Domain-generality or domain-specificity of the short-term memory: insights from a multisensory distraction paradigm

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Introduction

Unexpected changes (e.g., deviant stimuli) in a repetitive stream of standard stimuli are known to prolong responses in visual categorization tasks (e.g., Parmentier, 2014) and disrupt short-term memory (e.g., Hughes et al., 2007). While this deviation effect has been studied extensively using sounds, far less focus has been on unexpected changes in irrelevant bimodal stimuli. A further issue is whether a spatial change in either the tactile, auditory or in both modalities simultaneously, affects verbal and spatial short-term memory similarly.

Aim

Examine whether the short-term memory (STM) is domain-specific by using deviant spatial changes in bimodal (auditory and vibrotactile) and uni-modal (vibrotactile) to-be-ignored (TBI) sequences.

Methods

Across two experiments subjects performed (47 and 50, in Experiment 1 and 2, respectively) verbal and spatial STM tasks while being exposed to TBI sequences.

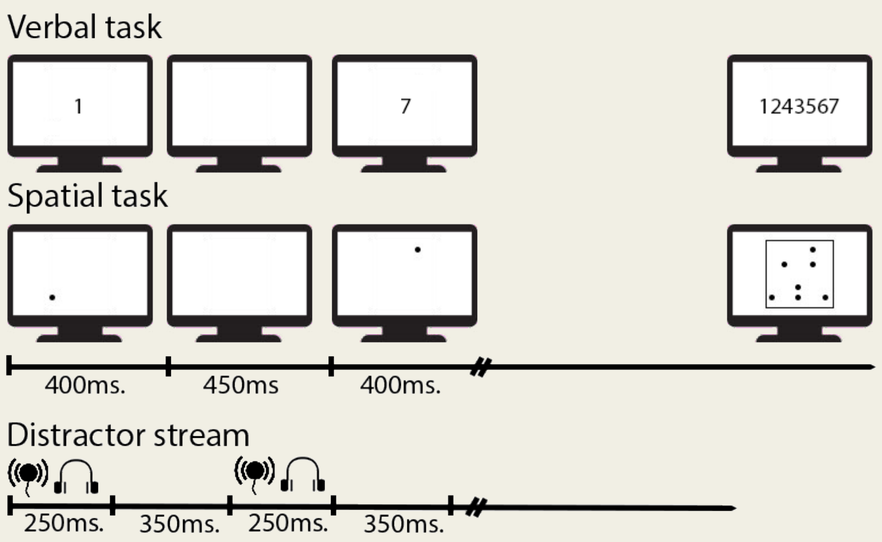

Figure 1: A schematic overview of the tasks and distractor streams used in the two experiments.

In the verbal task, 7 digits were taken randomly without replacement from the digit set 1-9. In the spatial task, 7 items (dots) were taken randomly from a 5 x 5 matrix.
The vibrotactile sequences were comprised of 10 repetitions of a vibration of 240Hz, and the amplitude of 1.8g (peak-to-peak), delivered using coin vibration motors. The auditory sequences were comprised of 10 repetitions of a 600Hz tone, delivered through sound attenuated headphones. See Figure 1 for a schematic overview of the experiments.
In Experiment 1, TBI sequence consisted of both auditory and vibrotactile sequences (simultaneously presented) whereas only vibrations were used in Experiment 2. The TBI sequences changed side of the body on 20% of the trials (spatial deviant trials). The task was to remember the order of the TBR items.

Results & Discussion

The proportion of correctly recalled items was analyzed using a 2 (Task: Spatial, Verbal) x 2 (Trialtype: Standard, Deviant).
Experiment 1. Subjects performance were significantly worse in the spatial task. Performance in the spatial deviant trials was worse compared to standard trials (See Table 1).

Table 1: Results Experiment 1

Effect	DF	*MSE*	*F*	ω_p^2	*p*
Task	1, 46	0.03	165.00 ***	.78	<.0001
Trialtype	1, 46	0.00	13.19 ***	.22	.0007
Task:Trialtype	1, 46	0.00	0.39	-0.013	.54

To further examine the impact of the spatial deviant, one-way ANOVAs for each tasks were conducted. It revealed that the spatial deviant affected both tasks negatively (see Figure 1), meaning that a spatial change can distract both spatial and verbal STM.

Experiment 2. Performance was significantly worse in the spatial task but there was no evidence that the spatial change (i.e., spatial deviant) in the vibrotactile TBI sequence affected performance. See Table 2.

