

Effect of Hand Symmetry and Preference on Bimanual Coordination in Children

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Introduction

- Bimanual tasks involve two hands to complete and can be either symmetrical or asymmetrical in nature.
- Prior research has shown that children developing bimanual coordination learn symmetrical bimanual skills before asymmetrical skills.
- Children typically begin developing hand preference at around 2.5 years old
- More stable hand preference may support better bimanual coordination.

RESEARCH QUESTIONS

- Does symmetrical or asymmetrical movement of the hands impact children's ability to perform bimanual tasks?
 - Do symmetrical advantages in the task decrease with age?
- Does right-hand preference give children an advantage on the specified bimanual task?

Methods

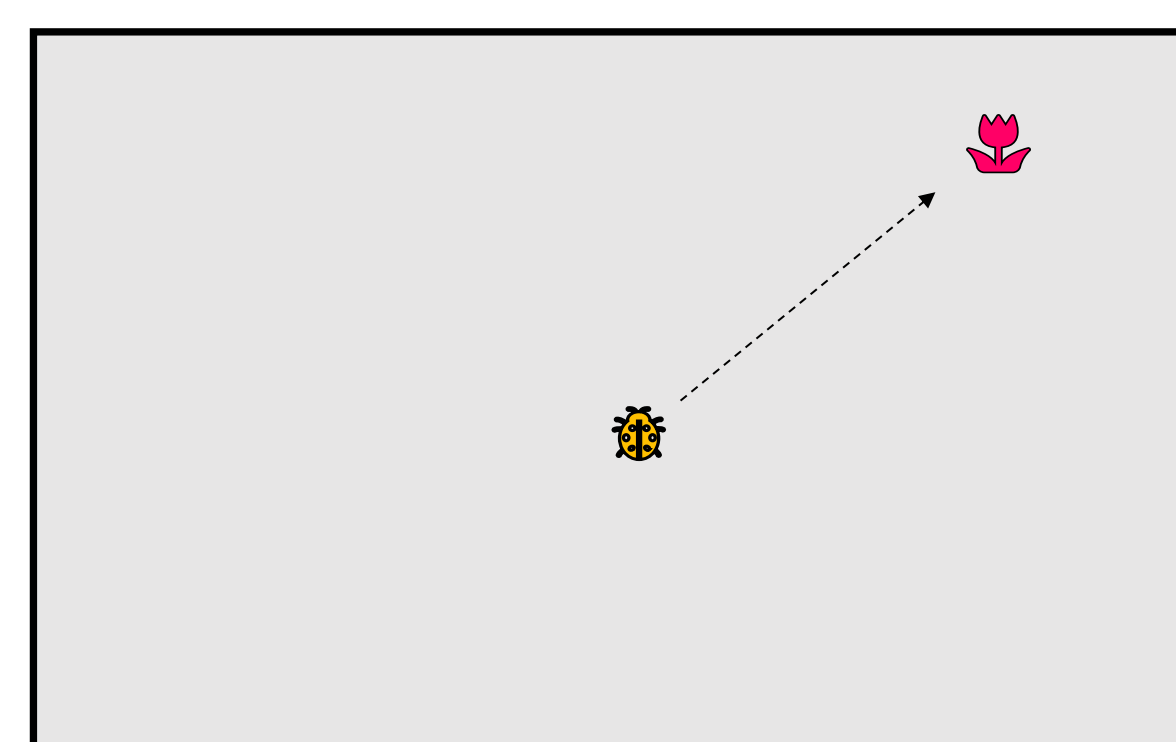
Participants

Children ages 5-8 years (n = 72)

- 5-year-olds: n = 15
- 6-year-olds: n = 14
- 7-year-olds: n = 24
- 8-year-olds: n = 19

