
EXAMINING THE ROLES OF PATTERNING KNOWLEDGE, SPATIAL ASSEMBLY, AND ANALOGIC REASONING IN EARLY MATHEMATICS DEVELOPMENT

SRCD BIENNIAL MEETING, APRIL, 2021, THU, APRIL 8, 10:00AM-11:30AM

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EMPHASIZING THE NUMBERS IN PATTERNS DURING TRAINING: EFFECTS ON PATTERNING AND MATH SKILLS

SRCD BIENNIAL MEETING, APRIL 2021

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PREPRINT- <[HTTPS://TINYURL.COM/PATTERNSTUDY](https://tinyurl.com/patternstudy)>

BACKGROUND

- Most early math research and theory has classically focused on the contributions of numeracy skills (Sarama & Clements, 2009)



- Recent work focuses more broadly to include the contributions of early non-numeracy topics such as repeating patterning (e.g., Fyfe et al., 2019; Rittle-Johnson, Zippert, Boice, 2018; Wijns et al., 2019; Zippert et al., 2019; 2020)



Burgoyne et al., 2017

BACKGROUND

■ Gaps

- Is the patterning and math link causal?
- What is the mechanism through which patterning → mathematics knowledge?

■ Patterning → Numeracy → Math

- Evidence that patterning and numeracy are correlated (Fyfe et al., 2017; Mackay & De Smedt, 2019; Wijns et al., 2019; Zippert et al., 2019; 2020)
- Shared reliance on rules and regularities
 - Numeracy
 - Can rely on counting string to answer magnitude comparison problems (5 comes later in the count sequence than 3, so 5 is bigger)
 - The next number in the count sequence after 4 is 5, so $4+1=5$ (successor principle; Gelman & Gallistel, 1978; Sarnecka & Carey, 2008)
 - Patterns
 - Reciting items in order in the pattern sequence helps to know what comes next
 - Knowing the unit repeats over and over in the count sequence helps you determine what comes next

AIMS

1. Can we improve repeating patterning skill in preschool through targeted instruction?

Hypothesis 1: Yes

2. Can we improve successor principle knowledge through targeted tutoring?

Hypothesis 2: Yes

3. Can improving patterning along with numeracy promote numeracy and mathematics knowledge more than numeracy training alone?

Hypothesis 3: Yes

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- 212 preschool children ($M = 4.7$ years, $SD = .37$)
 - Recruited from 12 preschools (5 public, 7 private)
 - 56% male, 53% white, 10% bilingual
 - 35% received some form of financial assistance for school
 - 72 in patterning + numeracy, 70 in literacy + numeracy, 70 in control
 - Additional 21 students dropped due to persistent non-compliance issues or missing 2 training sessions

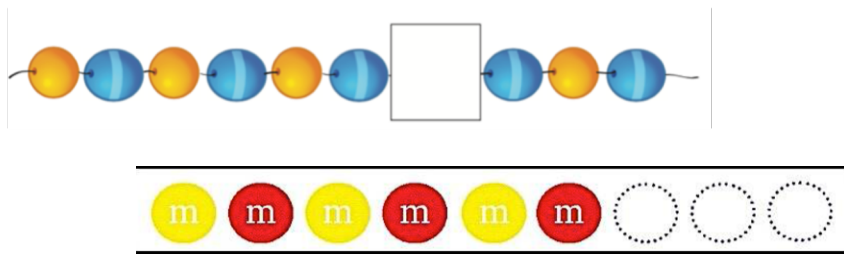
STUDY 2 DESIGN

- Participants randomly assigned to 3 conditions:
 - 1. Repeating Patterning + Numeracy Instruction**
 - a. Repeating patterning activities and Numeracy activity (successor principle) at end of each lesson
 - 2. Literacy + Numeracy Instruction**
 - a. Literacy activities so spend same time with experimenter and Numeracy activity (successor principle) at end of each lesson
 - 3. Passive control group**
 - a. Regular classroom instruction only
- Most patterning and numeracy activities modified from Building Blocks Pre-K curriculum
- Literacy activities taken from Opening the World of Learning (OWL) Prek-K curriculum

