

Examining Potential Causal Connections and Mechanisms between Children's Block Play and Mathematics Learning

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Introduction

- Block play is ubiquitous in preschool settings and is an important context where the development of math skills can occur¹
- Correlational work links block play to math^{2,3}, but there is little **causal evidence** to support these claims
- It is also unclear whether more intentional and structured block play is better for math learning than the unstructured, free play option often offered in classrooms
- No studies have identified **why** block play may promote early math, although several STEM-related skills (i.e., math language, spatial skills, executive function) have been suggested as mediators^{4,5}
- There is a critical need to empirically test causal associations among structured and unstructured block play and math learning and identify mechanisms, particularly for children most in-need of intervention (e.g., children from low SES backgrounds)**

Project Aims and Hypotheses

- Empirically evaluate the impacts of different types of block play (unstructured, semi-structured) on children's math skills in a low-income sample (*completed*)

Hypothesis: Children assigned to either block play condition will demonstrate greater gains in math skills than children in a BAU control group. Children in the semi-structured condition will demonstrate greater gains in math skills than children in the unstructured condition.

- Evaluate the extent to which children's math language, spatial skills, and executive function act as mechanisms linking block play with children's math learning (*in progress*)

Participants

- 242 children (50% female; $M_{age} = 52.01$, $SD = 6.78$) from two Midwestern states
- Children came from families with low incomes (Head Start or free/reduced lunch eligible)
- 20% of the sample were Spanish speaking Dual Language Learners (DLL)

Pre and Posttest Measures

Math Skills

Numeracy: Preschool Early Numeracy Screener- Brief Version⁶

Cardinality: Cardinality Measure⁷

Numeral Identification: Numeral Identification Measure⁷

Geometry: Child Math Assessment- Geometric Subscales⁸

STEM-Related Skills

Quant and Spatial Math Language: Preschool Assessment of the Language of Mathematics⁹

Spatial Assembly: Test of Spatial Assembly³

Behavioral Self-Regulation: Head-Toes-Knees-Shoulders¹⁰

Cognitive Flexibility: Card Sort Task¹¹

Inhibitory Control: Day Night Stroop¹²

Working Memory: Hide and Seek Task¹³

Complex Planning: Tower of Hanoi Task¹⁴

Intervention Procedure

Children were randomly assigned to one of three conditions.

Block play groups met for 15 min, 2x a week for 8 weeks and were identical except for the prompt given by an interventionist at the start of the session.

Semi-Structured Block Play (n = 72) Prompts differed by session and became more complex as the intervention progressed.

Week 1: "Today your job is to build a tower together!"

Week 3: "Today your job is to build a zoo where animals both big and small can live. In your zoo, you need to make spaces for the different sized animals and a wall around the zoo so the animals do not escape."

Week 7: "Today I am going to show you a picture of a structure. Your job is to work together to build the structure you see in the picture."