Table 2: Results Experiment 2

Effect	DF	*MSE*	*F*	ω_p^2	*p*
Task	1, 49	0.02	169.37 ***	.50	<.0001
Trialtype	1, 49	0.00	0.68	.0005	.41
Task:Trialtype	1, 49	0.00	0.11	-0.018	.74

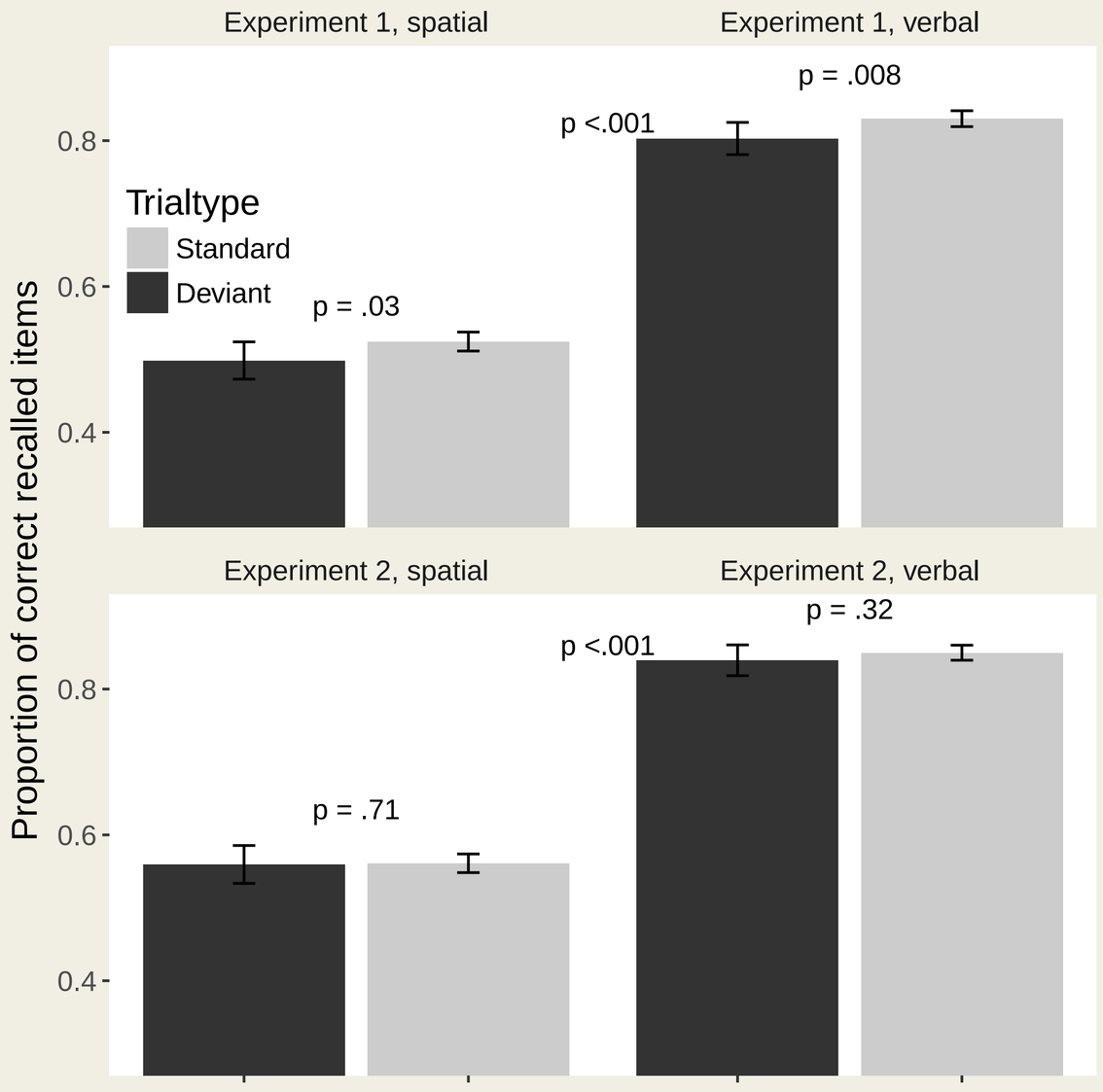

Figure 2: Proportion of correct recalled items across tasks and trialtypes in the two experiments.

Conclusions

- An unexpected spatial change in a bimodal TBI sequence affects both verbal and spatial short-term memory whereas a spatial change in a vibrotactile TBI sequence does not.
- Our results from Experiment 1 (see also Vachon et al. 2016) questions the assumption of domain-specificity but is in line with Cowan's model (e.g., 1995) and multisensory perspectives (e.g., Quak et al., 2015).
- However, our results from Experiment 2 may be troublesome for multisensory perspectives of STM/WM.

References

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LaTeX files, r-scripts, data, and other additional information is available at https://github.com/marsja/poster-stm-distraction

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