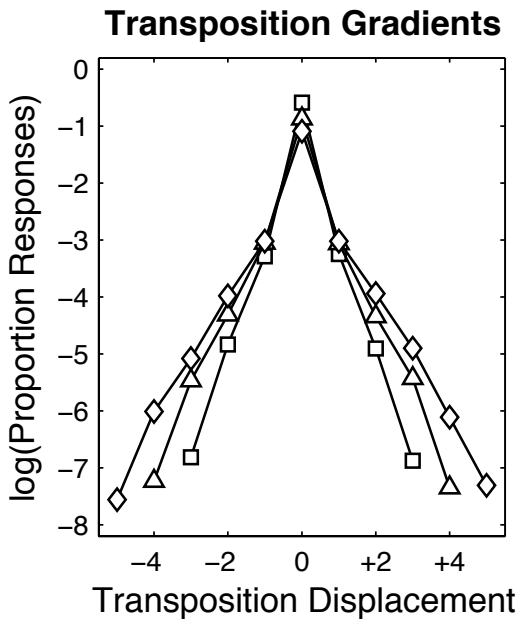
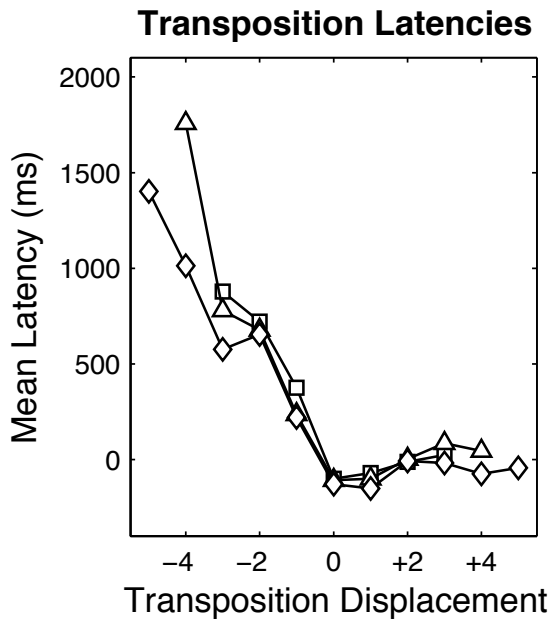
Experiment 2: Visual STM

- *Forward serial order reconstruction* of sequences of unfamiliar faces
- $N = 18$
- Sequence Length (within-participants): 4- / 5- / 6-items
- 100 trials per sequence length (2 x 150 trial sessions)
- Unique faces on each trial

