# Gaze Strategies During Visually-Guided and Memory-Guided Grasping


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## INTRODUCTION

Normally, we look at objects when we reach out and grasp them - such actions are referred to as *visually-guided.*

During visually-guided grasping, subjects first look at the region on the object where their index finger will grip it and then they look toward the object's centre of mass (COM) during the actual reach[1,2].

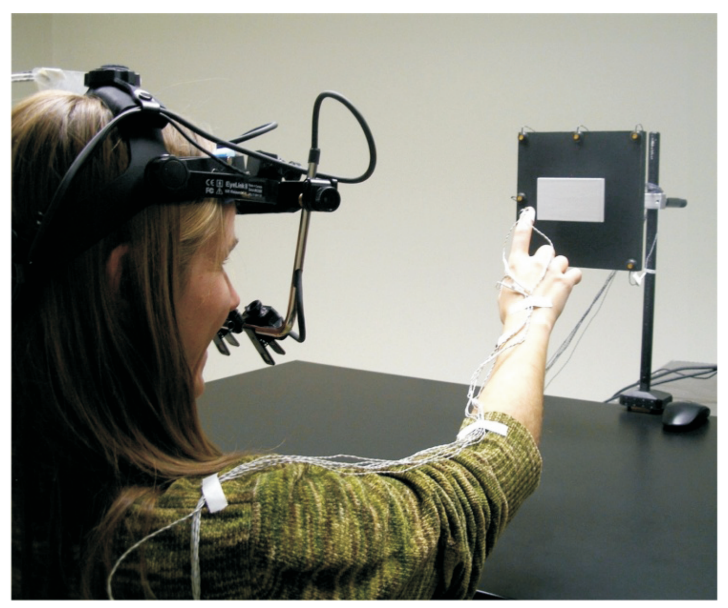
We can also reach to grab objects without looking a them, and instead, use our memory of the object's shape and location to guide our motor actions (e.g., in the dark) - thus, these actions are called *memory-guided.*

QUESTION:

Do subjects show the same gaze strategies during the planning of delayed memory-guided grasps as they do planning visually-guided grasps?

