Growth Curve Modeling of Preschoolers’ Spatial Skills during Spatial Training

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Introduction

- Early spatial skills → later spatial and math skills (Mix & Cheng, 2012) and likely achievement in STEM disciplines (Wai, Lubinski, Benbow, & Steiger, 2010)
- Many longitudinal studies regarding achievement gaps have led to inconsistent conclusions (T.Shin et al., 2013)
- Low-income preschoolers have worse spatial skills than middle-income peers (Verdine et al., 2014); however, spatial skills are malleable (Uttal, et al., 2013)
- Little is known about which interventions optimize spatial skills for younger, especially low-socioeconomic (SES), learners, AND
- Almost nothing is known about the trajectory of spatial skills during training.
- The particular training used here required puzzle assembly with colored geometric forms (see Method).

Research Questions/Hypothesis

1. How does each child’s spatial ability change over time (within-person change) with spatial training?
2. Do children’s spatial skill trajectories during spatial training vary by SES (between-person change)?

Participants

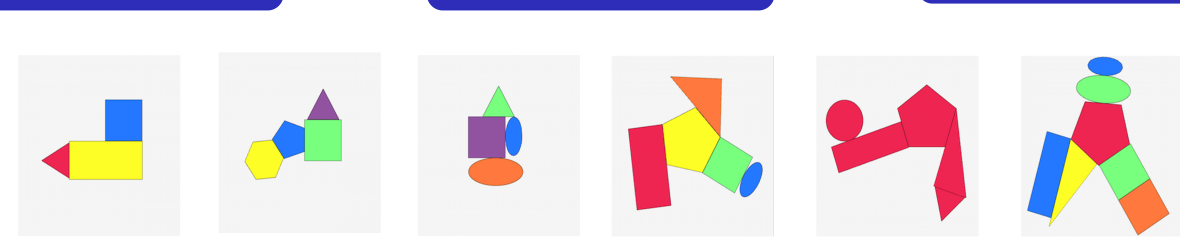
- 187 Three-year-olds tested at Head Start and private preschools
- 96 girls, M_{age}= 42.65 mo, SD_{age}= 3.37 mo, 50% Low SES