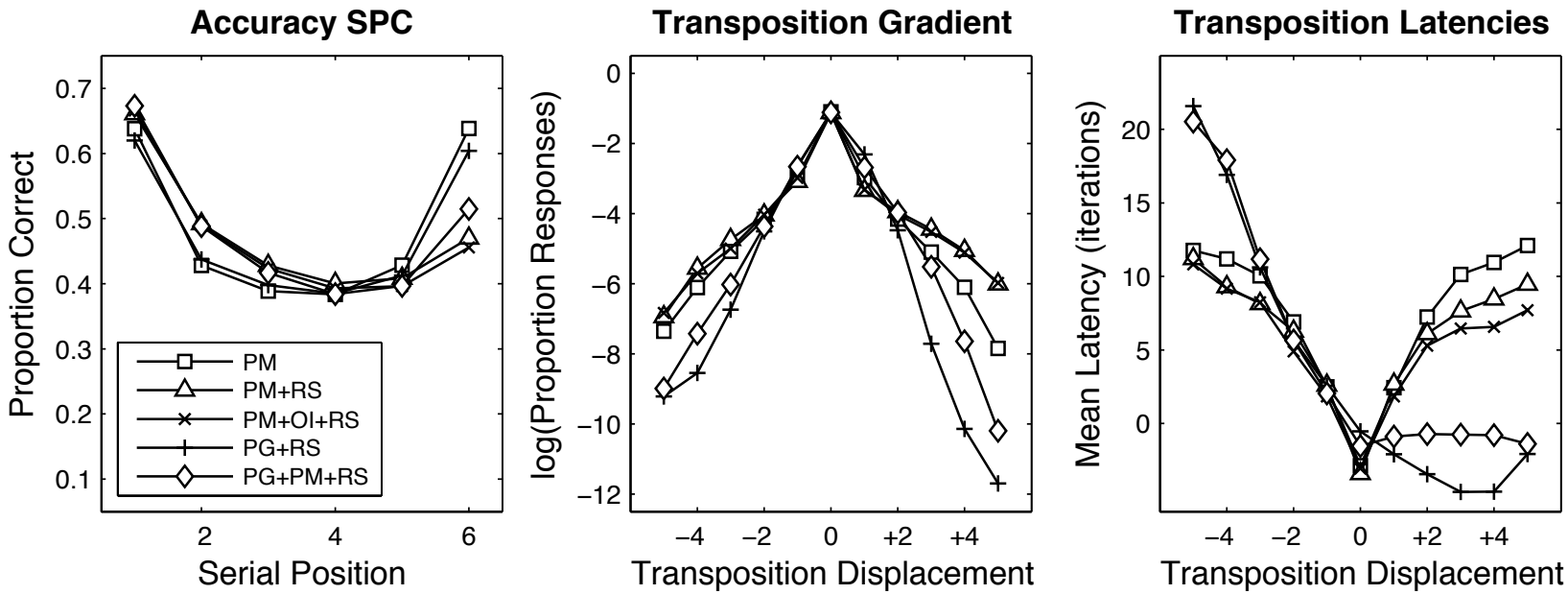
Data


Accuracy SPC
Proportion Correct
1.0
0.8
0.6
0.4
0.2
0.0
2
4
6
Serial Position
Four
Five
Six


Transposition Gradients
log(Proportion Responses)
0
−1
−2
−3
−4
−5
−6
−7
−8
−4
−2
0
+2
+4
Transposition Displacement


Transposition Latencies
Mean Latency (ms)
2000
1500
1000
500
0
−4
−2
0
+2
+4
Transposition Displacement

Quantitative model fits



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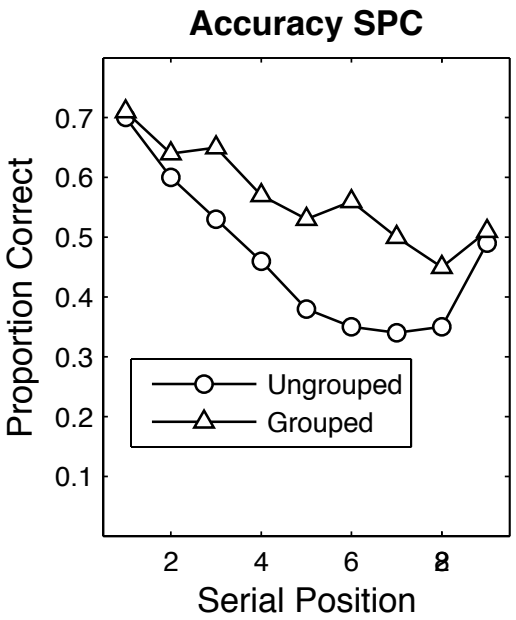
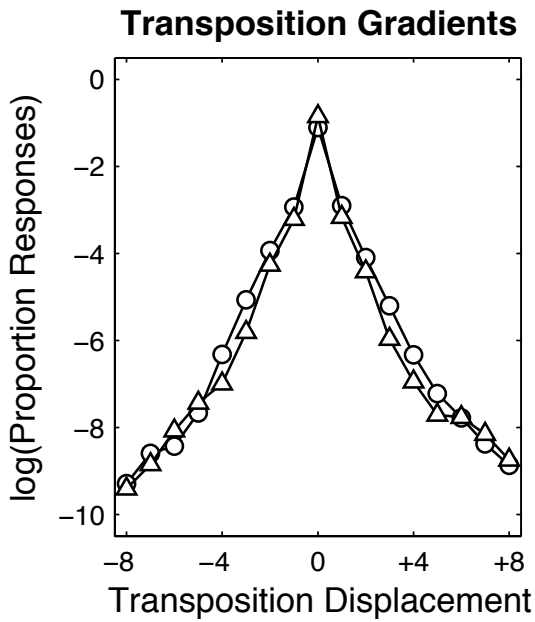
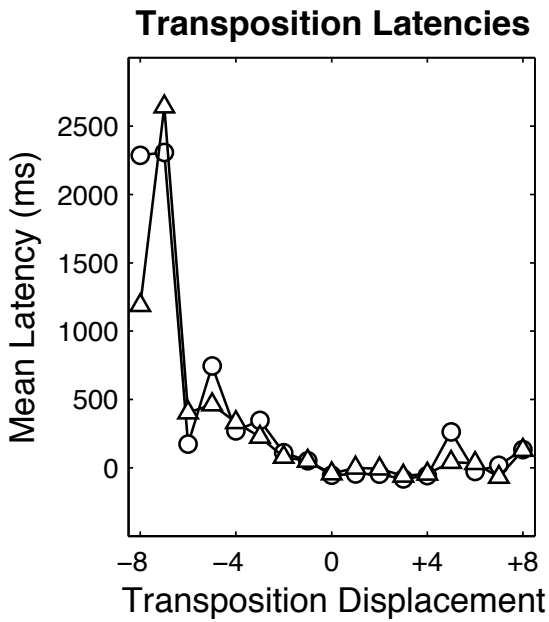
Experiment 3: Spatial STM