39 Female (54%)

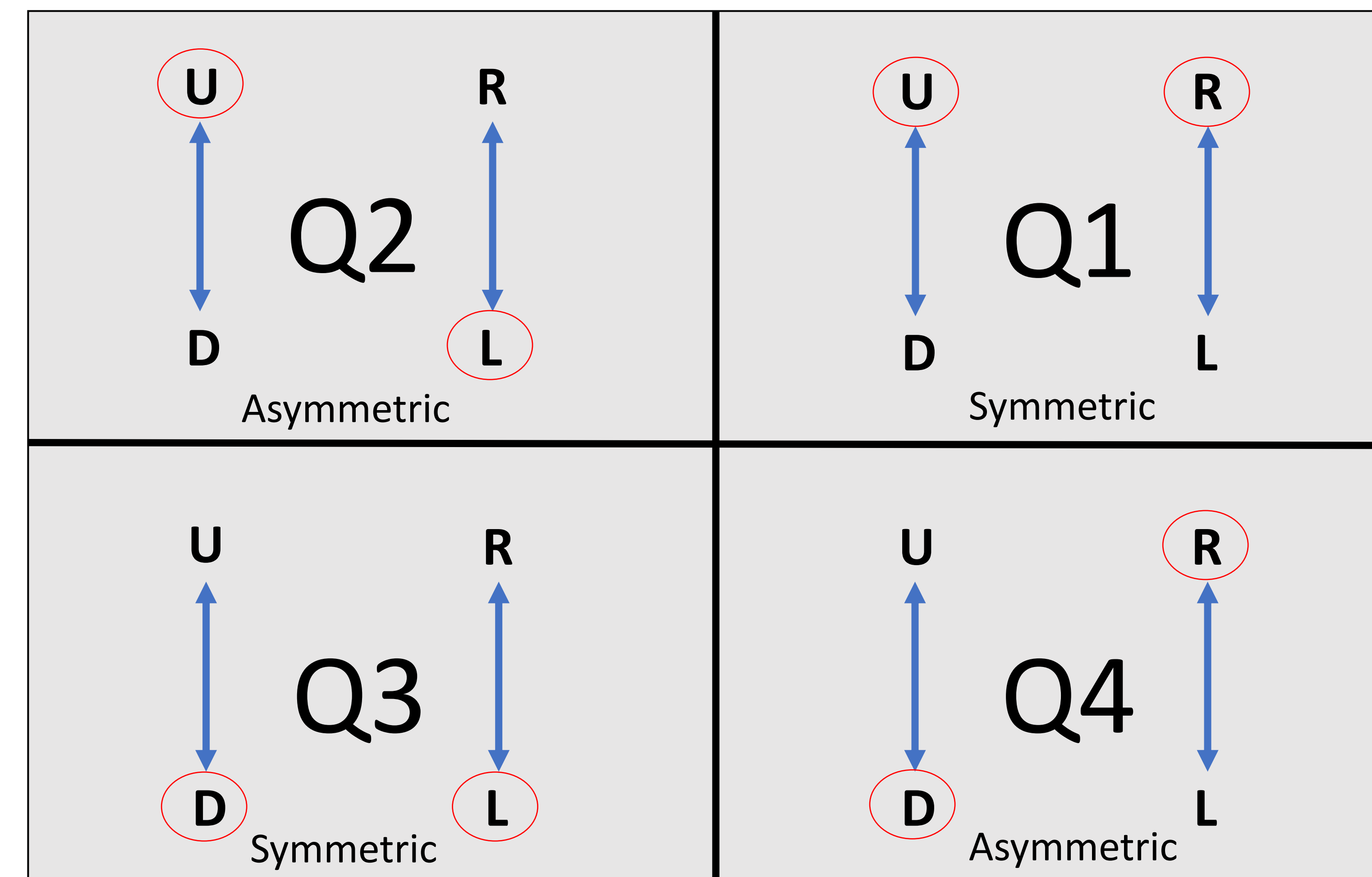