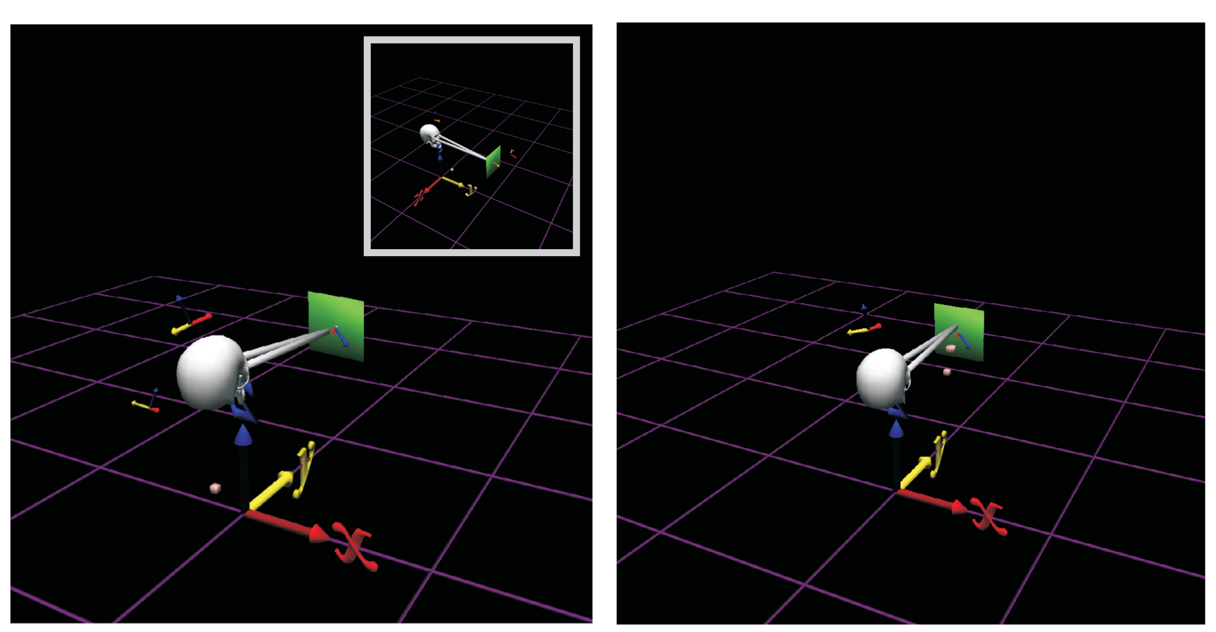
## DATA COLLECTION

**Figure 1:** *Integrated eye-hand motion tracking system.*



Eye position was recorded using the EyeLink 2 eye-tracker and grasp kinematics were recorded using the Optotrak motion-tracking system.

