Reading Your Mind Through Your Eyes: Using Eye Scan Patterns and Machine Learning to Predict Number Choice

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Introduction

- Eye tracking technology measures eye movements and positions in real time.
- Studies show that eye scan patterns convey spatial cognitive thoughts, suggesting the existence of the eye-cognition link [3].
- We extend this concept to determine if eye movements and fixations can be used to predict future thought.

Objectives

- To predict the number a person is thinking of and will think of using their eye scan pattern.
- To determine high performing features that can be used to predict a subject's response in a machine learning algorithm.

Methods

- Participants were asked to respond to the prompt: "Think of a number 1, 2 or 3 and say it out loud".

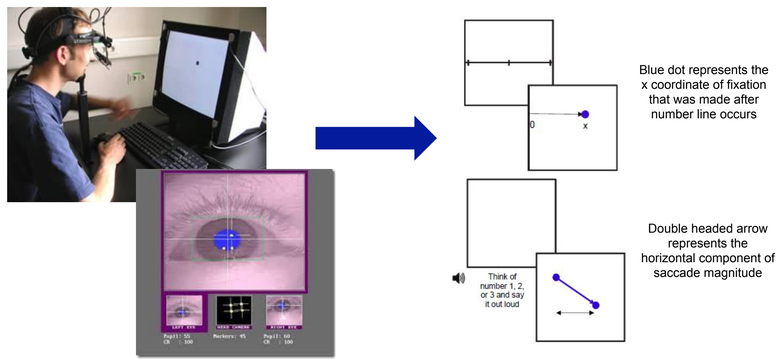


Figure 1: Fixation X, Saccade Magnitude, and Saccade Direction of subject's eye movement was obtained using a EyeLink II eye tracker

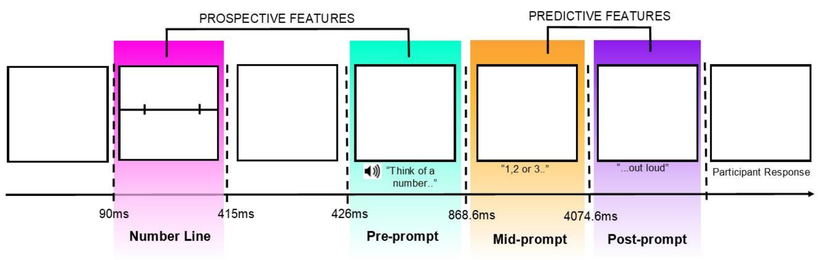
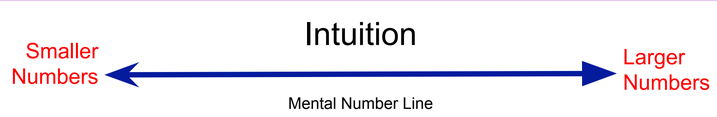


Figure 2 - Intervals for the features are represented through the shaded region. Data from before and after the midpoint for every time interval were analyzed.

Results and Discussion



- Prospective Features: Fixation X Coordinate and Saccade Magnitude of a subject's eye movement before they are instructed to think of a number during the **Number Line** and **Pre-prompt** time interval.
- Saccade Magnitude highly correlated with participants' response. Saccades were made toward the direction of the subject's response in mind.

