The Effect of Spatial Location on Goal Representation and Maintenance

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Introduction

According to context processing theory (Braver et al., 2001) cognitive control is based on the ability to represent and maintain goal information in working memory. The AX-CPT tests this idea by comparing performance on four trial types: AX, AY, BX, and BY. Many studies (Braver et al., 2001; Lorsbach & Reimer, 2010) have shown that good goal representation and maintenance leads to better performance on BX than AY trials.

The Event Horizon Model (Radvansky & Zacks, in prep.) makes claims about how the structure and processing of event information can influence the availability and processing of information across the flow of a sequence of events. One aspect of this is the process of event segmentation, which is outlined by Event Segmentation Theory (EST) (e.g., Zacks et al., 2007) in which information is parsed into separate events when event boundaries are encountered, such as shifts in spatial location. A second is that the current event holds preferential status in information availability. Third, information segregated into different events produces less interference so long as there is no strong overlapping information. Research suggests that event boundaries can improve performance by reducing interference between previous events and current events (Swallow, et al., 2009).

These two theories lead to the prediction that event boundaries may improve cognitive control by improving goal representation and maintenance. Goal representation and maintenance may be improved in the AX-CPT when the cue and target are separated by an event boundary (i.e., a location shift) events, thereby reducing interference. If this is the case, cue (goal) representation should be better when the cue and probe are presented in different locations than when they are presented in the same location. As a result, for BX trials, performance should be better in the **different** than the **same** condition. In contrast, for AY trials, performance should be better in the **same** than the **different** condition.

Methods

Four experiments were conducted. For each experiment, a 2 (Condition: same vs. different) x 3 (Trial type: AX vs. AY vs. BX vs. BY) repeated measures design was used. RT and error rate served as the dependent variables.

Participants were students at California State University, San Bernardino. N = 52, 32, 49, & 29 for Experiments 1, 2, 3, & 4, respectively.

Each experiment used a version of the AX-CPT in which sequences of letters are given as cue-probe pairs (See Figure 1). The object of the task is to press a "Yes" key to a target letter (X) when it follows a valid cue (A). A "No" key is to be pressed otherwise. Most (76%) of the trials consist of target trials (AX). The rest were distributed equally among the AY, BX, and BY trials. Within each trial type, half of the trials were in the same condition, and half were in the different condition.

In Experiments 1, 2, & 4, each trial began with a cue (500 ms) followed by a fixation cross (5000 ms in Exp. 1; 1000 ms in Exp. 2 & 3) for the cue-probe delay, and ended with a letter probe (500 ms). In Experiment 3, the cue was followed by a fixation cross for 500 ms which was, in turn, followed by mental rotation stimuli for 4000 ms. Immediately afterward, a second fixation cross was presented (500 ms) which was followed by the probe letter. A 1000 ms interval was used between trials using a blank screen. Testing occurred in a single session of 208 test trials divided into four blocks of 52 trials.

