

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

Background

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.

Methods

This study explored the link between executive functioning processes and infant locomotion through the assistance of a robot that allowed non-crawling infants to locomote. Thirty-five typically developing infants began the study at the age of five months. They were randomly assigned to either an experimental group or a control group. In the experimental group, infants learned to locomote using the robot; in the control group, infants did not use the robot. The infants completed a total of twelve sessions over a two month period. Each session lasted about twenty minutes. After the twelve sessions, at the age of seven months, infants were given a rule switching task to assess executive functioning. This task requires infants to learn a rule and then inhibit the learned rule when the stimulus switches positions. 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. 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. This task requires cognitive flexibility and inhibition, both of which have been associated with executive functioning.

Hypotheses

It was hypothesized that 1) infants in the experimental group will learn to use the robot to locomote, 2) the experimental group will score higher on the post-switch portion of the switch task compared to the control group, and 3) 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.

Results

A Paired-Samples t-test revealed that infants in the experimental group during sessions 8-12 ($M = 11.89$, $SD = 49.60$) showed greater intentional goal-directed movement compared to sessions 3-7 ($M = 60.03$, $SD = 45.27$), $t(19) = 5.44$, $p < .001$, $d = .61$. This t-test indicates that infants learned to use the robot to locomote to a desired location by the end of the twelve sessions, supporting our first hypothesis.

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 ($M = -2.17$, $SD = 4.49$) compared to the control group ($M = -2.17$, $SD = 5.98$). This result supports our second hypothesis.

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 $p = .023$). This indicated that the more infants locomoted during the final sessions on the robot, the higher they scored on the post-switch task, supporting our third hypothesis.

Discussion:

These results provide us with a better understanding of the link between early locomotion in infancy and the development of executive functioning. 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

- Diamond, A. (2013). Executive functions. *Annual Review of Psychology*. 64, 135-68
- Koziol, L. F., & Lutz, J. T. (2013). From movement to thought: The development of executive function. *Applied Neuropsychology*. Child, 2, 104-115