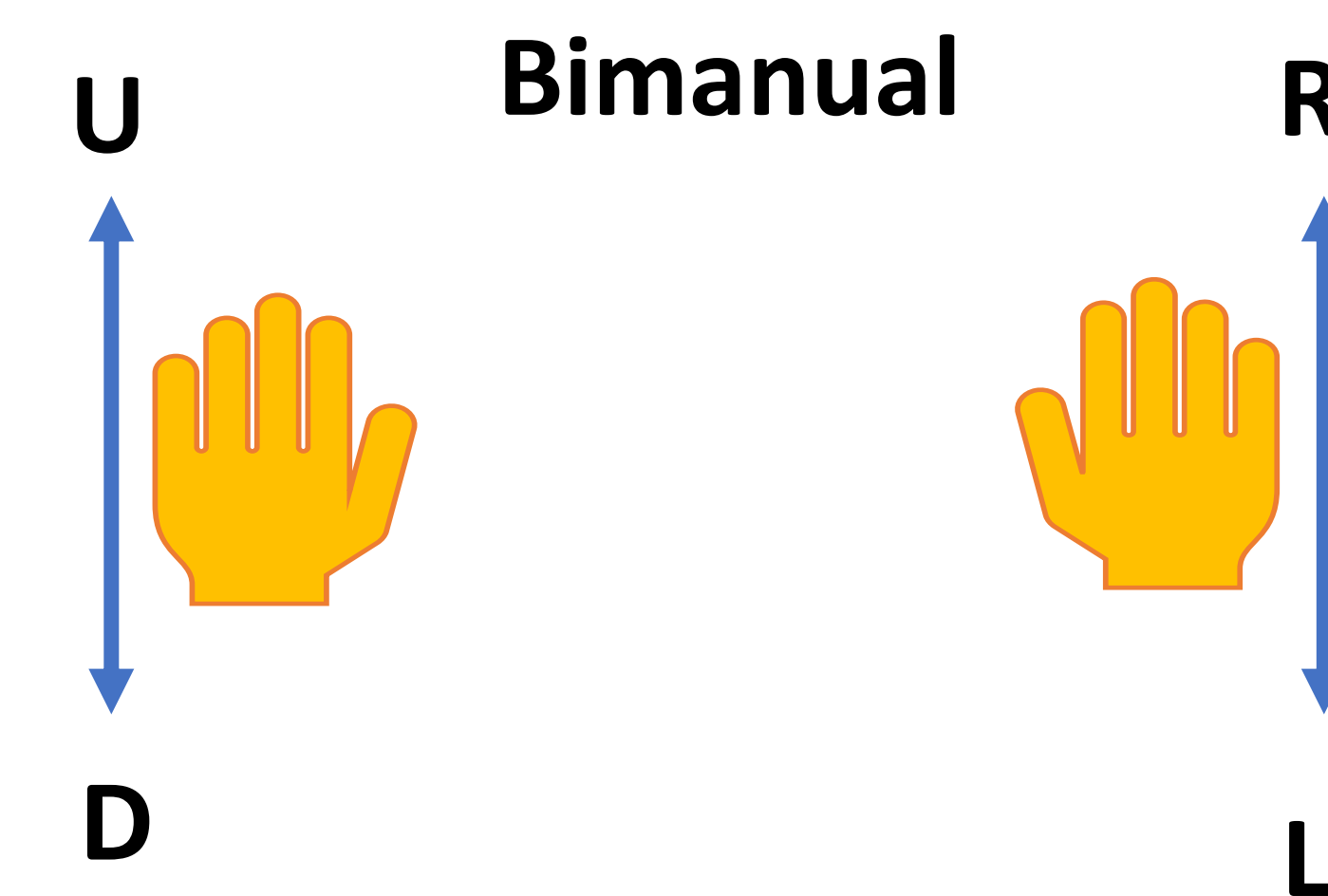
7 Left-Handed (10%)



