An Examination of Domain-Specificity Differences in Complex Span Tasks through Item Response Theory

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Introduction

Research Question

Are complex span (C-span) tasks psychometrically equivalent measures of working memory capacity (WMC) regardless of domain-specificity?

Complex Span Tasks

C-span tasks measure processing and storage components of WMC. They have been shown to measure general WMC. However, each C-span task is still domain-specific.
Even though overall C-span tasks measure WMC, there might be domain-specific differences across tasks.

Item Response Theory

IRT estimates latent attributes by creating psychometric estimations based on maximized information from individual items. In this study we estimated:
Item Discrimination (a): how well an item can distinguish between individuals (item-score reliability)
Item Difficulty (b): how difficult an item is on the ability scale

Key Results

Sample 1 Operation Span

Size	α	β		
		Block 1	Block 2	Block 3
3	0.76	-1.71	-2.06	-2.10
4	0.65	-1.19	-1.45	-1.52
5	0.57	-1.05	-1.24	-1.24
6	0.47	-0.57	-0.97	-1.01
7	0.44	-0.31	-0.46	-0.60

Sample 1 Symmetry Span

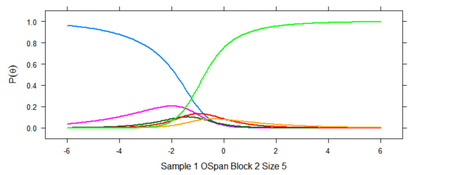
Size	α	β		
		Block 1	Block 2	Block 3
2	0.90	-2.25	-2.37	-1.97
3	0.78	-1.20	-1.35	-1.20
4	0.70	-0.55	-0.62	-0.59
5	0.56	0.13	0.03	-0.02

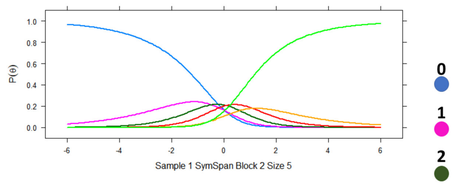
Sample 2 Reading Span

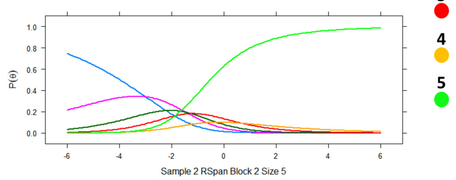
Size	α	β		
		Block 1	Block 2	Block 3
3	0.60	-3.02	-2.99	-2.51
4	0.48	-2.07	-2.11	-2.48
5	0.41	-1.76	-1.89	-2.54
6	0.38	-1.14	-1.34	-1.48
7	0.32	-0.79	-0.74	-1.02

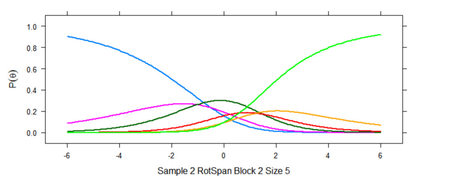
Sample 2 Rotation Span

Size	α	β		
		Block 1	Block 2	Block 3
2	0.84	-2.91	-2.53	-2.21
3	0.83	-1.42	-1.86	-1.53
4	0.56	-0.82	-0.88	-0.77
5	0.42	0.32	0.23	0.16









Method

Participants

Sample 1: N = 567, tasks: OSpan & SymSpan
Sample 2: N = 261, tasks: RSpan & RotSpan

Statistical Procedure

IRT Generalized Partial Credit Model with:
- constrained discrimination for items with same set size across blocks;
- free estimated difficulty across blocks and set sizes or,
- constrained difficulty across blocks.

Results

- Items in verbal tasks are **generally easier** than items in spatial tasks with the same set sizes;
- Spatial tasks tend to provide higher discrimination and are therefore more reliable;
- Longer items are more difficult but at least in verbal tasks, items became easier across blocks.

Conclusion

Overall, there are psychometric differences between verbal and visuospatial C-span tasks, and visual spatial tasks provided better estimates of WMC.
Longer items became easier across blocks, suggesting that participants might be using a rehearsal strategy when responding to verbal c-span tasks.