- *Forward serial order reconstruction* of sequences of nine spatial locations
- $N = 52$
- Temporal Grouping (Between-Participants): Ungrouped / 3-3-3 Grouping
- 70 trials per condition

Data







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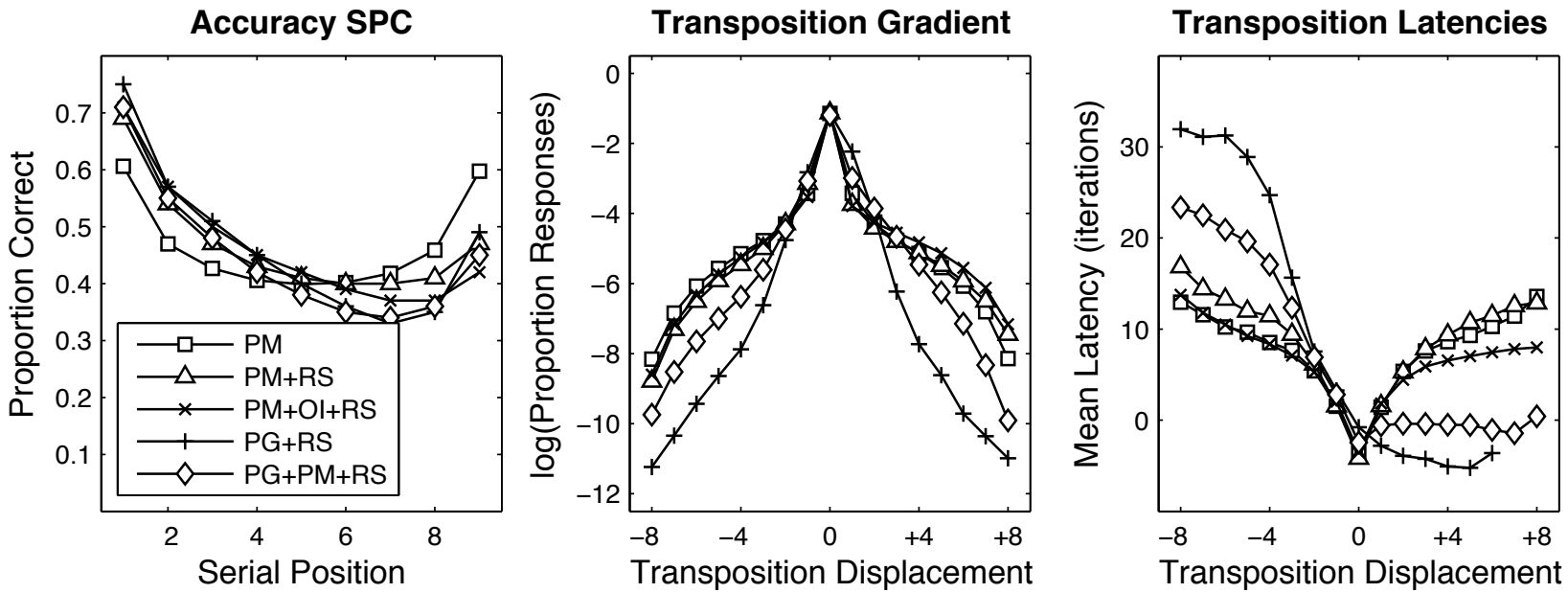

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Conclusions

- Dynamics of transpositions characterized by negative anticipation slopes and flat postponement slopes
  - pattern shown with verbal, visual, and spatial memoranda
- This latency pattern is *uniquely* predicted by a representational mechanism combining three principles:
  - primacy gradient
  - positional marking
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- Similarities in error latency patterns reveal some common principles for representing serial order across domains

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Acknowledgements

- Collaborators
  - Graham Hitch
  - Alan Baddeley


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  - Economic and Social Research Council (ESRC), U.K.
  - Experimental Psychology Society (EPS), U.K.

