

The Role of Visual Perspective-Taking in Children's Spatial Updating

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INTRODUCTION

- Visual perspective-taking (VPT): the ability to mentally represent a scene from a viewpoint different from one's own.
- Spatial updating: tracking one's position in space relative to important locations during movement.
- Cognitive link:
 - VPT and spatial updating rely on partly different brain networks, but share common cognitive processes (e.g., mental rotation and transforming space)
 - Precuneus supports these processes in both tasks^{2,6}.
- Middle childhood is a key developmental period for VPT, spatial updating, and the parietal brain regions that support these skills (e.g., precuneus)^{1,3}.
- Gap: VPT has been shown to predict better performance in spatial updating tasks in adults, but hasn't been studied in children^{4,5,7}.
 - Spatial updating is critical for everyday navigation (e.g., finding your classroom, a playground, the bus stop, etc.).
 - Understanding how VPT and spatial updating interact in childhood can inform developmental theory, assessment, and intervention for spatial reasoning.

Research Questions: Does VPT ability predict children's spatial updating performance during real-world navigation, after controlling for age?

Hypothesis: Children with stronger VPT ability will demonstrate greater accuracy in spatial updating, independent of age.

METHODOLOGY

Participants: 112 typically developing children ages 6-10 years.

Perspective-Taking Task:

Modified Piaget's Three Mountains Task

- Children sat at fixed viewpoint at a table with Styrofoam cones ("mountains") arranged in the center (see Figure 1a).
- A stuffed animal dog was placed at different locations around the cones (see Figure 1b).
- Children were asked to imagine what the dog could see and select the correct image from multiple options.

Levels

- Level 1: Two cones, three picture options
- Level 2: Three cones, four picture options

Scoring

- Each trial scored as correct (1) or incorrect (0) and summed across trials.
- Higher scores = better VPT ability.

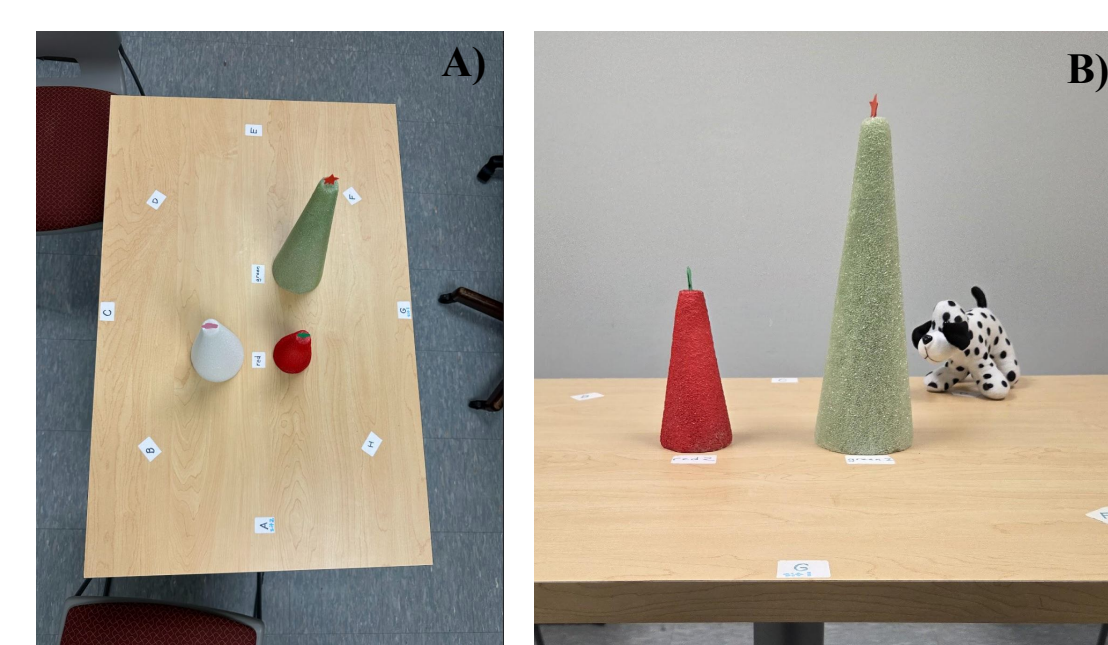


Figure 1. Modified Three Mountains Task. (a) Child viewpoint with cones; (b) Dog locations around cones.