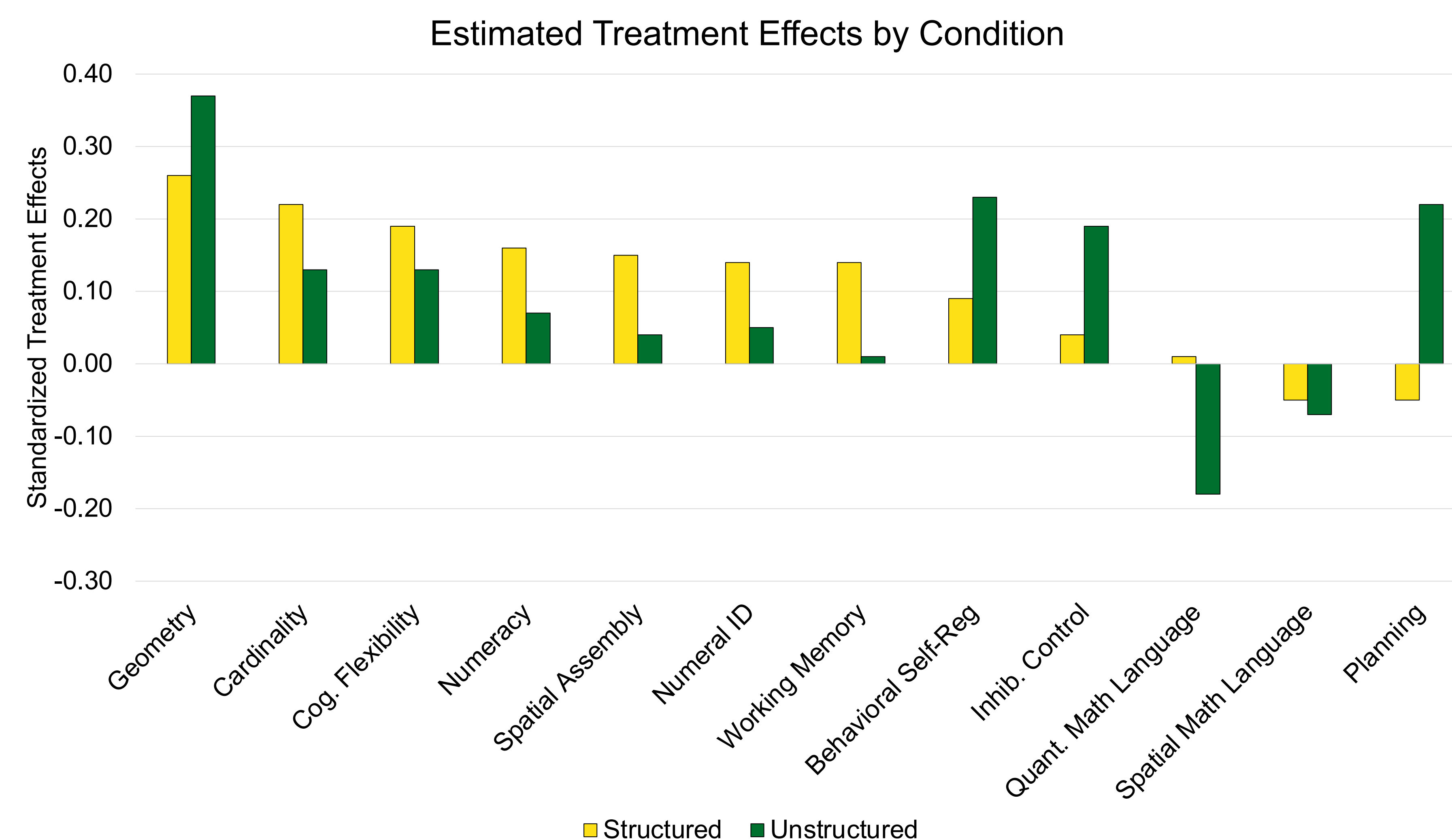
Unstructured Block Play (i.e., free play; n = 70) The same prompt was given each session:

"Today, your job is to build together! You can build anything you want. I can't wait to see what you build!"

Business As Usual Control (n = 88)

Results

Each outcome at posttest was regressed on intervention condition, covarying for pretest score, DLL status, vocabulary¹⁵, age, sex, and parent education and accounting for small group clustering.



Three effects were statistically significant:

- Unstructured play over BAU for geometry, $b = .37$, $p = .01$
- Unstructured play over BAU for behavioral self-regulation, $b = .23$, $p = .017$
- BAU over unstructured play for quant math language, $b = -.18$, $p = .034$

Conclusions and Next Steps

- The majority of effect sizes were positive, in line with our hypothesis that early math and other STEM-related skills can be developed through block play and **supporting the use of block play as an effective STEM learning experience**
- The expected advantage for children in the semi-structured condition was not supported; we next plan to explore children's engagement with the given prompt
- We also plan to unpack the iatrogenic effect of unstructured play on quantitative math language by considering how assessed math language relates to math language used *during* block play
- We are in the process of testing math language, spatial skills, and executive functions as mediators of the effect of block play on math for Aim Two

References

1 NAEYC, 2002, 2 Wolfgang et al., 2001, 3 Verdine et al., 2014, 4 Bustamante et al., 2018, 5 Hadani et al., 2018, 6 Purpura et al., 2015, 7 Purpura & Lonigan, 2015, 8 Klein & Starkey, 2004, 9 Purpura & Logan, 2015, 10 McClelland et al., 2014, 11 Zelazo, 2006, 12 Gerstadt et al., 1994, 13 Garon et al., 2014, 14 Carlson et al., 2004, 15 Dunne and Dunne, 2007

