Investigating Eye Movement Patterns in Three-Alternative Forced Choice Recognition Memory Paradigm in Rhesus Monkeys

Jianhua Liu[1], Jing Cai[2,3], Zhiyong Jin[3], Shiyang Pan[3,4], Mingfeng Cao[3,5], Huimin Wang[1], Sze Chai Kwok[1,3] (corresponding author)

1 Shanghai Key Laboratory of Brain Functional Genomics, School of Psychology and Cognitive Science, East China Normal University, Shanghai 200062, China; 2 Institute of Psychiatry, Psychology & Neuroscience, King's College London, De Crespigny Park, Denmark Hill, SE5 8AF; 3 Division of Natural and Applied Sciences, Duke Kunshan University, Kunshan, Jiangsu 215316, China; 4 Department of Electrical & Computer Engineering, Duke University, Durham NC 27708, USA; 5 Department of Biomedical Engineering, Johns Hopkins University

Introduction

This study aims to unveil intricate eye movement patterns during the process of recognition memory by introducing a three-choice paradigm. It provides a nuanced understanding of eye movements during authentic recognition memory processes.

Background

A "**repetition effect**" suggests fewer fixations and a smaller fixation area but prolonged viewing times for recognized items.

The "**priority viewing effect**" emerges when presented with two items—one recognized, one novel—allocating more time to the novel item, indicating a preference for new stimuli.

It involves three simultaneously presented items—one recognized and two strongly interfering distractors. Participants are challenged with identifying the recognized item, revealing an intensified priority viewing effect.

Our study introduces a three-choice paradigm to verify and clarify existing literature.
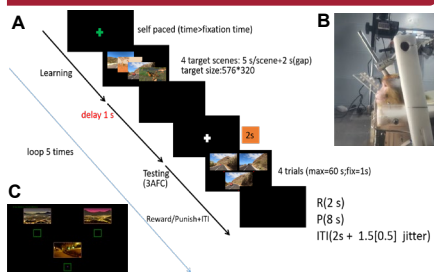
Methods

Figure 1. Experimental Procedure (A), Setup (B), and Photo of Devices (C)

Data Analysis

Logistic Regression: $g(p) = \ln(\dfrac{p}{1-p})$

Pupil Dilation $= \dfrac{\text{Final pupil max}[50\,\text{ms}]}{\text{Initial pupil max}[50\,\text{ms}]}$

Percentage $VT_A = \dfrac{VT_A}{(VT_A + VT_B + VT_C)}$

Eye movement Results

The viewing time and the number of gaze fixations of monkeys on target images negatively correlate with the probability of correctly selecting the target ($P < 0.05$).
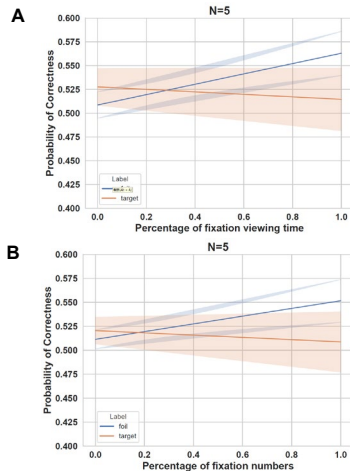

Figure 2. The impact of the proportion of fixation viewing time between target and foil images on accuracy (A), The influence of the proportion of the number of fixations on target and foil images on accuracy (B)

The viewing time and the number of gaze saccades of monkeys on target images negatively correlated with the probability of correct selection ($P < 0.05$).
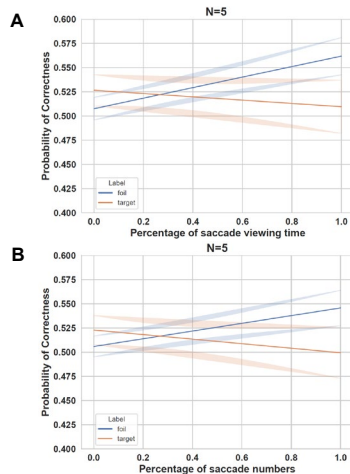

Figure 3. The impact of the proportion of saccade viewing time between target and foil images on accuracy (A), The influence of the proportion of the number of saccades on target and foil images on accuracy (B)

Pupil dilation Results

The pupil dilation ratio of 5 monkeys positively correlates with the probability of correct selection ($P < 0.05$).
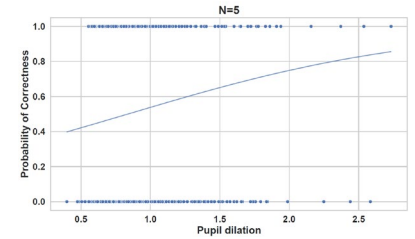

Figure 4. Pupil dilation levels during monkey's recognition memory-based selection

Behavioral Results

The selection accuracy is 51%, significantly higher than chance (33%). The reaction time of 5 monkeys negatively correlated with accuracy ($P < 0.05$).
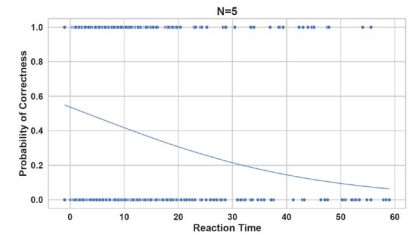

Figure 5. The impact of reaction time on accuracy in monkey's decision-making

Conclusion

Our study illustrated that, during a three-choice recognition memory task, monkeys consistently exhibited shorter viewing times for recognized items during successful recognition trials. This lends support to a priority viewing effect reminiscent of the new-old recognition effect, where a greater duration of viewing time is allocated to novel stimuli. These findings contribute valuable evidence to the ongoing exploration of eye movements during recognition memory tasks.

Acknowledgement
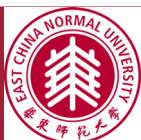
Contact
sze-chai.kwok@st-hughs.oxon.org
494203432@qq.com