Spatial Updating Task:

Point-to-Start Task

- Children walked three predefined outdoor routes, each beginning at a distinct landmark.
- At the end of each route
 - The child stood in a standardized position
 - A chalk "T" was drawn at their feet as a reference frame (see Figure 2a).
 - Asked to point to the starting landmark by dropping a ball of slime.

Scoring

- A line was drawn from the intersection of the "T" to where the slime landed and angle degrees were measured with a protractor (see Figure 2b).
- Responses within ± 25 degrees of the correct angle were scored as correct (1) or incorrect (0) and summed across trials.
- Higher scores = better spatial updating ability.

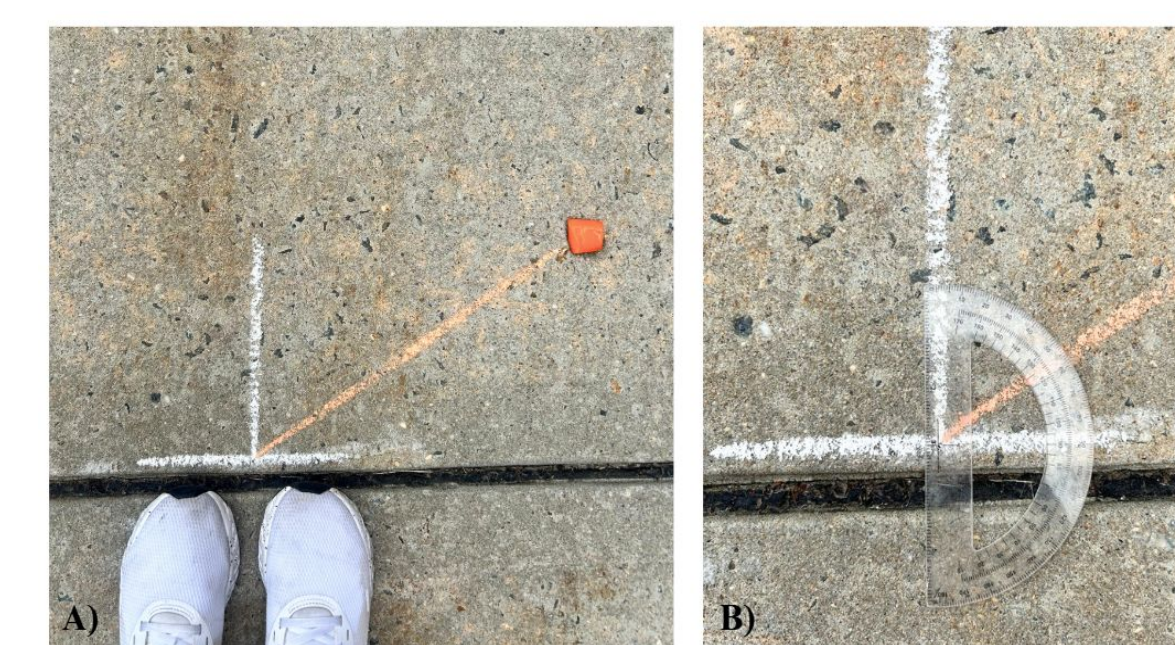
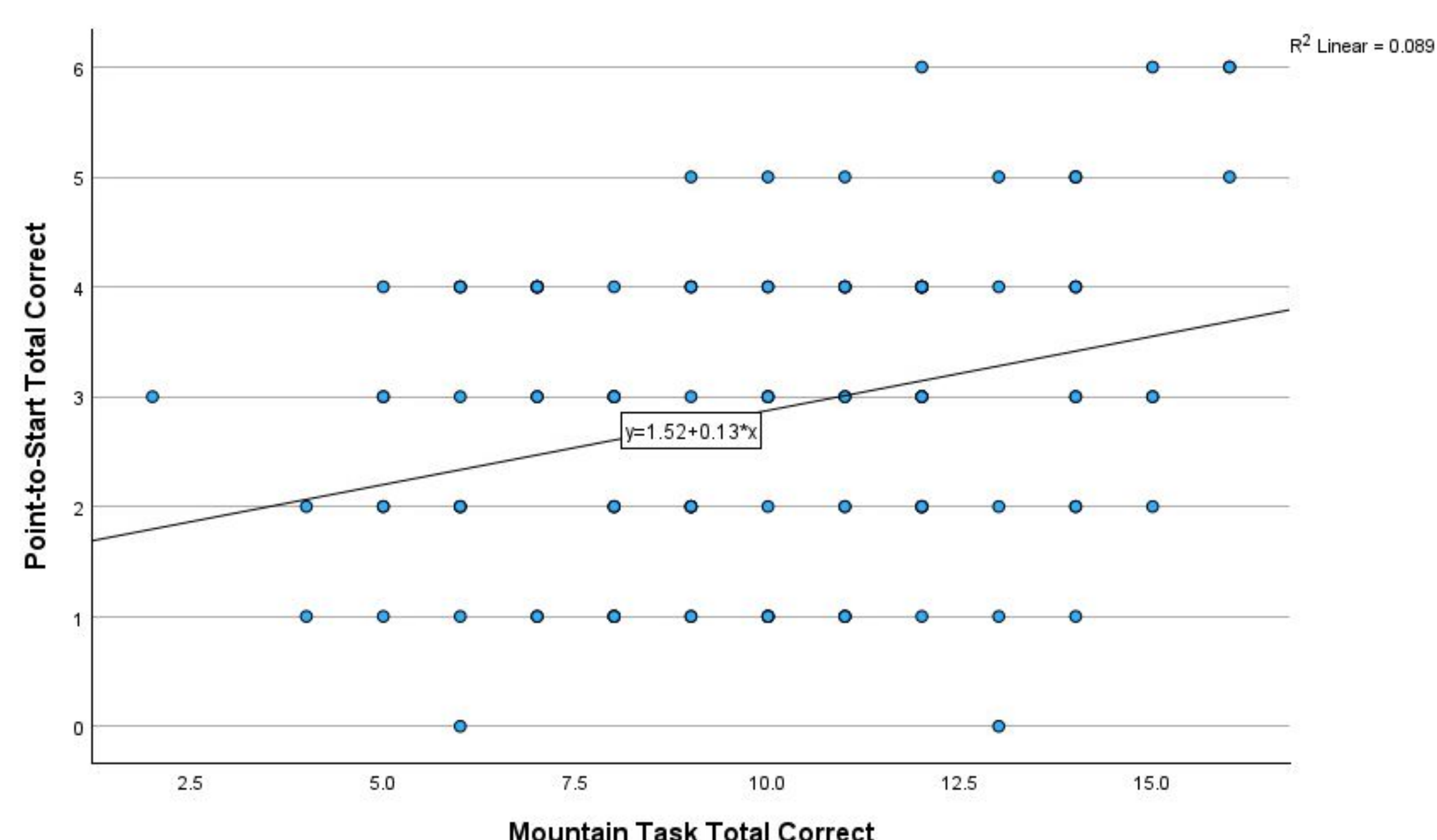