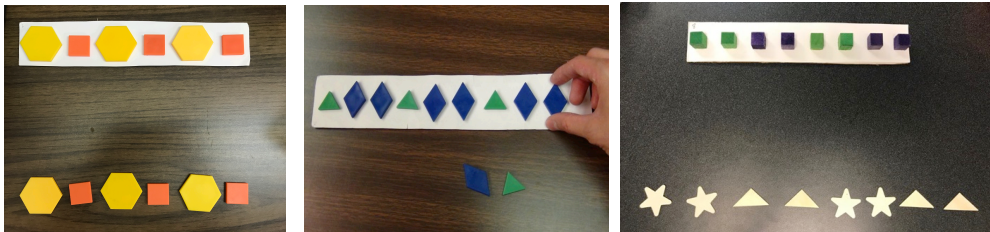


MEASURES

Teacher Patterning Measure Example Items

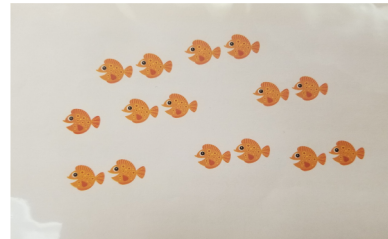


Research Patterning Measure Example Items



Successor Principle: Fish Pond Task

- Assess children's knowledge of the successor principle using numbers ranging from 2 to 20 with 10 items (7 addition and 3 subtraction). Based on Cheung et al. (2017)



“Three fish are swimming under the lily pad. Now watch... another fish swims in! Now are there 4 or 5 fish?”

MEASURES CONTINUED

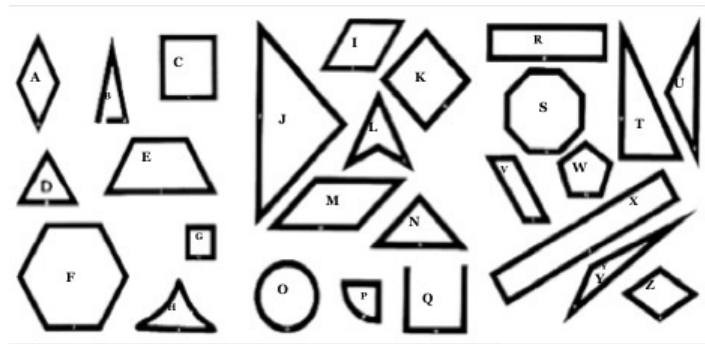
Broad Math & Numeracy Knowledge

The REMA Short-Form of Research-Based Early Mathematics Assessment
(Clements & Sarama, 2000; Weiland et al., 2012)

Numeracy example knowledge

1	•
2	••
3	•••
4	••••
5	•••••

Shape example



STUDY 2 DESIGN

Pretest

Children are pretested in one 25-minute session

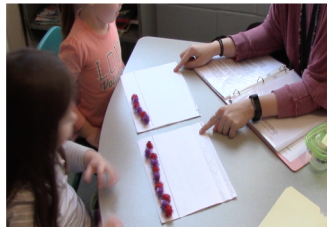
- Math (REMA)
- Pattern: Teacher-Based
- Successor Principle: Fish Pond

Randomized to Condition

Children are first randomized to condition, and then assigned to a group of 2 based on varying pattern ability

Intervention

Children in groups of 2 receive five 25-minute training sessions across 2-3 weeks



Post test Day 1

The day after session 5, children are assessed in one 20-minute session

- Pattern: Research-Based
- Successor Principle

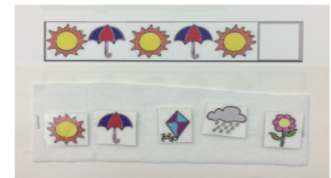


Post test Day 2

Within a few days of post day 1, children are assessed in another 20-minute session

- Math (REMA)
- Pattern: Teacher-Based

What's Next Pattern AB



"What comes next in the pattern? Use one of these."
[Experimenter gestures to response options.]