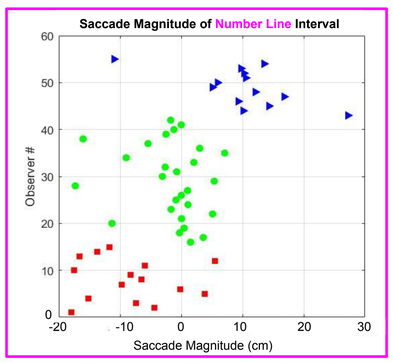


Figure 3 % Accuracy of Single Classifier: **83%**

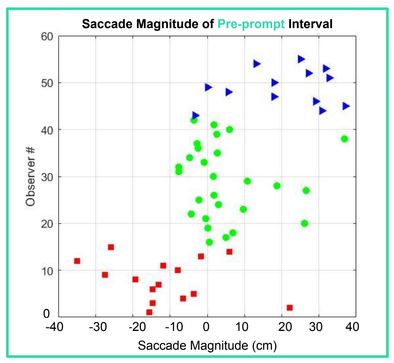


Figure 4 % Accuracy of Single Classifier: **89%**

- Predictive features: Fixation X Coordinate and Saccade Magnitude of a subject's eye movement after they are instructed to think of a number during the **Mid-prompt** and **Post-prompt** time intervals.
- Fixation X highly correlated with participants' response as these fixations were made in relative locations of the given numbers on a number line.

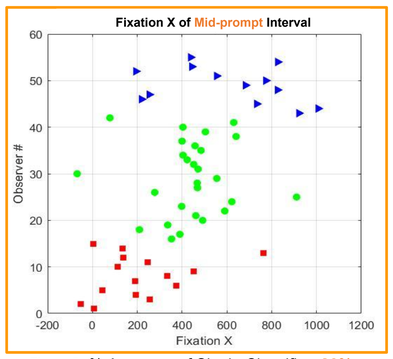


Figure 5 % Accuracy of Single Classifier: **80%**

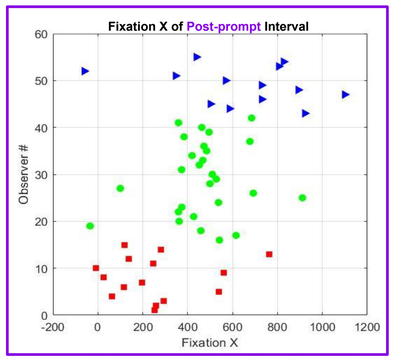


Figure 6 % Accuracy of Single Classifier: **89%**

- A predicted model was created by training a Random Forest (RF) Algorithm using Leave One Out Cross Validation (LOOCV).

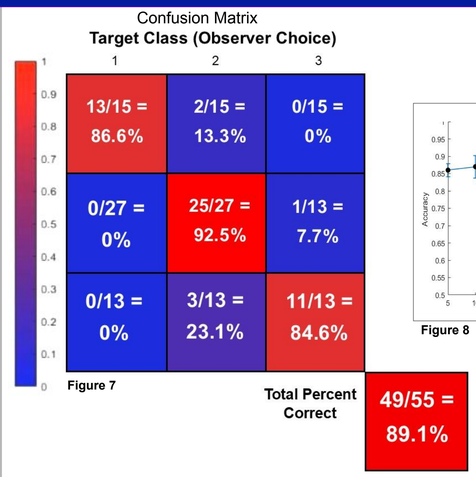


Figure 7

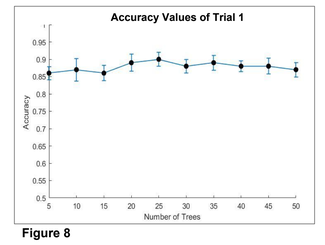


Figure 8

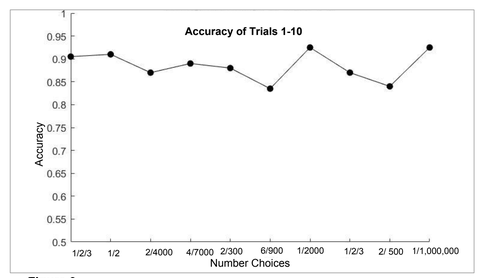


Figure 9

Conclusion

- Using machine learning, we achieve a high level of accuracy in predicting the number a person is thinking of and will think of.
- Future plans involve extending this work to other abstract domains of thought.

Applications

- Detection of abnormalities in numerical cognition through eye tracking technology can further the understanding of dyscalculia and other disorders.
- Eye scan patterns of individuals with ALS or Locked-in Syndrome can be used for communication and decision-making.

References

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