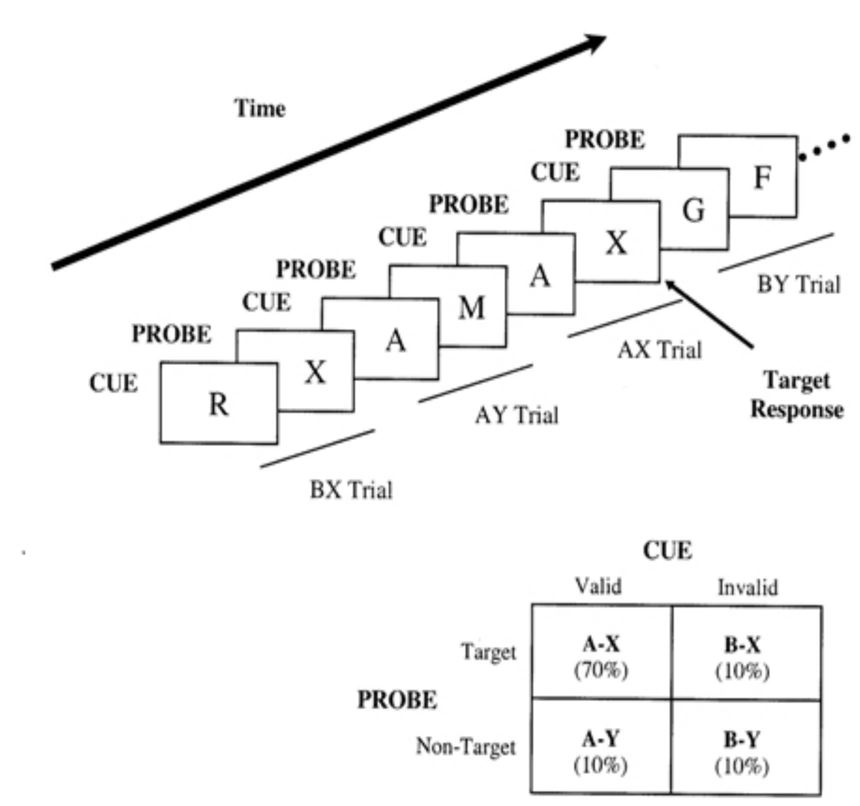

Figure 1. Overview of the AX-CPT paradigm. Adapted from Braver et al. (2001).

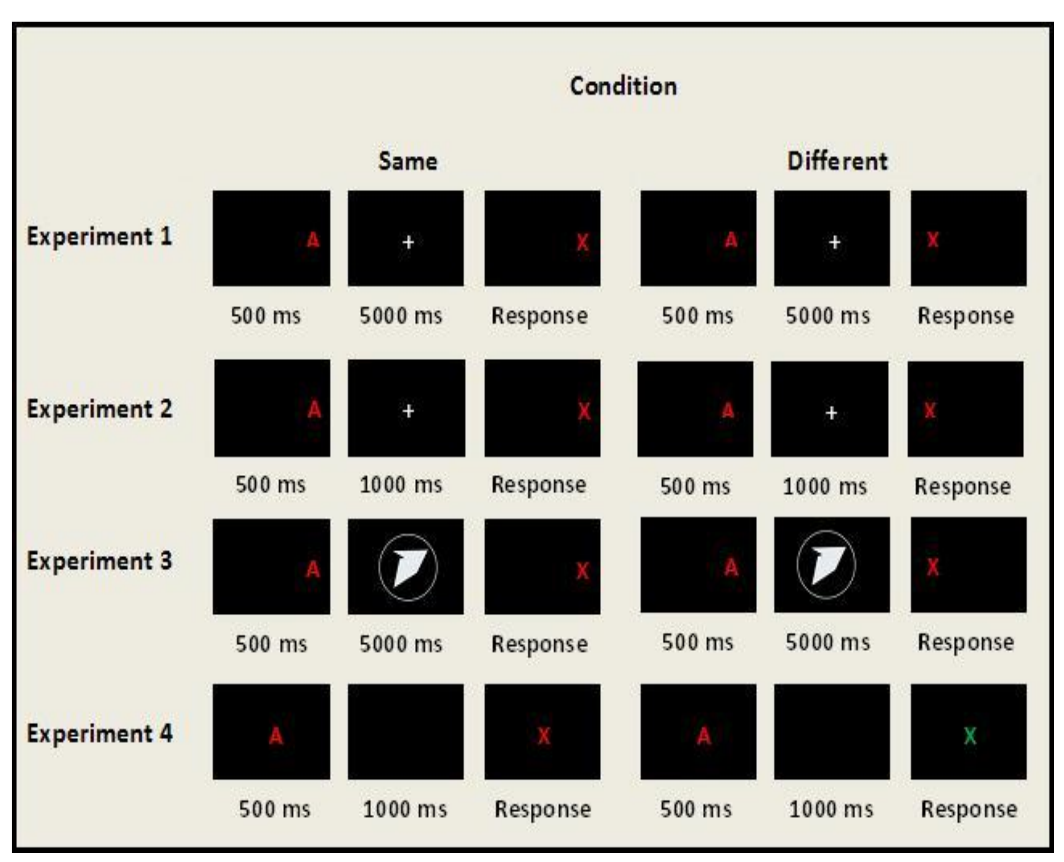

Figure 2. Overview of the stimuli from the four experiments.

Results

Experiment 1 (see Figure 3)

- AX RT data: different < same
- Significant Non-Target Trial Type x Condition interaction in RTs, $F(2, 102) = 4.65$, $p < .05$.
- BX RT data: different < same
- AY error rate data: different > same

Experiment 2 (see Figure 4)

- AX RT data: different < same
- Significant Non-Target Trial Type x Condition interaction in RTs, $F(2, 62) = 5.07$, $p < .05$.
- BX and BY RT data: different < same
- AY error rate data: different > same

Experiment 3 (see Figure 5)

- AX RT data: different < same
- No significant Non-Target Trial Type x Condition interaction.

