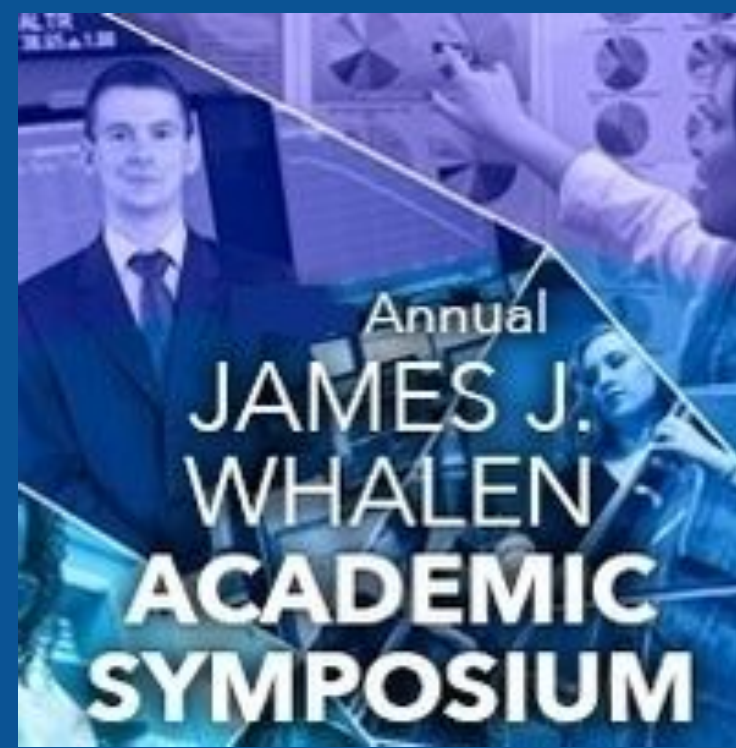


# Enhancing Cognition Through Movement: Exploring the Link Between Executive Function and Locomotion

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## Abstract

Theories have proposed that motor development plays a large role in the development of executive functioning. This study, a collaboration between departments at Ithaca College, explores the link between executive function and locomotion. The results indicated that infants who used a robot to help with locomotion performed better on an executive function task, which supports the past research. This has implications regarding interventions for infants with reduced motor capabilities.

## Introduction

Executive functioning involves processes that include inhibition control, cognitive flexibility, and working memory (Diamond, 2013). It has been proposed that motor development plays a crucial role in the development of executive functioning (Koziol & Lutz, 2013). However, the link between motor development and executive functioning has yet to be explored in infants.

### Hypotheses

- Infants in the experimental group will learn to use the robot to locomote
- The experimental group will score higher on the post-switch portion of the switch task compared to the control group
- The amount of time spent locomoting on the robot for the last five sessions will correlate with the post-switch score for infants in the experimental group

## Methods

### Participants

- 35 typically developing infants
  - 17 in locomotor condition and 18 in non-locomotor condition
  - infants learned to locomote using the robot in the locomotor condition and did not locomote in the non-locomotor condition.

### Materials

- Robotic locomotor device
- ASL eye-tracking device

### Procedure

- 12 sessions of play starting at 5 months
- At 7 months, infants were given a rule switching task
- **Rule-Switching Task (Figure 1):** The infants watch a video where a puppet appears. At the start of the task, a puppet appears on the right side of the screen, this occurs for nine consecutive trials (pre-switch). After the ninth trial, the puppet switches to the left side of the screen, appearing for another nine consecutive trials (post-switch). At the beginning of each trial, a visual cue appears in the center of the screen to capture the attention of the infant. This task requires infants to learn a rule and then inhibit the learned rule when the stimulus switches positions.
- **Scoring:** The task is scored based on anticipatory looks using an ASL eye-tracking system with GazeTracker software. The scoring for the trials was as follows: +2 for a correct look, 0 for no looks, -1 for looks in both directions, and -2 for an incorrect look.

## Results

- A Paired-Samples t-test revealed that infants in the experimental group showed greater intentional goal-directed movement during sessions 8-12 ( $M = 11.89$ ,  $SD = 49.60$ ) compared to sessions 3-7 ( $M = 60.03$ ,  $SD = 45.27$ ),  $t(19) = 5.44$ ,  $p < .001$ ,  $\eta^2 = .61$ ).
- An ANCOVA controlling for sex and ethnicity indicated that there was a significant difference between the control and experimental groups on the post-switch scores,  $F(1, 31) = 4.603$ ,  $p = .040$ ,  $\eta^2 = .129$ ; the locomotor group scored higher ( $M = -.18$ ,  $SD = 4.49$ ) compared to the control group ( $M = -2.17$ ,  $SD = 5.98$ ).
- A partial correlation analysis, controlling for sex and ethnicity, showed a positive relationship between total time in motion for sessions 8-12 and the post-switch score for the experimental group ( $r = .49$ , one-tailed  $p = .023$ ).

