The effects of saccades on visual working memory representations

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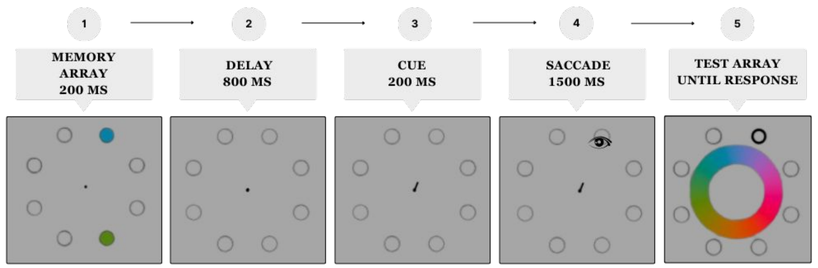
Introduction

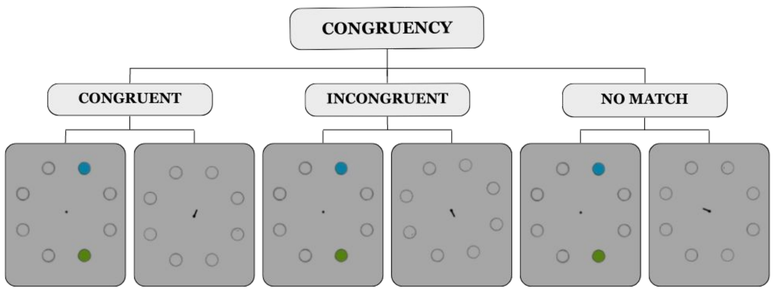
Previous research has shown that motor movements, such as saccades, influence the weighting of action-relevant object representations within visual working memory (VWM)[1,2]. We previously found evidence that manual motor movements results in inhibition of the action-irrelevant VWM representations while they enhance action-relevant VWM representations.[3]

Research Question:
Do saccades modulate action-relevant items, action-irrelevant items or both?

In the present study, we investigated whether saccades can also result in similar inhibition of the action-irrelevant or enhancement of the action-relevant VWM representations. We tested whether executing a saccadic eye-movement toward a location improves the memory representation displayed at that location, suppresses representations at other locations, or involves a combination of these mechanisms.

Method



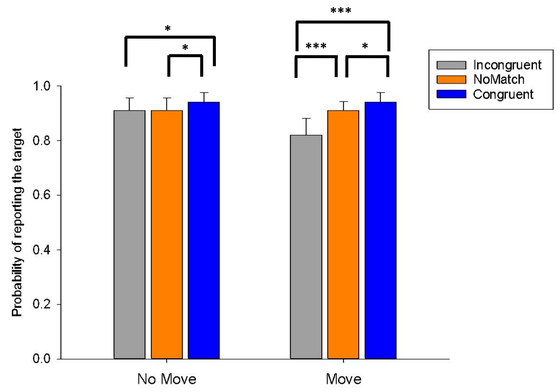


Conditions
Motor Movement: No Movement, Movement
Congruency: No Match, Incongruent, Congruent
Set Size: Set Size 2 (Experiment 1), Set Size 3 (Experiment 2)

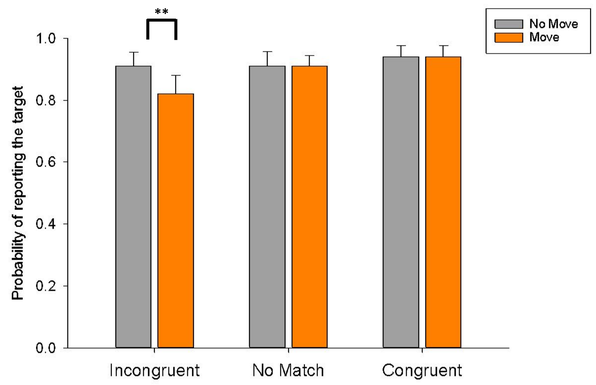
Analyses
Participants' response distributions were analyzed using a probabilistic mixture model with MATLAB Memtoolbox,[4] which calculated the probabilities of reporting the target color value, the non-target colors, and a randomly chosen color value.