Experiment 4 (see Figure 6)

- AX RT data: same < different Note: opposite of Experiments1 & 2.
- No significant Non-Target Trial Type x Condition interaction in RTs.

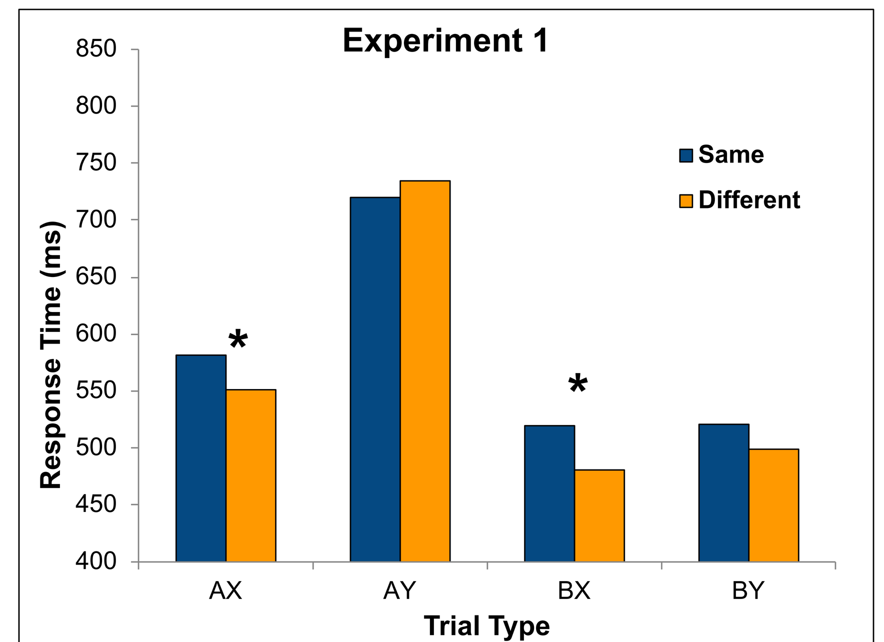

Figure 3. Mean response times in Experiment 1. Cue-probe delay = 5000 ms. $^*p < .05$

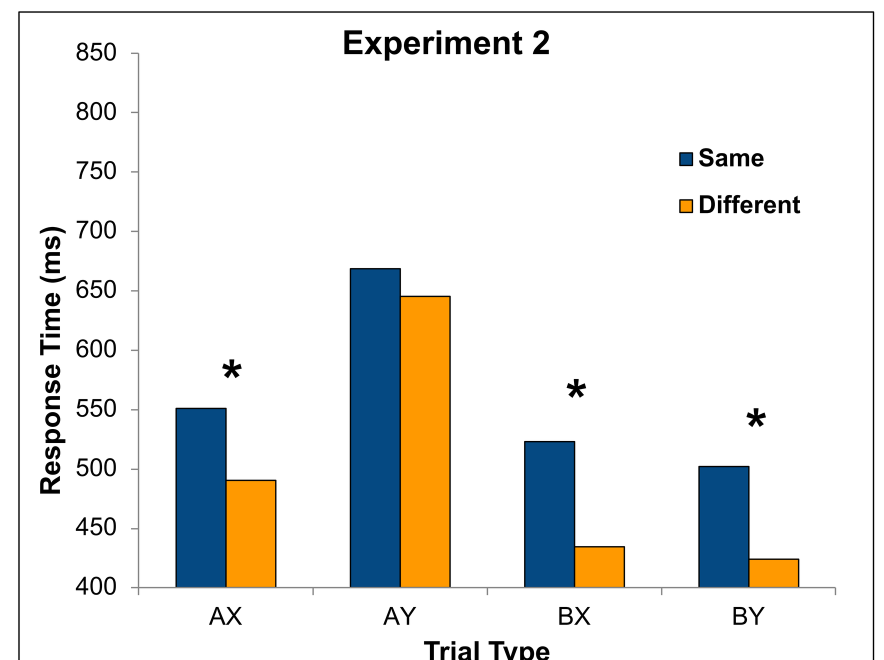

Figure 4. Mean response times in Experiment 2. Cue-probe delay = 1000 ms. $^*p < .05$

