Scanpath of Macaque Monkeys across Repeated Video Viewings

（猕猴重复观看视频时的扫描轨迹）

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Introduction

This is a behavioral study in the field of cognitive neuroscience that aims to understand the distribution mechanism of the visual attention of macaque monkeys.

此为一项认知神经科学领域内的动物行为学研究，旨在探究猕猴的视觉注意力分配机制。

Background

Humans and many other species sense visual information with varying spatial resolution across the visual field and deploy eye movements to actively sample regions of interests in scenes.

眼睛视野的空间分辨率并不均匀，因此人和其他动物必须不断进行眼动，以主动地对场景中的重要信息进行采样。

Foveated Vision (中心凹视觉)

- **Foveal vision:** maximal acuity and contrast sensitivity in a small region around the gaze position
- **Peripheral vision:** a large field of view, albeit with lower resolution and contrast sensitivity

Figure 1. Foveal, blend, and peripheral vision

Scanpath (扫描路径)

- **Fixation (注视):** the point during which the eyes are relatively stationary
- **Saccade (扫视):** the rapid eye movement between fixations

Scanpath is the sequence of eye movements made up of fixations and saccades. It reveals the pattern in which animals distribute attention.

扫描路径是注视和扫视构成的序列，它可以揭示动物分配注意力的模式。

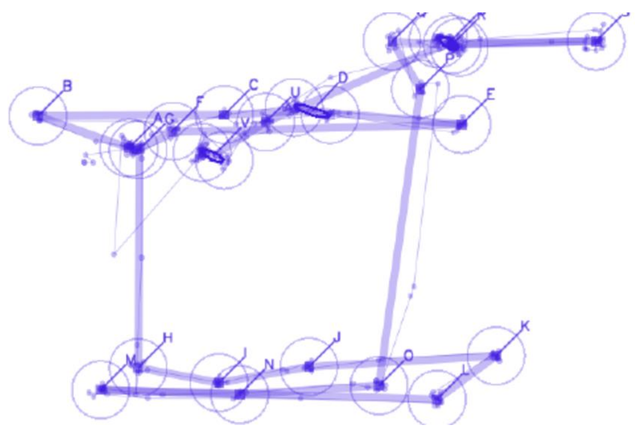

Figure 2. Example of a scanpath visulization

Modulation Mechanism (加工机制)

How do the brain modulate the selective attention?

大脑如何加工注意选择?

Top-down or bottom-up?

自上而下还是自下而上加工?

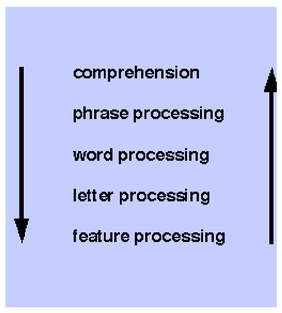

Figure3. Level of processing

Methods

Head-fixed monkeys performed naturalistic free viewing of three types of videos (Primate, Non-primate, Scenery). Each video was played for 30 times.

头部固定的猕猴观看三种视频（灵长类、非灵长类动物、景观），每个视频播放三十遍。

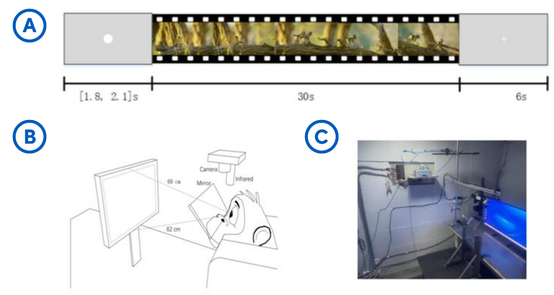

Figure 4. Experimental Procedure (A), Setup (B), and Photo of Devices (C)

Fixations and saccades during the viewings were recorded by an EyeLink eye tracker. Monkeys were given liquid reward before and after a video was played.

实验通过一台EyeLink眼动记录仪来获取猕猴观看视频时的注视和扫视信息。视频播放前后都会给予液体奖赏。

Data Analysis

Correlation Analysis (相关性分析)

The scanpaths acquired from different repetitions of viewing the same video were compared and overall correlations were calculated.

比较不同观看次数的扫描路径，分析总体相关性。

Grid Analysis (网格分析)

The area of 2560× 1440 screen is divided into grid. The distribution of fixations across 30 viewings was studied.