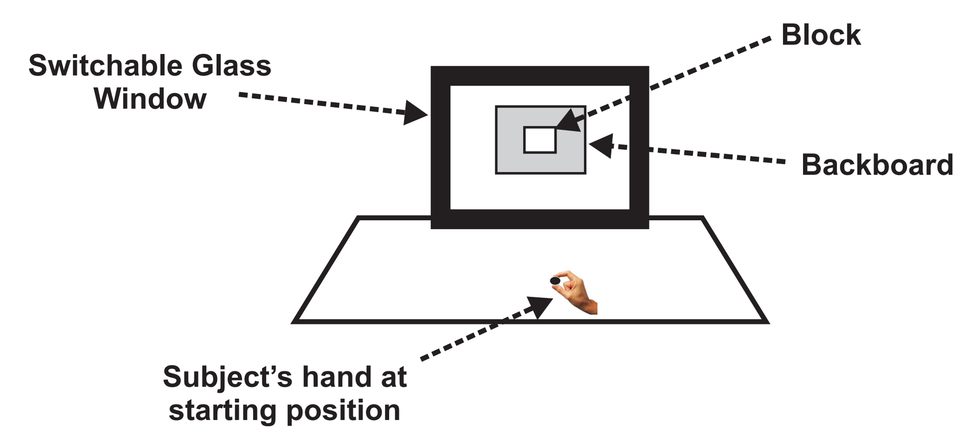
**Figure 2:** *Screenshots of the MotionMonitor software.*



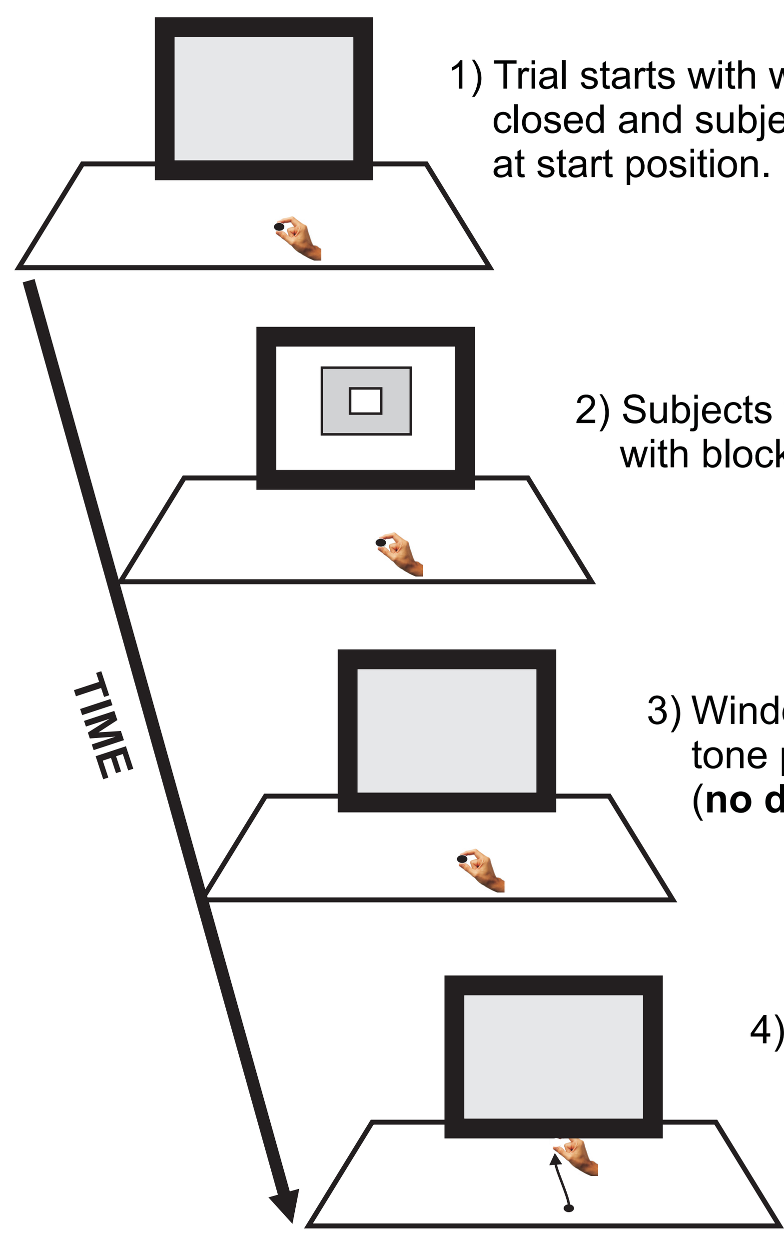
Eye and hand data recorded from the two separate tracking systems were integrated into the same frame of reference via the MotionMonitor software.