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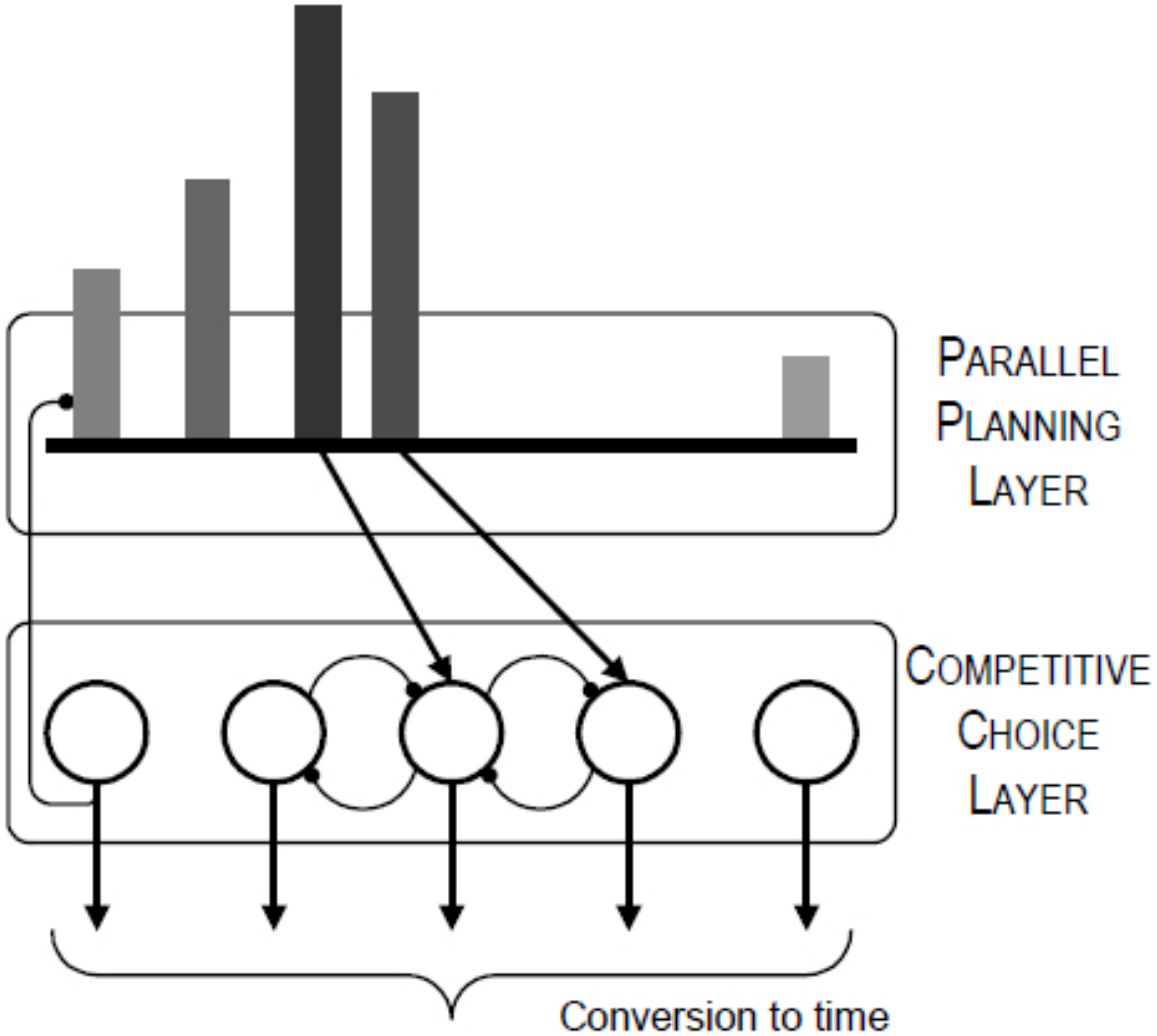
Competitive Queueing (Grossberg, 1978a, 1978b; Houghton, 1990)



Parameter space sensitivity analysis