Exploring the Links Between Patterning, Numeracy, and Math Knowledge

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Background

- Math knowledge develops early and predicts later math and reading achievement (Duncan et al., 2007). Thus, it is important to determine foundational skills that support this development.
- Though most research and theory have focused on the contributions of numeracy skills, patterning skills are also theorized to be important for early and later math development (Sarama & Clements, 2004).
- Empirically, patterning skills in preK predict fifth-and sixth-grade general math achievement, even after controlling for a wide range of other math and cognitive skills (Fyfe, Rittle-Johnson, & Farran, 2019; Rittle-Johnson, Fyfe, Hofer, & Farran, 2016).
- Though patterning skills and general math knowledge are linked, little is known about how patterning skills relate to specific early math skills in early childhood. Evidence with elementary schoolers suggests patterning is related to calculation skill (Fyfe, Evans, Matz, Hunt & Alibali, 2017; Mackay & De Smedt, 2019).
- Emerging evidence indicates significant positive relations between patterning and general numeracy in preK (Wijns, Torbeyns, Bakker, & De Smedt, 2019; Zippert, Clayback, & Rittle-Johnson, 2019)
- Research on the link between patterning and specific aspects of numeracy knowledge, as well as how both predict general math and numeracy knowledge, is strongly needed, as current Common Core State Standards (2010) prioritize numeracy over patterning in math instruction in the early grades.

Study Aims

1. How are patterning knowledge and specific aspects of numeracy related in preK?
2. How do patterning and specific aspects of numeracy each explain variation in general math and numeracy knowledge?

Methods

Participants and Design:

- Two hundred twelve 4- to 5-year-olds (M_{age} = 4.7 years, *SD* = .37, 44% female)
- Recruited from 7 private and 5 public preschools
- 47% were non-Hispanic White, 29% were African American, 4% were Asian, 5% were Hispanic, and 9% were Biracial or other.
- General math and numeracy knowledge, patterning knowledge, and specific aspects of numeracy knowledge were assessed in the Fall of the preK year.

Measures

General Math & Numeracy Knowledge:

- The Research-Based Early Mathematics Assessment (REMA)-Short Form (Weiland et al., 2012). Contains numeracy and shape knowledge subsections.

Patterning Knowledge:

- Teacher-Based Pattern Measure (Rittle-Johnson, Zippert & Boice, 2019; see Figure)

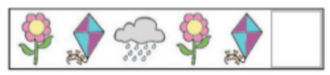
Specific Aspects of Numeracy Knowledge:

- Successor Principle (adapted from Sarnecka & Carey, 2008)
- Count to 50 (item from REMA)

Methods

Figure: Sample Items from Teacher-Based Patterning Assessment

What Comes Next Pattern ABC



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

Missing Item Pattern AB

"Find the missing bead [experimenter gestures to picture cutout response options below] to complete the pattern [experimenter gestures across pattern]."

Results

Table 1: Correlations Between General Math and Numeracy Knowledge, Specific Aspects of Numeracy Knowledge, and Patterning Knowledge

	M(*SD*)	1.	2.	3.	4.	5.
1. General Math Knowledge	10.09 (3.80)	---	.82**	.59**	.55**	.60**
2. General Numeracy Knowledge	5.19 (1.91)	.78**	---	.58**	.50**	.55**
3. Count to 50	18.14 (11.68)	.53**	.52**	---	.55**	.51**
4. Successor Principle	6.66 (1.93)	.48**	.43**	.50**	---	.47**
5. Patterning	2.90 (2.50)	.55**	.50**	.46**	.42**	---

Note: Raw bivariate correlations are shown above the diagonal, and partial correlations controlling for age are shown below the diagonal. **p < .01.

Table 2: Patterning and Numeracy Skills Predict General Math and Numeracy Knowledge

	General Math Knowledge			General Numeracy Knowledge		
Model Variables	***B*(*SE*)**	**β**	**ΔR^2**	***B*(*SE*)**	**β**	**ΔR^2**
Step 1: Control			.18**[a]			.15**[a]
Age	4.34(.64)	.43**		1.99(.33)	.39**	
Step 2: Numeracy			.33**[b]			.32**[b]
Age	2.04(.54)	.20**		.85(.28)	.17**	
Successor Principle	.74(.11)	.38**		.35(.06)	.36**	
Count to 50	.11(.02)	.33**		.06(.01)	.34**	
Step 3: Patterning			.07**[c]			.04**[c]
Age	1.29(.52)	.13*		.55(.28)	.11**	
Successor Principle	.50(.11)	.26**		.25(.06)	.26**	
Count to 50	.08(.02)	.24**		.04(.10)	.27**	
Patterning	.40(.07)	.34**		.16(.04)	.28**	

Notes. [a] df = (1, 208) [b] df = (2, 206) [c] df = (1, 205).*p < .05. **p < .01

Conclusions

- Findings align with past work suggesting that patterning is important for general math and numeracy knowledge (Rittle-Johnson et al., 2016; Wijns et al., 2019; Zippert, Clayback, & Rittle-Johnson, 2019).
- Findings extend past work in demonstrating links between patterning and specific aspects of numeracy knowledge. They also further indicate that patterning and specific aspects of numeracy each explain unique variance in general math and numeracy knowledge.
- The association between patterning and specific aspects of numeracy knowledge may be explained by their shared reliance on rules and regularities.
- This work suggests that repeated patterning instruction may be important for promoting early development of specific aspects of numeracy knowledge, and that patterning should be emphasized *along with* numeracy in early math standards. More longitudinal and experimental research is needed to confirm the causality and directionality of these relations.

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For more information and to view this poster online: http://vu.edu/patterns-and-math, Erica.L.Zippert@vanderbilt.edu