将视频区域用网格划分，研究猕猴的注视分布。

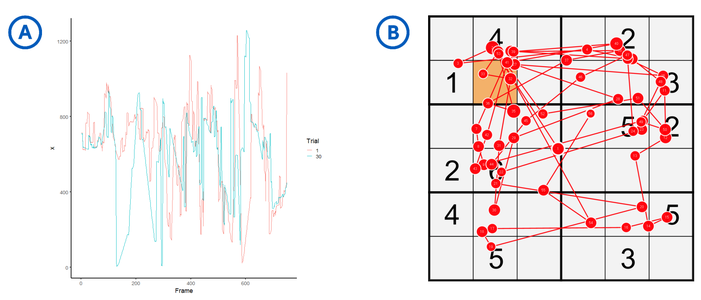

Figure 5. Correlation between different scanpaths is calculated (A) and Example of a scanpath in grids(B)

Results

Difference between Video Categories (不同种类视频观看的差异)

The scanpaths of Primate videos across repetitions illustrated a high consistency. The scanpaths of Nonprimate and Scenery videos were inconsistent.

猕猴观看灵长类动物视频时的扫描路径展现出高度一致性。

Figure 6. Correlation of scanpath across repeated viewings. Left to Right: Primate (A), Nonprimate (B), Scenery (C)

Correlations with 1st viewing scanpath were calculated and a linear regression was carried out. The results of Primate viewings suggest that monkeys lose their scanpath consistency when viewing the same video repeatedly.

重复观看时灵长类视频时猕猴逐渐丧失了扫描路径的一致性。非灵长类和景观类视频观看未发现此趋势。

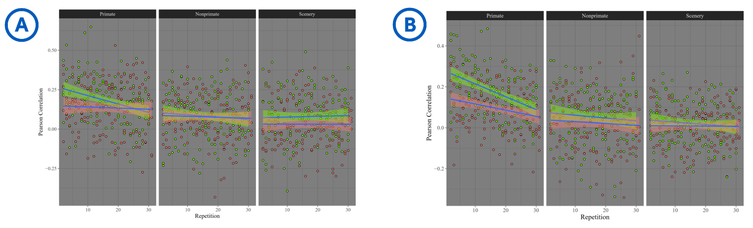

Figure 7. Linear regression of x coordinates correlation (A) and y coordinates correlation (B).

Fixations at each grid and in each frame across 30 viewings were summed to get the distribution.

三十次视频观看记录的每一帧内每个网格的注视都对应求和，以得到猕猴注视的分布情况。

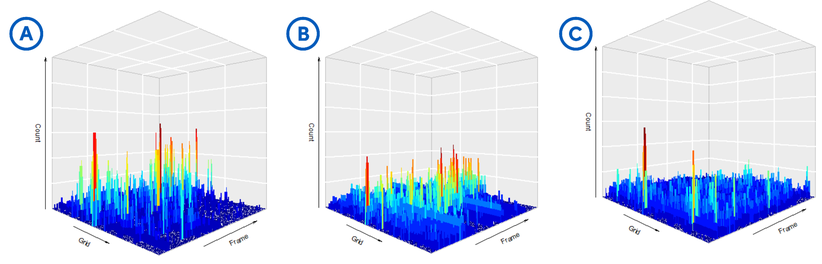

Figure 8. Fixation counts for across 30 viewings. Left to Right: Primate (A), Nonprimate (B), Scenery (C)

Peak clusters were found in the viewing of Primate and Nonprimate videos, but the viewing of Scenery videos illustrated a diffused fixation distribution. The results suggest that macaque monkeys modulate meaningful information with a consistent scanpath pattern.

在灵长类和非灵长类视频的结果中发现峰簇，而景观类视频的注视分布是分散的。结果表明，猕猴在重复观看的过程中以一致性的方式加工有意义的信息。

Scanpath of repeated viewings （重复观看的扫描路径）

Scanpath across 30 viewings were plotted together to search for possible shift.

三十次观看的扫描路径一起画出以寻找可能的偏移。

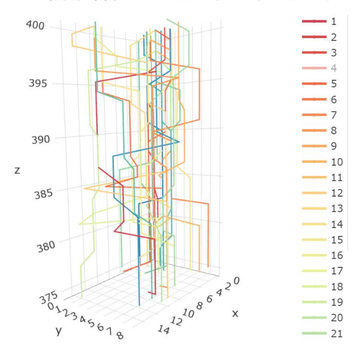

Figure 9. Scanpath in a short time window

Ongoing Analysis

Based on the data collected, we're going to build a Hidden MarKov Chain Model (HMM) to predict the probability of fixation transitions.

我们将使用已有的数据建立一个隐马尔可夫模型以预测猕猴观看视频时的注视迁移。

A saliency model will be implemented to get the visual attraction of video regions.

一个显著性模型会被用以获取视频区域的视觉吸引力。

Acknowledgement

This research is funded by Duke Kunshan University Office of Undergraduate Studies and the Summer Research Scholars Program. Experiments were conducted in the facilities of East China Normal University. Special thanks to members of Kwok Lab whose names are not listed but make contribution to the project.

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