Statistical Analyses	Statistic	Significance (p-value)	Effect size ( $\eta^2$ )
Correlation	$r = 0.49$	0.023	N/A
Paired sample t-test	$t(19) = 5.44$	0.001	0.61
ANCOVA	$F(1,31) = 4.60$	0.04	0.129

Table 1.

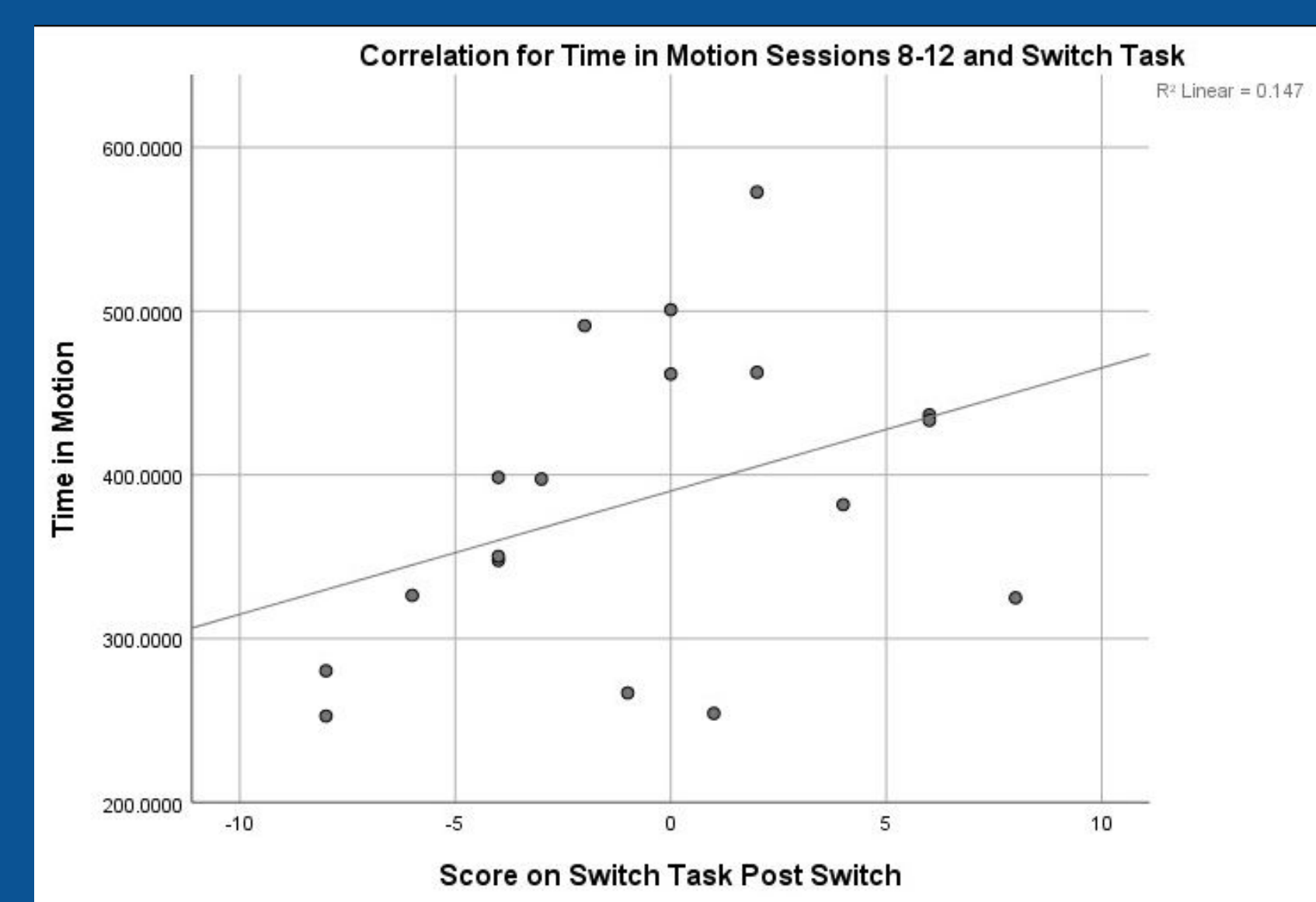


Figure 2. Correlation

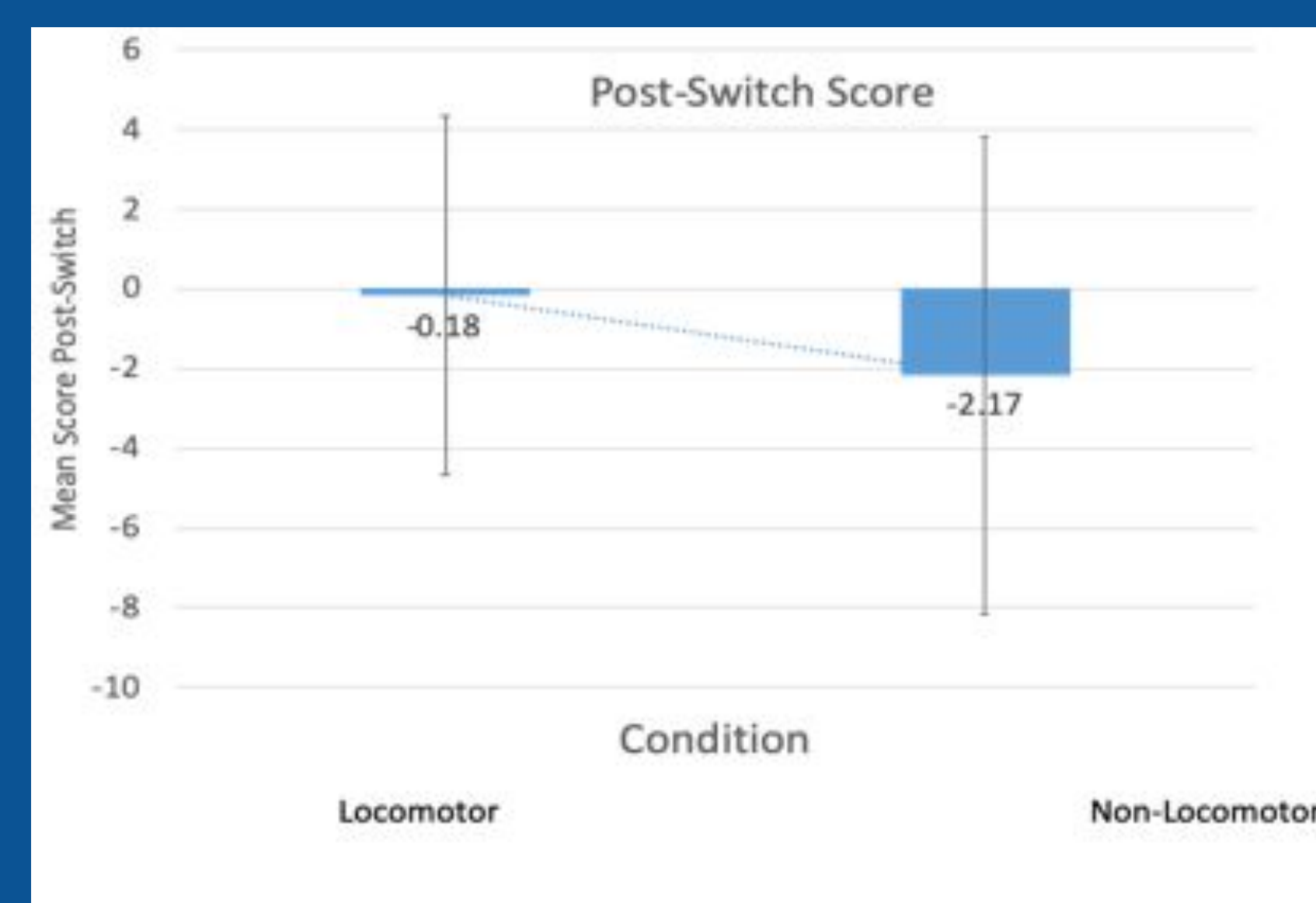


Figure 3. Post-Switch Score

## Figures

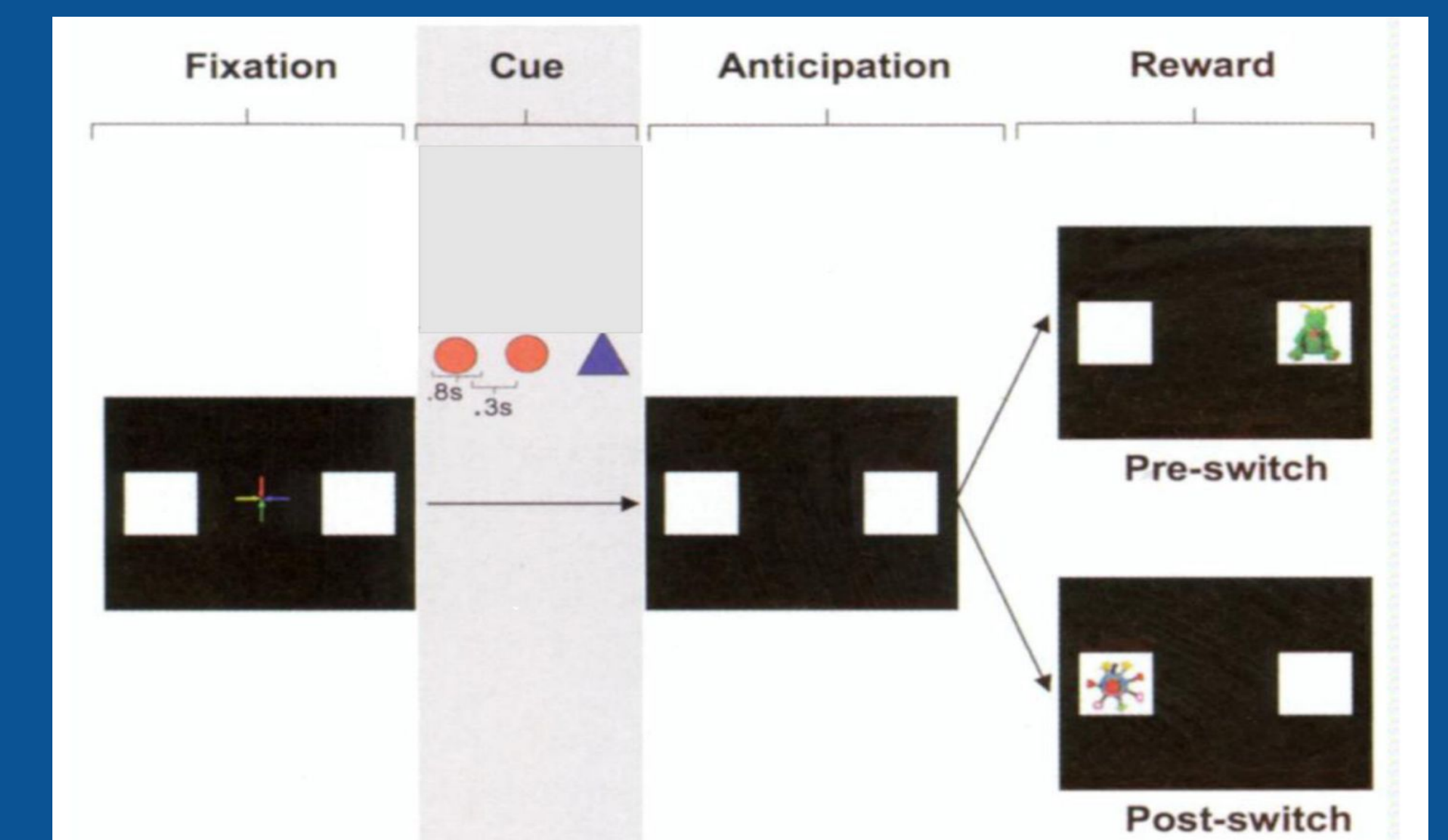


Figure 1. Rule-Switching Task

## Discussion

All of our hypotheses were supported by the data.

- The t-test indicated that infants learned to use the robot to locomote to a desired location by the end of the twelve sessions
- The results of the ANCOVA indicated that the experimental group scored higher on the Switch Task post-switch when compared to the control group
- The partial correlation analysis indicated that the more infants locomoted during the final sessions on the robot, the higher they scored post-switch

These results provide us with a better understanding of the link between early locomotion in infancy and the development of executive functioning in infancy. They also suggest that a robotic assistive device can be used as a potential intervention to help the development of executive functioning in infants with reduced motor capabilities.

## References

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## Acknowledgements

A special thanks to all the families that participated in this study, as well as the Ithaca College's undergraduate research teams.

This study was funded by The National Science Foundation and Ithaca College