OVERVIEW OF PATTERNING + NUMERACY TRAINING SESSIONS

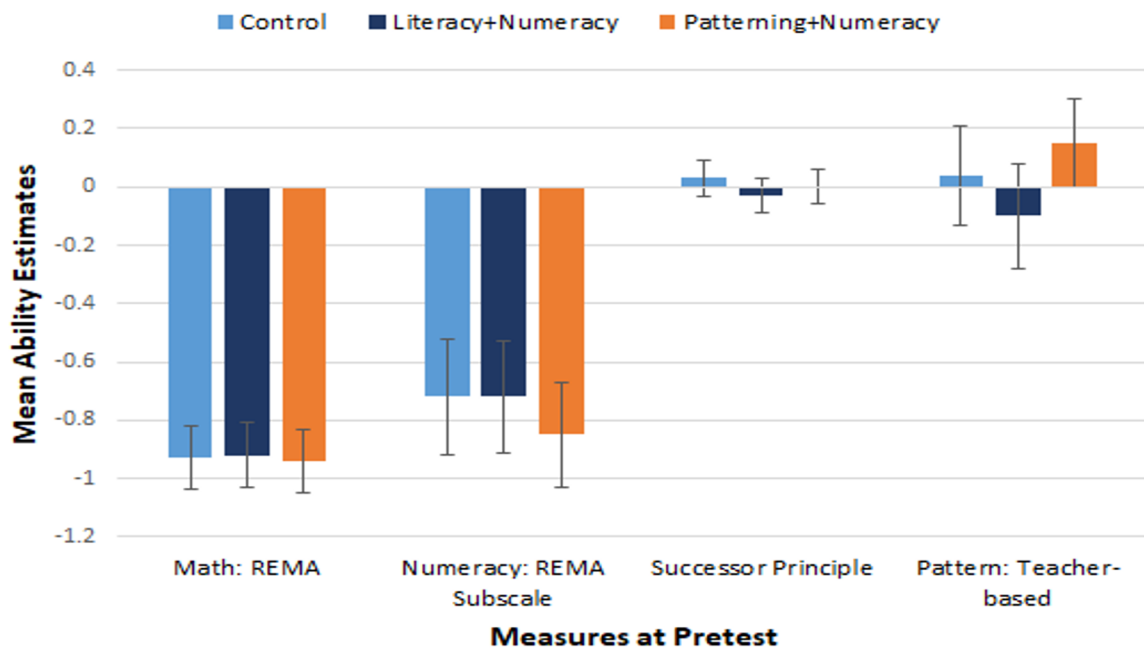
Session	Patterning Focus	Numeracy Focus (Successor Principle)
1	Duplicate and extend patterns	Add 1 (small numbers)
2	Duplicate and extend patterns	Add 1 (small numbers)
3	Identify core unit of patterns	Subtract 1 (small numbers)
4	Abstract patterns	Add 1 (large numbers and review small numbers)
5	Review core unit of patterns and abstract patterns	Add and subtract 1 (small and large numbers)

OVERVIEW OF LITERACY + NUMERACY TRAINING SESSIONS

Session	Literacy Focus (OWL Unit 1 Week 2)	Numeracy Focus (Successor Principle)
1	oral language, phonological awareness, alphabet knowledge, concepts of print, motivation to read, listening comprehension	Add 1 (small numbers)
2	oral language, phonological awareness, alphabet knowledge	Add 1 (small numbers)
3	oral language, phonological awareness, alphabet knowledge	Subtract 1 (small numbers)
4	oral language, phonological awareness,	Add 1 (large numbers and review small numbers)
5	oral language, concepts of print, motivation to read	Add and subtract 1 (small and large numbers)