Figure 2. Point-to-Start Task. (a) Child at end of route with chalk "T" reference; (b) Dropping ball of slime to indicate starting landmark.

RESULTS

- Linear regression was used to examine whether VPT predicted spatial updating ability, controlling for age and the age x VPT interaction.
- The overall regression model was significant, $F(3, 108) = 3.68, p = .014$ (see Figure 3).
- Visual perspective-taking ability **significantly** predicts spatial updating
 - Higher VPT scores were associated with higher spatial updating scores, $\beta = .13, t = 2.87, p = .005$
 - accounted for approximately **9.3% of the variance**
- Age alone was not a significant predictor as spatial updating performance, $\beta = .005, t = 0.68, p = .484$
- No age x VPT interaction: The link between VPT and spatial updating does not vary across 6-10 years.



CONCLUSIONS

- Children who are better at imagining other viewpoints are better able to update spatial locations, indicating overlapping cognitive mechanisms.
- Findings help us understand how perspective-taking and navigation skills interact in childhood.
- Assessing visual perspective-taking may help identify underlying cognitive mechanisms contributing to spatial navigation difficulties.
 - VPT tasks could serve as an early marker for later spatial updating difficulties
- Training VPT may lead to downstream improvements in spatial updating
 - Future studies should examine whether training visual perspective-taking leads to improvements in spatial updating.

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