*p<.05
**p<.01
***p<.001

Experiment 1 Results



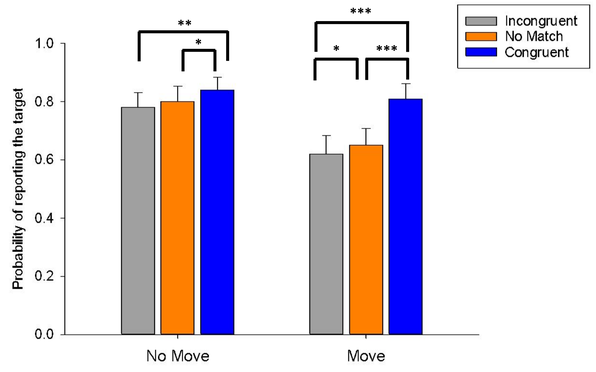
- Effect of Congruency: Congruent trials (.94) resulted in highest target reports, followed by No Match (.91) and Incongruent trials (.87).
- Comparison of Move trials: Executing a saccade to the Incongruent location (.82) resulted in worse target reports compared to No Match control (.91), suggesting **inhibition** of the no-movement locations. Moreover, we observed significantly better reports for the Congruent location (.94) relative to the No Match, suggesting **enhancement** of the movement location.



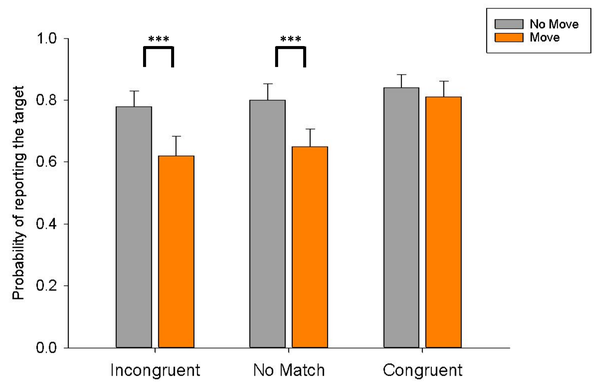
- Effect of Movement: Executing a saccade resulted in lower target reports, but only in the Incongruent condition, indicating an **inhibition** effect.

*p<.05
**p<.01
***p<.001

Experiment 2 Results



- Effect of Congruency: Congruent trials (.83) resulted in highest target reports, followed by No Match (.70) and Incongruent trials (.73).
- Comparison of Move trials: Executing a saccade to the Incongruent location (.62) resulted in worse target reports compared to No Match control (.65), suggesting **inhibition** of the no-movement locations. Moreover, we observed significantly better reports for the Congruent location (.81) relative to the No Match, suggesting **enhancement** of the movement location.



- Effect of Movement: Executing a saccade resulted in lower target reports in the Incongruent and No Match conditions, but not in the Congruent condition indicating an **inhibition** effect.

Conclusions

1. Our results showed substantial evidence for the **inhibition of action-irrelevant items**:
   - Saccades to an incongruent location significantly decreased correct target reports compared to when no saccade was executed.
   - For trials involving saccades, Incongruent condition resulted in worse performance than No Match control condition.
2. We also showed significant **enhancement of action-relevant items:** Congruent trials consistently showed higher target reports than both No Match control and Incongruent trials.
3. These results contradict with previous research which only found enhancement effects[1,5]

References

[1]Heuer, A., Crawford, J. D., & Schubö, A. (2017). Action relevance induces an attentional weighting of representations in visual working memory. Memory & Cognition, 45(3), 413–427. https://doi.org/10.3758/s13421-016-0670-3.
[2]Heuer, A., Ohl, S., & Rolfs, M. (2020). Memory for action: A functional view of selection in visual working memory. Visual Cognition, 28(5–8), 388–400. https://doi.org/10.1080/13506285.2020.1764156
[3]Mugno, M. K., Parker, J., Kinder, K. T., & Tas, A. C. (2022). The mechanisms of selection-for-action on visual working memory representations. Journal of Vision, 22(14), 4442-4442
[4]Suchow, J.W., Brady, T. F., Fougnie, D., & Alvarez, G. A. (2013). Modeling visual working memory with the MemToolbox. Journal of Vision, 13(10):9, 1–8, http://www.journalofvision.org/content/13/10/9, doi:10.1167/13.10.9.
[5]Ohl, S. & Rolfs, M. (2020). Bold moves: Inevitable saccadic selection in visual short-term memory. Journal of Vision, 20(2):11. https://doi.org/10.1167/jov.20.2.11