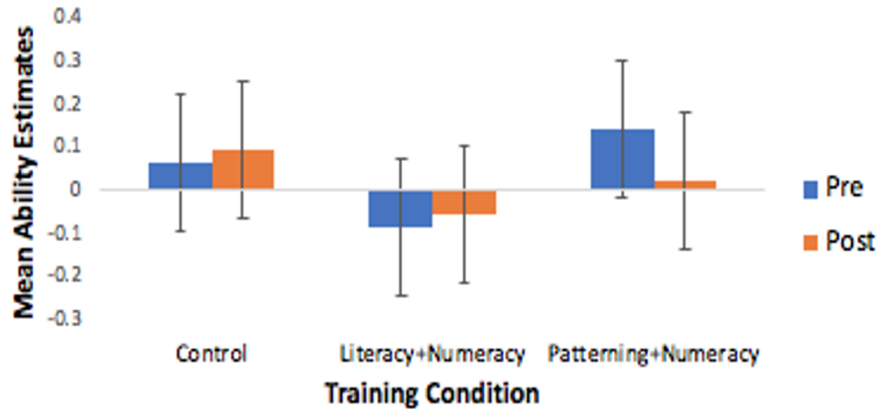
PRETEST RESULTS

IRT Scores at Pretest by Training Condition

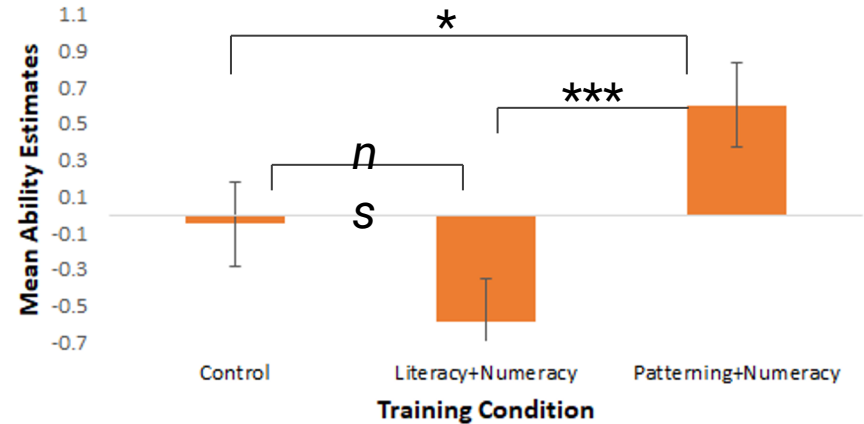


POSTTEST RESULTS

Teacher-based Pattern Scores by Training Condition



Research-based Pattern Scores by Training Condition



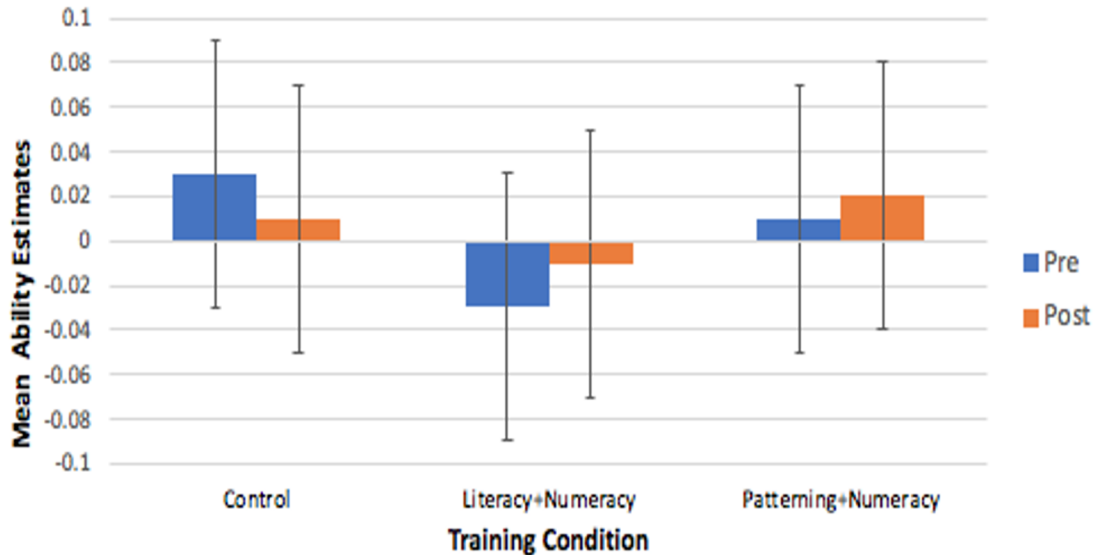
Study 1 Hypotheses:

Children's repeating patterning knowledge can be improved through targeted instruction. (yes but aligned measure only)



RESULTS

Successor Principle Scores at Posttest by Training Condition



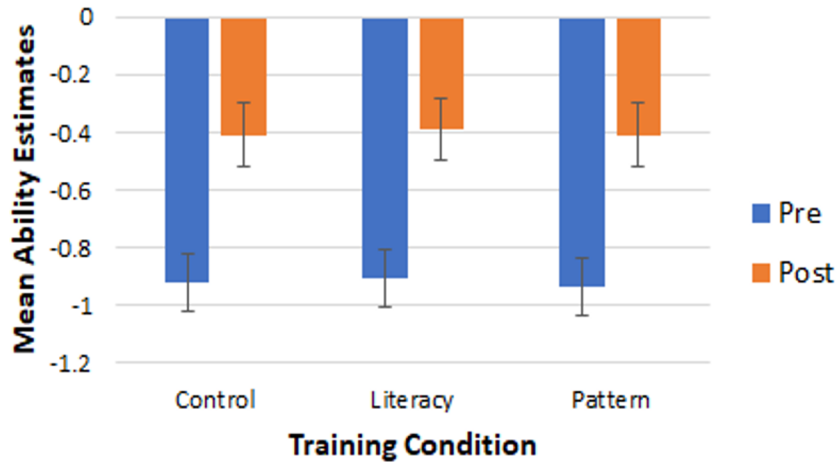
Study 2 Hypotheses:

Hypothesis 2: Children's knowledge of the successor principle, a core early numeracy skill, can be improved through targeted instruction.

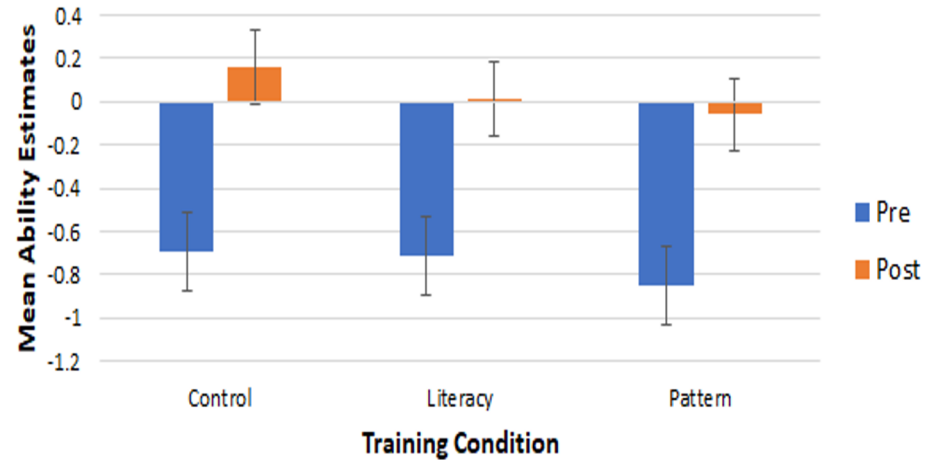


POSTTEST RESULTS

REMA Math



REMA Numeracy



Study 3 Hypotheses:

Hypothesis 3: Improving children's repeating patterning knowledge prepares them to learn more from numeracy instruction on the successor principle, both on that skill and math more broadly.



DISCUSSION

Summary

- Patterning instruction improved patterning knowledge, but only on measure aligned with training and more focused on unit of repeat
- Instruction did not differentially improve math or numeracy and did not improve successor principle knowledge at all.
- In line with other studies with young children that did not find effects of training numeracy and non-numeracy skills together (Barnes et al., 2016; Kroesbergen et al., 2012; Kyttälä et al., 2015)
- Patterning + numeracy instruction may support other numeracy skills
 - Knowledge of count sequence (what's before/after, but not highest count; Zippert et al., 2020)
 - Ordinal knowledge (e.g., what number comes before 5)

THE PATTERNING TEAM!



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