iPad Game Display, Example Trial

Protocol

- Bimanual skill learning:** Participants practiced a lab-created visuomotor iPad task on three separate days.
 - One block of testing involved 24 trials of the game. 3 blocks of testing were completed on day 1, while one block was completed on both days 2 and 7.
- Outcome Measures:**
 - Path length (normalized): distance moved divided by the Euclidian distance between starting location and the target; e.g. path length = 2, the participant's path traveled a distance that was twice the distance of the most direct path.
 - Completion Time: amount of time taken to reach the target (maximum 10 seconds).
- Hand preference assessment:** Children performed 15 functional actions (e.g. combing hair, picking up a bottle) using one of their hands two times as part of the Home Handedness Questionnaire. The hand used for the action contributes to a total score between -1 (left-hand) and 1 (right-hand) that indicates hand preference.



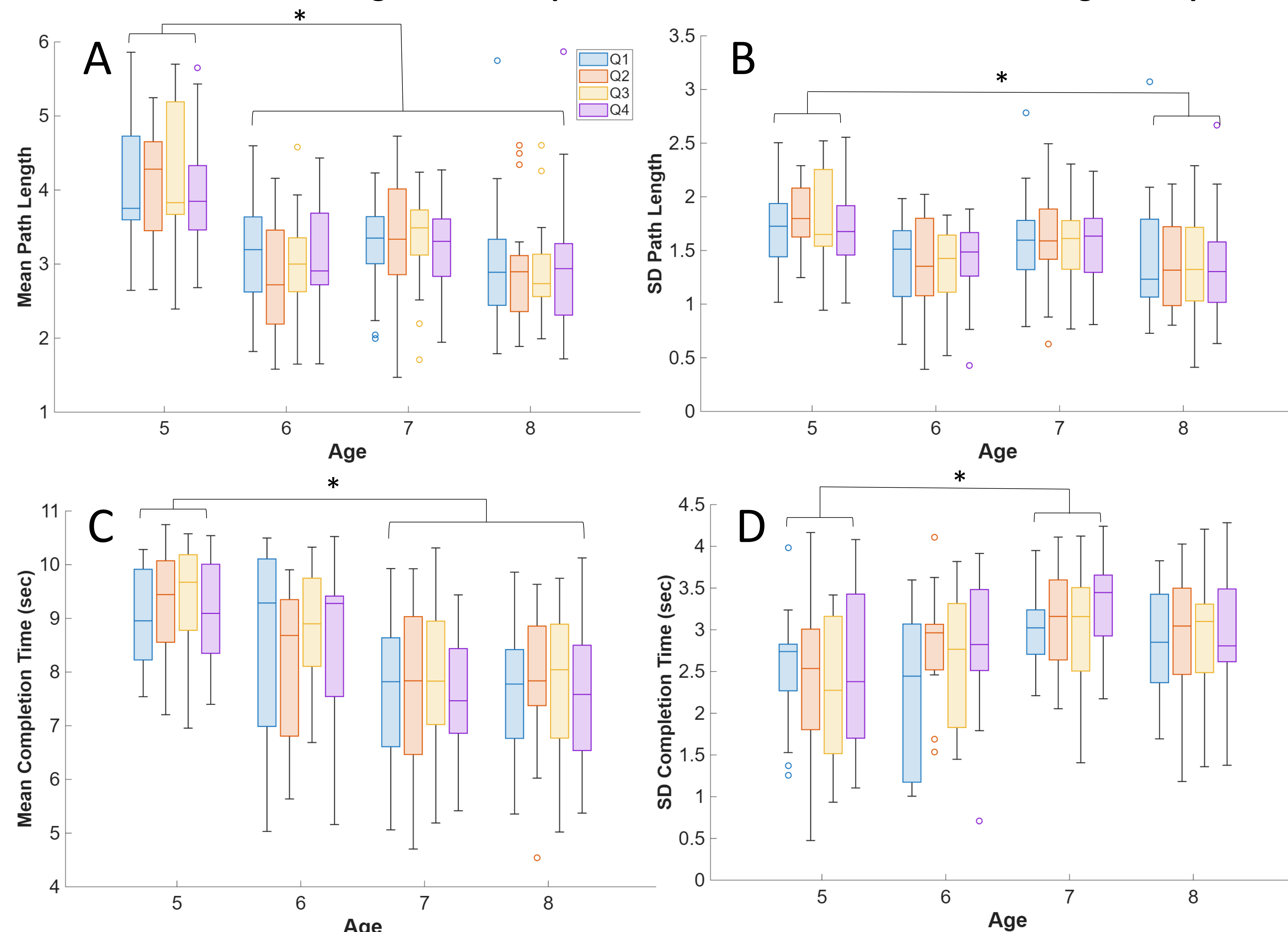
iPad learning task: Participants control a point cursor using two handheld joysticks on a gaming controller. The goal of the task is to move a bug to a target location (flower) located in randomly generated locations. When moved in the vertical direction, the left joystick moves the bug in the vertical direction (up/down) and the right joystick moves the bug in the horizontal direction (right/left). The screen is divided into four quadrants that the target appears in equally. Quadrants 1 and 3 (Q1, Q3) require movement of the hands in the same direction (symmetric) while quadrants 2 and 4 (Q2, Q4) require movement of the hands in opposite directions (asymmetric).

Completion time was different between the quadrants (without relation to symmetry).

The standard deviation of completion time was higher in asymmetric quadrants.