## EXPERIMENTAL TASKS

**Figure 3:** *General experimental design.*




**MEMORY-GUIDED GRASPING TASK**



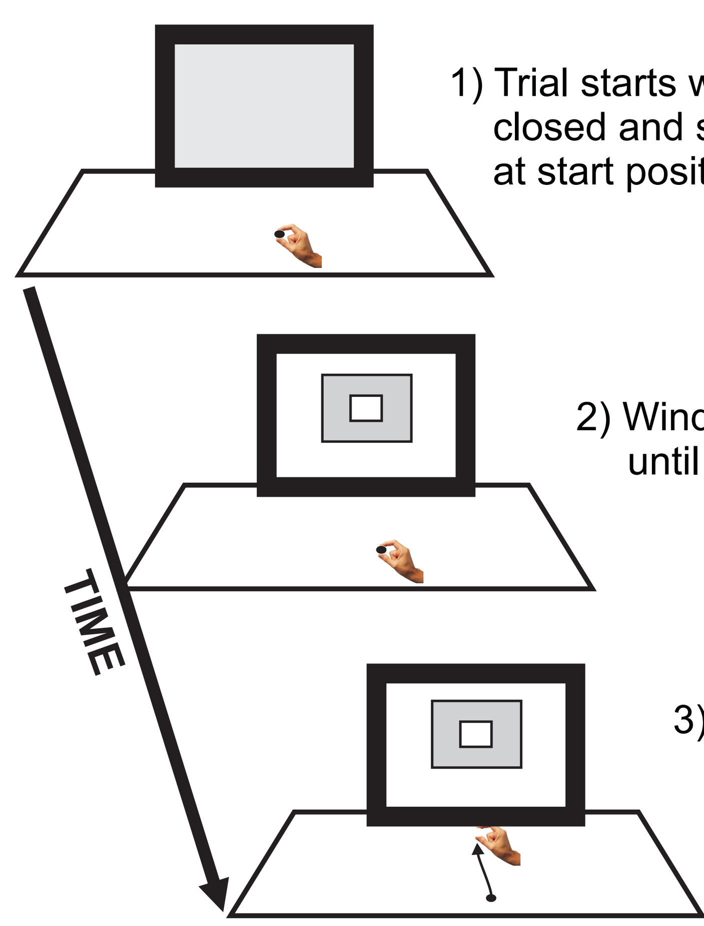

1) Trial starts with window closed and subject's hand at start position.

2) Subjects were presented with block for 1 sec.

3) Window closes and an auditory tone presented either immediately (**no delay**) or after a **2 sec delay.**

4) After tone subjects reach and grasp block with index finger and thumb.

**VISUALLY-GUIDED GRASPING TASK**




1) Trial starts with window closed and subject's hand at start position.

2) Window opens and remains open until end of trial (grasp is finished).

3) After window opens, subjects reach and grasp block with index finger and thumb.