Method

Week 1 — **Pre-Test**

Weeks 2-6 — **5-week training (1x/week)**

Week 7 — **Post-test**



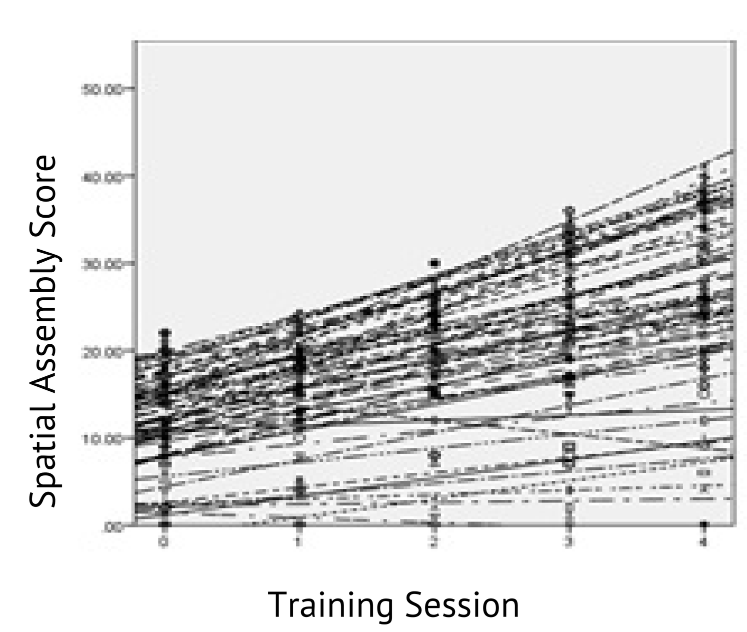
Intervention

2D TOSA Training Conditions Embedded in Birthday Party Game

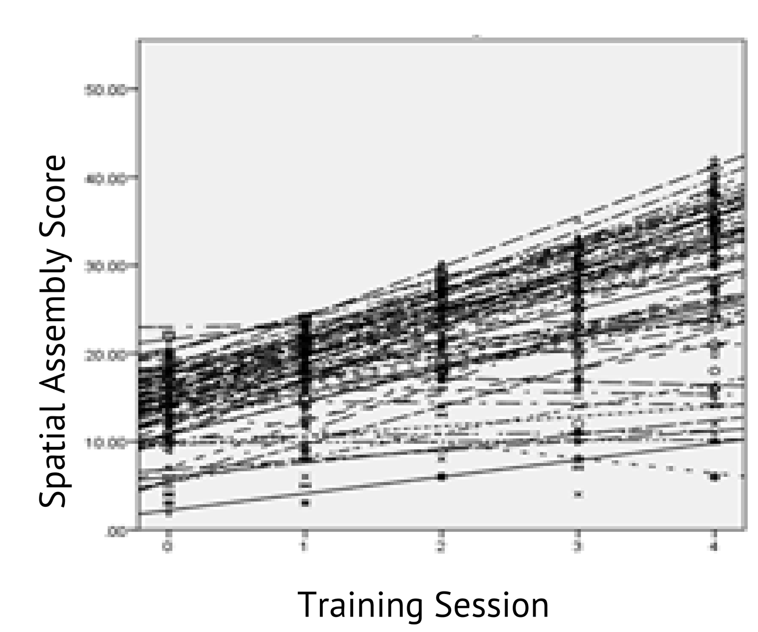
	Shape Familiarization	Demo Trial	Training Trials
Modeling & Feedback	Child looks at the shapes	E shows the correct locations to place shape. Then E asks child to place shapes.	Pieces indicated as being wrong and fixed
Gesture	Child traces shapes	E models tracing correct location before placing. Then E asks child to trace and place shapes.	E traces correct shape location before moving incorrect pieces
Spatial Language	Told the name of each shape and shape properties and child repeats the name	E talks about shape locations and names them as they are placed. Then E asks child to say where shapes go and place shapes.	E names incorrect shapes and talks about correct spatial locations while placing
Control	No training during weeks 2-6		

Results

Growth curves (lines) for Low SES

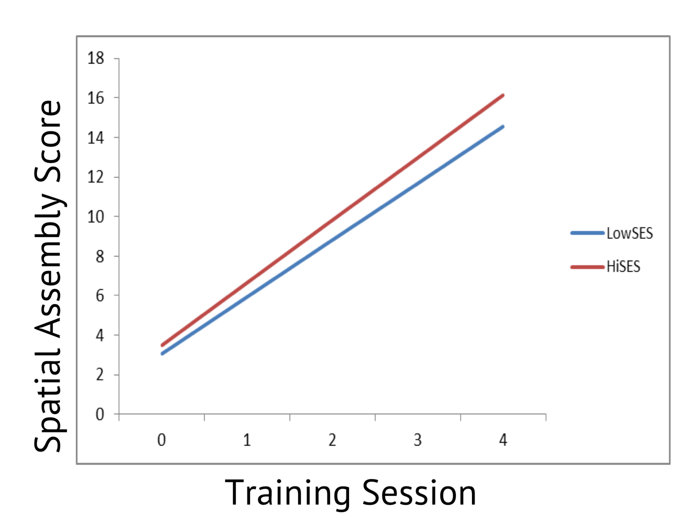


Growth curves (lines) for High SES



- Moderate variance of Level 1 residuals VAR(εij)*, That is, each person’s regression line fits the data points “pretty well”. There is variance in the residuals (at Level 1) remaining to be explained.
- ICC = 0.39

Prototypical Growth Trajectories



- There was a significant effect of SES on the intercept indicating that low-SES children had a lower starting point than high-SES children.
- However, SES did not impact children’s growth rate during training.

Discussion

- Spatial training using puzzle assembly is effective with 3-year-old children. All children completed the training.

  - Growth rate did not vary by SES.

- Plots indicate a linear, continuous growth pattern with individuals having different starting points, and different slopes (rate of change).

  - But over time, there is more spread in scores, which may indicate possible subgroups (e.g., age in months, bilingualism, gender)

Future Directions

- Additionally, other factors such as age and home environment (whether they have spatial toys) could also have an effect on the starting point and rate of growth.
- Identify and group by high and low growth rates and examine if that predicts later spatial and math performance.

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