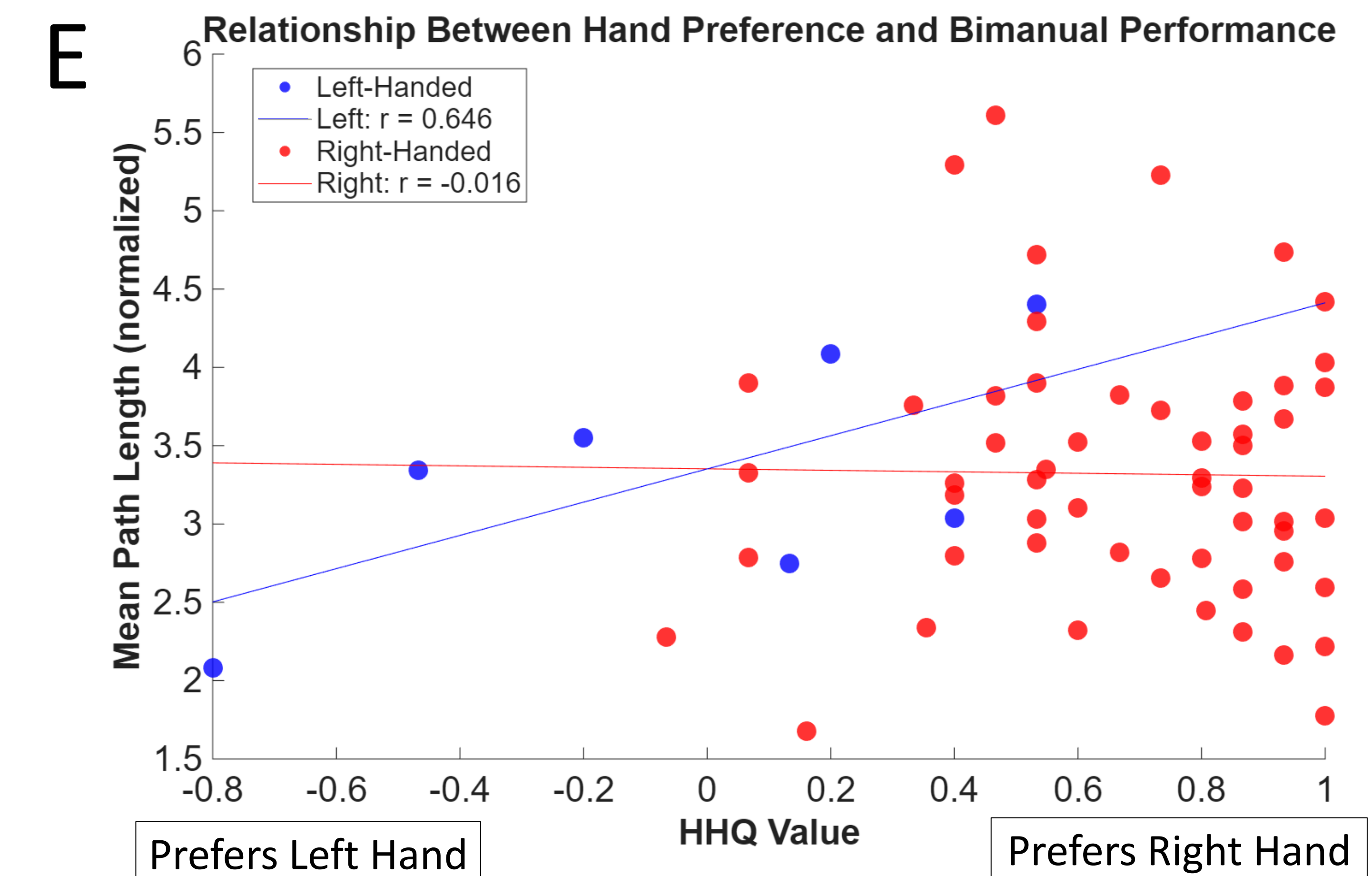
Age had a significant effect on some performance measures when comparing other age groups to 5-year-olds.

Differences in Path Length and Completion Time Across Quadrants and Age Groups



Figures A-D: the differences between quadrants in performance (Path Length and Completion Time) grouped by age

Figure E: HHQ Value comparison to Mean Path Length (normalized), grouped by hand preference based on a writing task (MABC-2)



Results

- The results of a two-way ANOVA indicate that there was no statistically significant interaction of Age*Quadrant on mean performance or variability for path length or completion time ($p > 0.097$).
- There was an overall main effect of quadrant for mean completion time. Quadrant 3 had the slowest completion times on average ($p = 0.05$).
- There was an overall main effect of age for path length and completion time:
 - Mean path length was significantly larger for 5-year-olds compared to 6, 7, and 8-year-olds ($p = 0.004$, $p = 0.029$, $p = 0.001$). The standard deviation of path length approached significance between 5 and 8-year-olds ($p = 0.057$).
 - Mean completion time was significantly larger for 5-year-olds compared to 7 and 8-year-olds ($p = 0.002$). The 5-year-olds had lower standard deviation of completion time than 7-year-olds ($p = 0.001$).
- The standard deviation of completion time was significantly higher in asymmetric quadrants than in symmetric quadrants ($p = 0.018$).
- Left-hand performance had a moderate, positive correlation to mean path length but there was no linear relationship for right-hand performance.

Conclusions

- Overall, hand symmetry did not impact bimanual performance on a novel visuomotor iPad task.
- Children do not necessarily perform better on bimanual tasks with stronger right-hand preference or stronger hand preference in general.
- Younger children (5-year-olds) tend to differ more from 7 or 8-year-olds, indicating large steps in motor development in these age groups.

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