## RESULTS

**Figure 4:** *Vertical eye position in each task.*

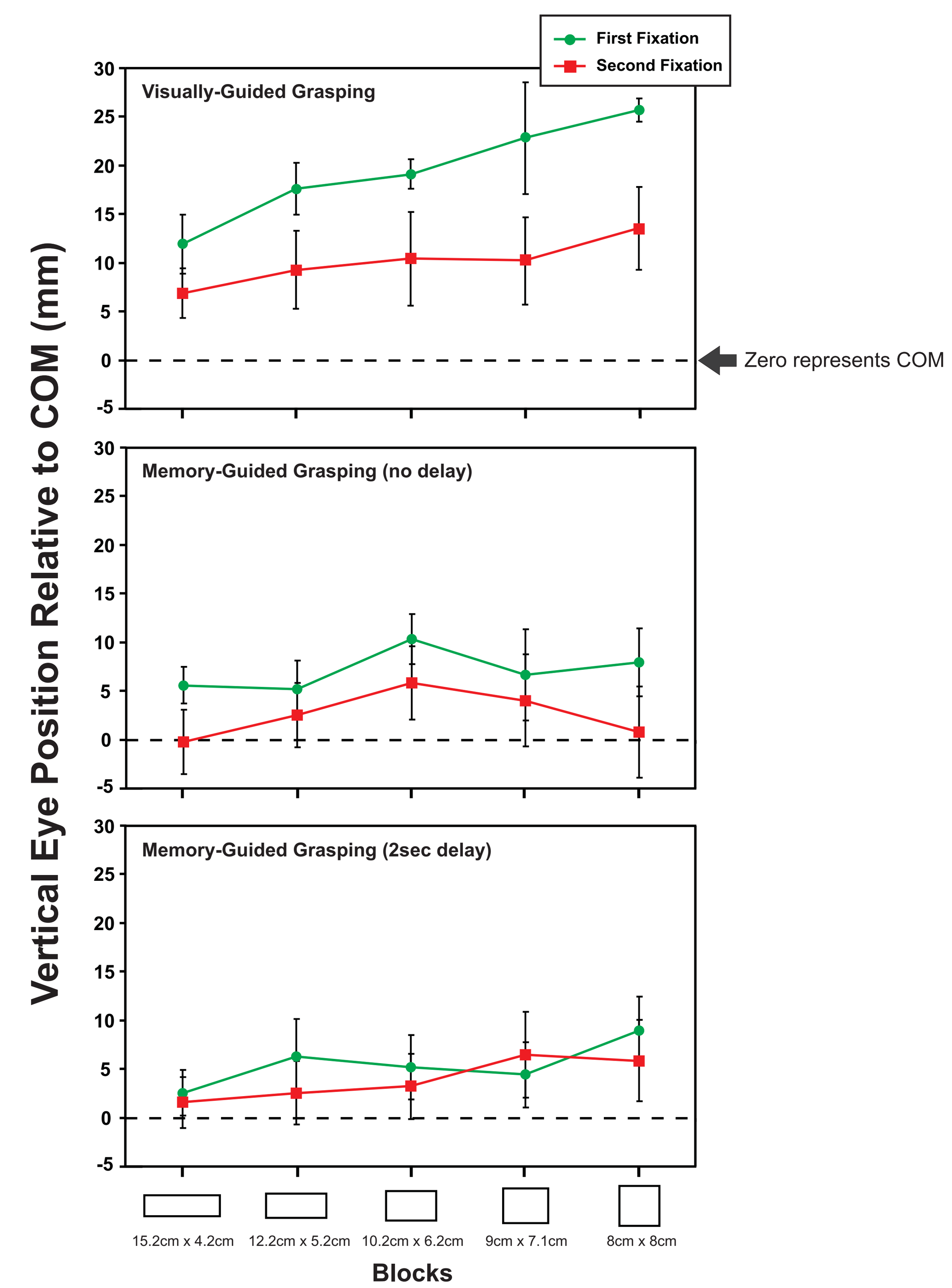
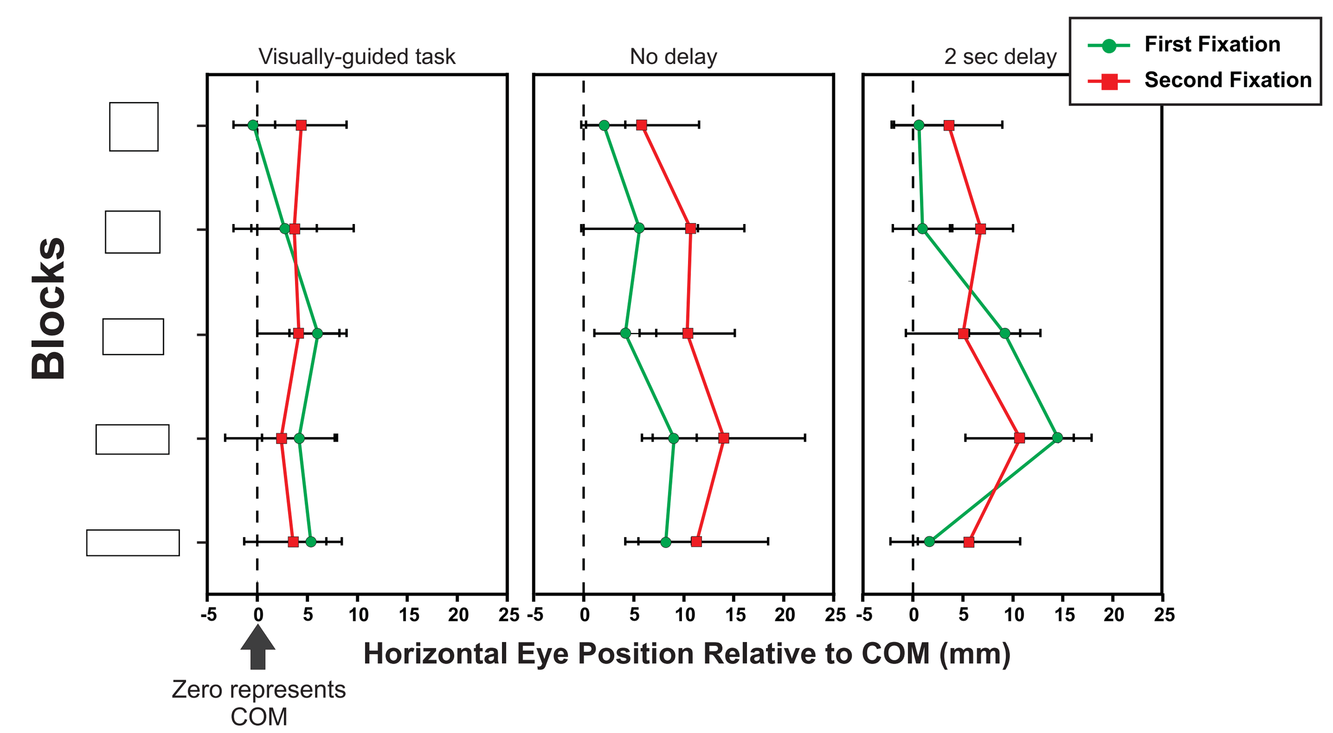


