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The Relationship Between Executive Attention and Spatial Working Memory in Adults

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Background and Significance

The study examined the effects of executive attention on spatial working memory in adults using a location recall task. Attention is suggested to play a crucial role in maintenance of a remembered location in spatial working memory. Awh and Jonides (2001) found that reaction times to a presented stimulus were faster when the stimulus was held in spatial working memory. A subsequent study found that when holding a location in spatial working memory, tasks which shift attention cause memory performance to be worse for the remembered location. An ERP study by Awh and Jonides (2001) found similar response amplitudes between visual responses for memorized locations and directed spatial attention. These results are significant because they suggest that spatial attention is used as a rehearsal mechanism for holding locations in spatial working memory. Another study found that when a location is held in spatial working memory, an onset of an external stimulus, i.e., a distractor, caused a shift in the memory representation in the direction of the location (Stigchel, Merten, Meeter, & Theeuwes, 2007). In contrast Schutte, Keiser, and Beatte (2015) found that in a similar task 6-year-olds' memory representation of the target location shifted away from the distractor.

Our study examined executive attention in adults and the effect distractors have on memory representations held in spatial working memory. We hypothesized that when a location is held in spatial working memory, a distractor that captures attention will shift the memory representation towards the distractor if the distractor is close in space to the remembered location. If the distractor is far in space from the location held in spatial working memory, the memory representation will shift away from the distractor. We also tested the hypothesis that adults with better top-down control of attention (i.e., better executive attention) will make smaller errors in the spatial working memory task.

Examining executive attention on spatial working memory is important to better understand the processes underlying spatial working memory. Examining the specific effects of distractor on a memory representation in spatial working memory will help determine how executive attention and working memory are related, and will have implications for theories of spatial cognition, such as Dynamic Field Theory.

Figure

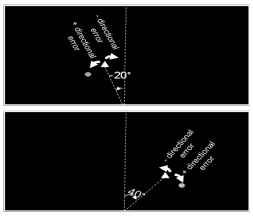


Figure 1. A diagram of the screen for the spatial working memory task with targets at –20° (top panel) and 40° (bottom panel) and a distractor approximately 20° from the targets.

Methods

Participants:
The participants consisted of 40 female and 45 male adults at the University of Nebraska- Lincoln.

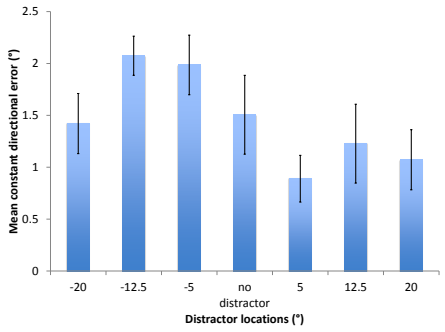
Task:
Spatial working memory task. Participants sat in front of a large touch-screen monitor. Each trial consisted of a target that appeared for 1500 ms at one of two possible locations, –20° or +40° from the midline symmetry axis. After a delay of 10 seconds, the participant touched the screen at the remembered location of the target. Of the 160 total trials, three fourths of them consisted of a distractor that appeared ±5°, ±12.5°, or ±20° from the target.

Attention network task. For this task the participants completed the attention network task (ANT) developed by Fan and colleagues (2002). The ANT measured executive attention, alerting, and orienting.

Results

No main effect or interactions with Executive Attention, so it was dropped from the final model.

Significant distractor main effect, F(6,546)=3.961, p=.001



Discussion

Executive attention, as measured by the ANT, was not related to spatial working memory performance. Thus, the hypothesis that executive attention and spatial working memory would be related was not confirmed.

We hypothesized that a distractor would bias memory responses. When the distractor was near the target location, we hypothesized that responses would be biased towards the distractor. When the distractor was far from the target, we hypothesized that responses would be biased away from the distractor. In the Spatial Working Memory task (SWM), distractors biased the responses, thus the hypothesis was partially confirmed. However, the results showed the following pattern:

- Distractor near target: responses biased away from distractor
- Distractor far from target: responses not biased

According to Dynamic Field Theory, distractors near the target, but not too close to the target, will "push" the memory of the target away from the distractor due to inhibition associated with the distractor. Distractors very close to the target will "pull" the memory of the target toward the distractor due to excitation associated with the distractor. The closest distractor may have been too far from the target to "pull" the memory toward it.

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