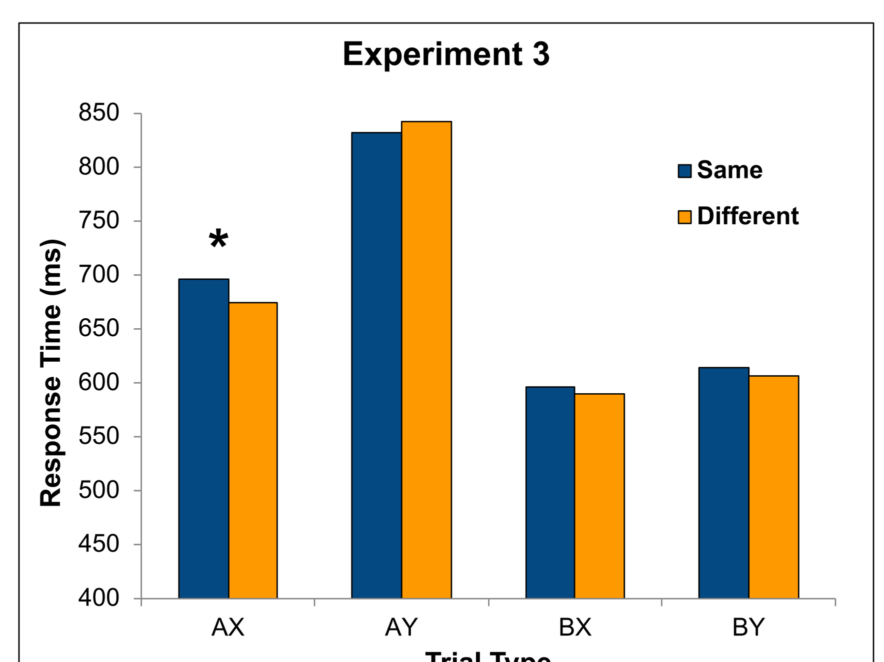

Figure 5 Mean response times in Experiment 3. Cue-probe delay = 5000 ms. $^*p < .05$

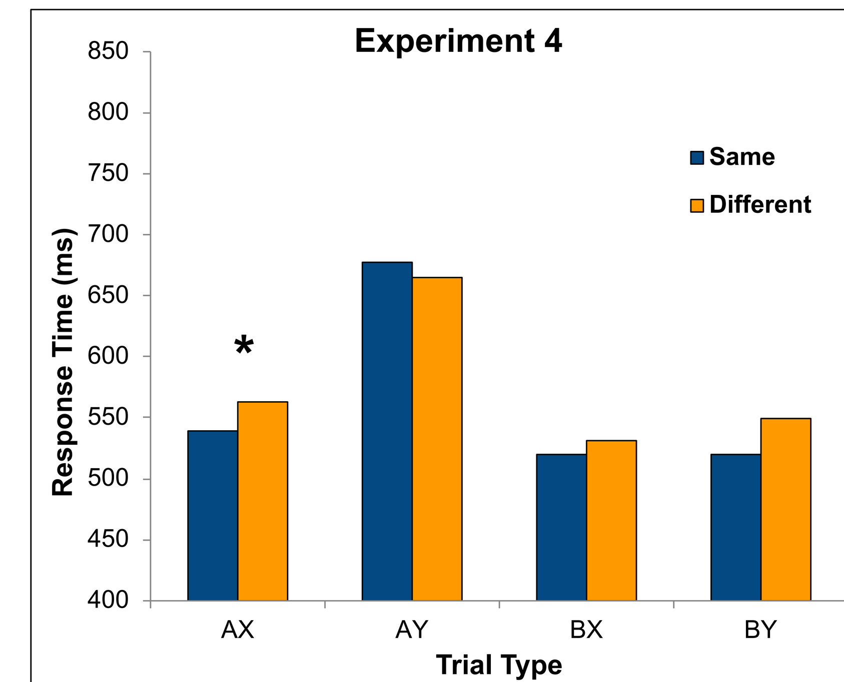

Figure 6. Mean response times in Experiment 4. Cue-probe delay = 1000 ms. $^*p < .05$

Conclusions

- In all four experiments AY trials were slower and/or produced more errors than BX trials, consistent with previous studies that have examined the role of goal representation and maintenance in cognitive control.
- More importantly, by reducing interference, spatial shifts between the cues and probes within the AX-CPT affected the representation and/or maintenance of goal information. When they were in different locations, goal information (i.e., cues) was represented and maintained in working memory better than when they were in the same location. This was manifested by improved performance on BX trials, and decreased performance on AY trials.
- The shift effects were (a) spatial in nature and, so, were interfered with by other forms of spatial processing (e.g., mental rotation), and (b) were not caused by general differences (or similarities) in features (characteristics) of the cues and probes (e.g., color).

References

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