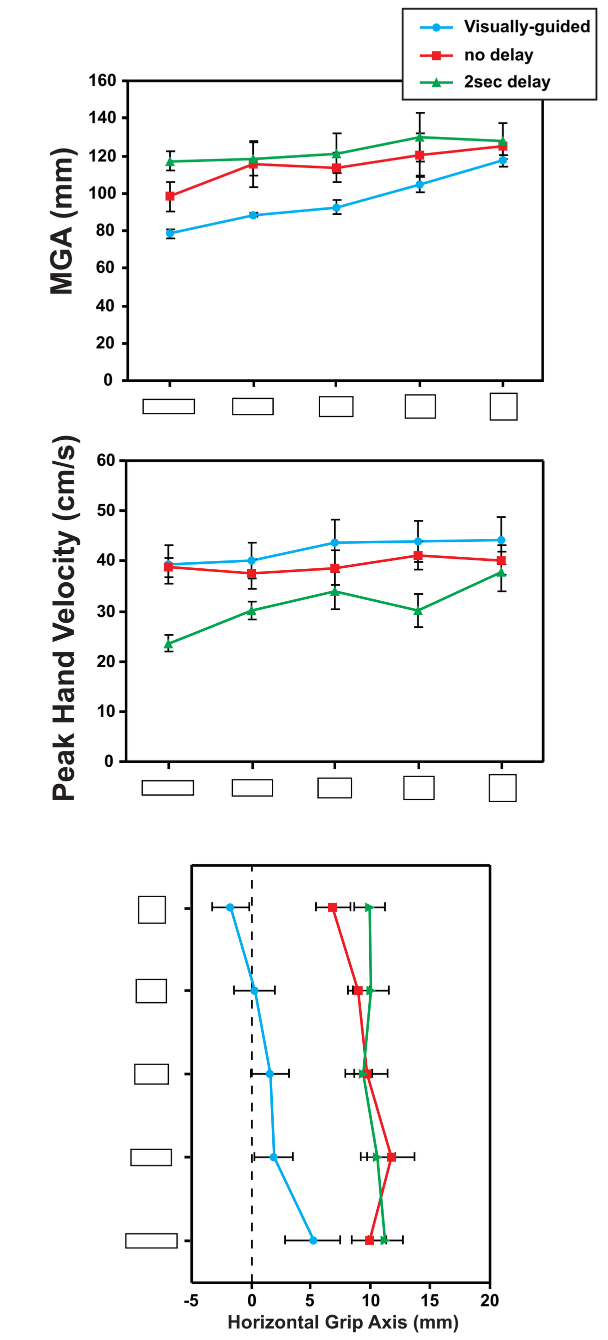

**Figure 5:** *Horizontal eye position in each task.*




- In the visually-guided grasping task, first fixations were higher than second fixations and directed closer to the top of the block, whereas second fixations were directed closer to the COM.
- In the memory-guided grasping task, no statistical differences were found between first and second fixations in both no delay and 2 sec delay conditions.
- Fixations in memory-guided task were lower than fixations in visually-guided task.
- Horizontal position of first and second fixations showed no differences in both tasks though fixations were closer to COM in the visually-guided task than the memory-guided task.

## RESULTS

**Figure 6:** *Hand kinematic data in each task.*




- Maximum grip aperture (MGA) in visually-guided task increased with block size showing appropriate grip scaling.
- MGA was larger in memory-guided task and generally increased with block size but this scaling was not significant.
- In general, peak hand velocity tended to increase with block size.
- Reaches were significantly slower in the 2 sec delay memory-guided task.
- In visually-guided task, grip axis between index finger and thumb was more rightward of COM for the widest block and shifted leftward as block width decreased.
- Grip axis in memory-guided task were more rightward than grip axis in visually-guided task memory-guided task.

## CONCLUSIONS

- We compared the gaze strategy during the planning of delayed memory-guided grasps and visually-guided grasps.
- In the visually-guided task, first eye fixations were directed closer to the top of the blocks corresponding to the index finger's grasp point and nearer the COM corresponding to index finger placement.
- Our visually-guided results suggest gaze targets future grasp points during the planning of the grasp, consistent with the findings from previous studies[1,2].
- In the memory-guided task, subjects spent more time looking closer at the COM and grasps are more rightward on blocks than visually-guided grasps.
- Memory-guided gaze data resembles gaze patterns during perceptual tasks[3].
- Our memory-guided results suggest subjects analyzed the block's overall shape to build an overall perceptual representation for memory-guided actions.
- Our data suggest different cognitive chronometry for the control of eye and hand movements between the two tasks.
- In the visually-guided task, eye movements are initially driven by action-related grasp targeting computation for the index finger placement before switching to perceptual analysis of the overall block during the reach.
- In the memory-guided task, eye movements are driven wholly by the perceptual representation of the block, but hand movements are driven more by the perceptual representation of the block after sufficient delay.

## REFERENCES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2) Johansson, R. S., Westling, G., Backstrom, A., & Flanagan, J. R. (2001). Eye-hand coordination in object manipulation. *Journal of Neuroscience, 21(17)*, 6917-6932

3) Kowler, E. & Blaser, E. (1995). The accuracy and precision of saccades to small and large targets. *Vision Research, 35(12)*, 1741-1754



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