Evaluation of visual search patterns using eye-tracking in a Visual Working Memory task

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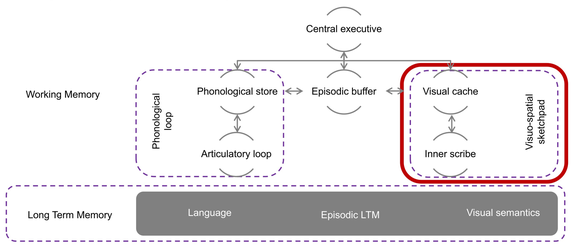
Introduction

Figure 1

Working memory model (Baddeley, 2003)



Optimal signal-to-noise processing of important sensory stimuli, including directing attentional resources to relevant environmental events, is adaptive. For example, there is evidence that humans and other animals use external cues that have been associated with the occurrence of relevant environmental events to direct attentional resources toward those events more quickly and accurately than when no external cues are provided. Previous research on visual processing in humans (Griffin & Nobre, 2003; Souza et al., 2016), and non-human animals (Brady & Hampton, 2018) has demonstrated that cues presented before (i.e., pre-cue) or after (i.e., retro-cue) a target stimulus improves visual working memory (VWM) for the identity and spatial location of the target stimuli.

Although cueing has been reported to improve identity and spatial processing, the mechanisms by which it does so are not fully understood. Differences in the degree of improvement for identity vs. spatial features of an object depend on the type of stimulus (e.g., simple coloured crosses vs. more complex stimuli snowflakes) and the number of stimuli presented (e.g., four crosses vs. one snowflake). Given the complexity and number of stimuli on the screen, participants may have used different visual encoding patterns to process them, which could imply an interaction between cueing and stimulus complexity.

Eyetracking allows the evaluation of the dynamics of the intake of visual information and the analysis of search patterns of saccadic eye movements (Hyönä, 2010); which involves two temporal stages: fixations, where the gaze position is relatively still, and saccades, where eyes move quickly between fixations (Luck & Hollingworth, 2008).

The goal of the current project is to evaluate if pre and retro-cues alter the pattern of fixations and saccades.

Methods

Participants

A total of 20 young adults between the ages of 18-35 will be recruited from campus through the TCU SONA Psychology Research Participation System. All of them must report normal or corrected to normal vision and hearing in a demographics survey at the beginning of the experimental task. Participants who do not meet those criteria will be excluded from the study. All the protocols will be submitted to the Texas Christian University Institutional Review Board (IRB) for approval.

Stimuli and task

Participants will carry out a 2D signal detection task (same-different) in a Meta Quest Pro VR headset with eye tracking capacities. They will be divided into two groups and exposed to either coloured crosses (e.g., red, blue, green, yellow, orange, cyan, pink, grey; Griffin & Nobre, 2003) or white snowflakes, and then must make a delayed decision about the colour or location of a probe stimulus.

Figure 2

Complex and simple stimuli of the experimental task

Figure 3

Eyetracking deice for presenting the experimental task

Table 1

Trial distribution of the experimental task

Trials	Training (x1)	Test (x2)
Pre Identity	8	8
Retro Identity	8	8
Baseline Identity	8	8
Pre Spatial	8	8
Retro Spatial	8	8
Baseline Spatial	8	8

Figure 3

Projected fixations durations (A) and saccades durations (B) between groups

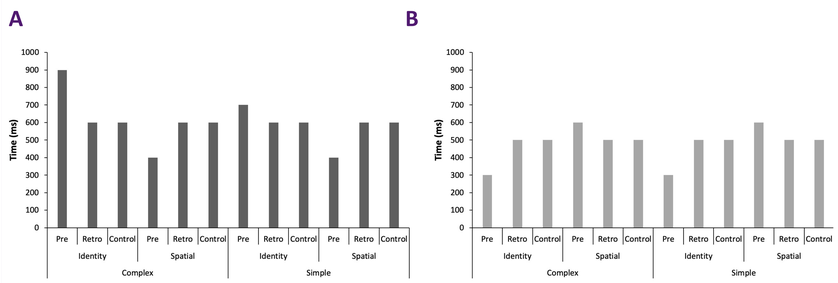
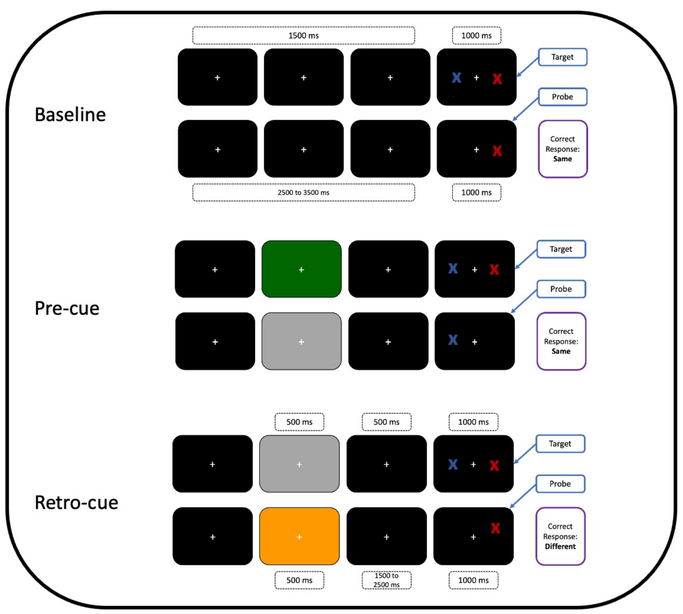


Figure 4

Design of the experimental task



Expected Results

Predictions:

- Participants will exhibit longer fixation durations on pre-cue identity trials, particularly in the group exposed to complex stimuli.
- Identity pre-cues will direct their gaze more often to the area where the stimulus will be presented.
- Spatial pre-cues will exhibit the shortest fixation duration given the participants are being cued to encode spatial information.
- Retro and control trials will exhibit shorter fixation durations given the participants will encode identity and spatial information from the stimulus to solve the task.
- Participants will exhibit longer saccade durations on pre-spatial trials, in both groups.
- Spatial pre-cues will direct their gaze across the area where the stimulus is presented, to encode more accurate spatial information.
- Identity pre-cues will exhibit the shortest saccade durations given the participants are being to encode identity information from a specific portion of the screen.
- Retro and control trials will exhibit moderate saccade durations given the participants will encode identity and spatial information from the stimulus to solve the task.

Discussion

The G-SERC grant has provided the lab with cutting-edge equipment, allowing me to complement my training as a PhD candidate in multiple advanced techniques, such as programming in VR, eye tracking, and data analysis of complex data sets. In addition, It has also provided more opportunities for the undergrad research assistants who work with me in the lab to learn new techniques as part of their research process, and allowed me to improve my teaching skills while working with them on this research project.

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