# Project Progress Report

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**Topic:** Effects of Retro-Cuing on Visual Short-Term Memory

## Introduction

Visual short-term memory (VSTM) is important because it allows us to store and retrieve visual information, even after the stimulus is no longer present. VSTM has a limited capacity - some researchers have maintained that the number of items that can be stored in VSTM is limited (Zhang & Luck, 2008).
Increasing the number of items in VSTM reduces the precision of memory recall (Bays & Husain, 2008; Zhang & Luck, 2008). This implies that there is a tradeoff between two mnemonic parameters - quality and quantity.

Studies on retro-cuing suggest that attention during memory maintenance can protect information from being forgotten. (Griffin & Nobre, 2003; Landman, Spekreijse, & Lamme, 2003;
Makovski, Sussman, & Jiang, 2008; Matsukura, Luck, & Vecera, 2007). This is also supported by the Sperling experiment results.

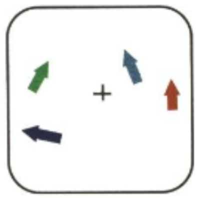
The inherent question we are trying to answer is whether can selective attention help improve our retention, in the context of visual short term memory (VSTM). That is, can forgotten items be restored to memory with attention?

## Hypothesis

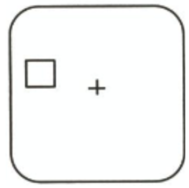
Selective attention (retro-cuing) will increase the probability of recalling items in VSTM but may not improve the precision of memory representations.

## Experiment Design

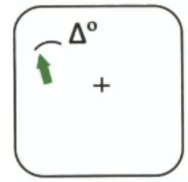
### Description



Participants are shown a memory array consisting of a set of four or eight randomly oriented arrows in easily discriminating colors (red, blue, green, cyan, yellow, magenta, or white; colors are randomly selected without replacement).



Recall was tested using a memory probe - which is always one of the arrows from the array. Participants have to indicate whether the probe is rotated clockwise or anticlockwise.




The angles of rotations of the arrows - 5°,15°, 30°, or 45° - are also varied to test if the recall changes with change in the orientation.

## Paradigms

Our experiment will have three independent variables (variables that are manipulated by the researcher).

1. Set Size: 4 arrows vs 8 arrows
2. Angle of Rotation: 20° and 45°
3. Cue Condition: No-cue vs Post-cue

The dependent variable (the variable that we want to measure) in the experiment is the recall accuracy or the proportion of correct responses. Thus, we measure the number of responses indicating that the arrow is rotated clockwise - in the case where it is actually rotated clockwise.

The study will follow an **experimental design** because it involves an independent variable and a dependent variable. The experiment will also a follow a **within-group design** wherein every participants experiences all the trials.

The target audience for this experiment is people between the age of 18 and 50 years, having normal or corrected-to-normal vision. Our tentative sample population for the final experiment is 15-20 volunteers.

The experiment is displayed on a laptop screen and input is received through the keyboard. We made sure to provide uniform lighting and a quiet environment to prevent the effect of any confounding variables on the results.

## Tasks

The memory array consists of four or eight differently coloured arrows (red, blue, green, cyan, yellow, magenta or white) displayed on a black screen. Each arrow has a random orientation.

TRIAL TYPES:

1. No-Cue Trials
    - The memory array is displayed for 200ms
    - 800ms delay (no cue is presented)

- The probe appears for 200ms

2. Retro-cue Trials
    - The memory array is displayed for 200ms
    - Initial delay of 800ms and then a cue (which is a simple sqaure box) is presented for 200ms
    - Another delay of 800ms and the probe appears for 200ms

Participants responded with either clockwise or anti-clockwise using corresponding keyboard inputs (right arrow key for clockwise, left arrow key for anti-clockwise). The whole experiment took approximately 16 minutes per person, and there were 12 trials for each condition.

## Measures

We measure the proportion of correct clockwise/anti-clockwise responses to each probe presented.

## Predictions

Going off our hypothesis, we predict that

- there will be a higher accuracy in the retro-cue trials, than compared to the trials without a cue.
- there will be better performance in the set size of 4 compared to the set size of 8.
- the accuracy for 45° rotations will be higher than for the 20° rotations.

## Statistical Analyses

We are planning to analyse our data using a 2 (no-cue and retro cue condition) × 2 (20° and 45° angle) × 2 (set size of 4 and 8) repeated measures ANOVA (Analysis of Variance).

## Pilot Data

Each combination has been conducted for 12 trials and the average of those accuracy scores are presented in the table. The accuracy score is calculated as:

$$accuracy\ score = \frac{correct\ responses}{total\ trials} * 100$$

| Participant | Set Size = 4 | Set Size = 4 | Set Size = 4 | Set Size = 4 | Set Size = 8 | Set Size = 8 | Set Size = 8 |
|---|---|---|---|---|---|---|---|
| Retro-Cue | Cue | No-Cue | Cue | No-Cue | Cue | No-Cue | Cue |
| Angle of rotation | 20° | 20° | 45° | 45° | 20° | 20° | 45° |
| P1 | 75 | 58.3 | 75 | 83.3 | 58.3 | 33.3 | 83.3 |
| P2 | 83.3 | 83.3 | 91.7 | 75 | 58.3 | 75 | 75 |
| P3 | 75 | 66.7 | 91.7 | 83.3 | 66.7 | 50 | 75 |
| P4 | 83.3 | 75 | 83.3 | 66.7 | 75 | 58.3 | 83.3 |
| P5 | 91.7 | 83.3 | 75 | 91.7 | 83.3 | 50 | 66.7 |
| Average | 81.66 | 73.32 | 83.34 | 80 | 68.32 | 53.32 | 76.66 |

## Analysis Plan

1. We first plan to preprocess the raw data and remove any trials where we do not get any response (invalid data).
2. Calculate the mean accuracy for each participant.
3. Using ANOVA, compare the results of the cue and no-cue conditions and generate visualisations of our results.

4. Validate our results using our hypothesis.

## References

Murray, Alexandra M., Anna C. Nobre, Ian A. Clark, André M. Cravo, and Mark G. Stokes. "Attention Restores Discrete Items to Visual Short-Term Memory." Psychological Science 24, no. 4 (2013): 550–56. http://www.jstor.org/stable/23409260.

Gluck, M.A., Mercado, E. and Myers, C. (2013) Learning and Memory From Brain to Behavior. 2nd Publishers, New York