

# More than Just Numbers: Examining How Pattern and Spatial Skills Predict Preschoolers' Math Knowledge

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# Why study Early Math?

- Variation in U.S. children's math skills before school entry (Starkey, Klein, & Wakeley, 2004)
- Early math skills predict academic achievement in math *and* reading across primary and secondary school (Duncan et al., 2007; Jordan et al., 2009; Nguyen et al., 2016)
- Important to identify varied predictors of early math knowledge

# What is early math, more broadly?

**Number**



**Algebra**



**Geometry**



**Measurement**



**Data Analysis  
and Probability**

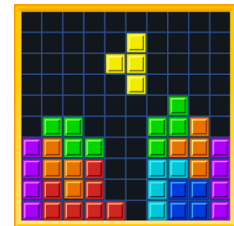


# Pattern and Spatial Skills

- **Pattern skills**- understanding predictable sequences (e.g., shapes, sounds, or functional relations between variables; Burgoyne et al., 2017; Rittle-Johnson et al., 2015)



- **Spatial skills**- visual imagery and mental manipulation of spatial information (Uttal et al., 2013)



- **Both**

- Predict later math achievement
- Linked to each other (Collins and Laski, 2015)
- Minimally emphasized in Common Core State Standards

# Current Study

Rittle-Johnson, B., Zippert, E., Boice, K. (in press).  
The Roles of Patterning and Spatial Skills in Early  
Mathematics Development. *Early Childhood  
Research Quarterly*.

# Research Aims

- **Aim 1**-Examine relations between pattern and spatial skills in preschoolers
- **Aim 2**-Determine how both skills predict math knowledge at the beginning and end of the preschool year

# Methods and Procedure

## ○ **Sample**

- 73 preschoolers ( $M_{age} = 4 \text{ yrs, } 7 \text{ months}$ )
- 57.5% Female; 46.6% African American, 42.5% White
- 55% Qualified for financial assistance to attend preK

## ○ **Time 1:** beginning of pre-K

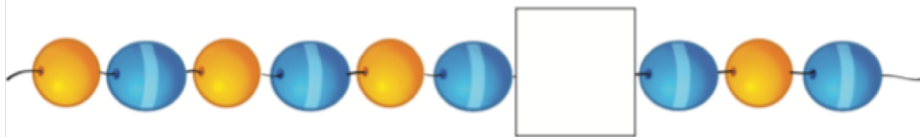
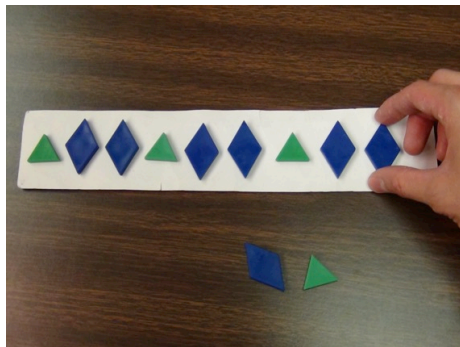
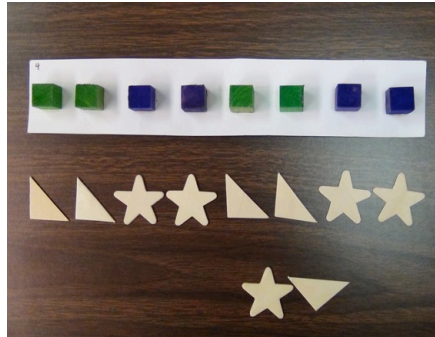
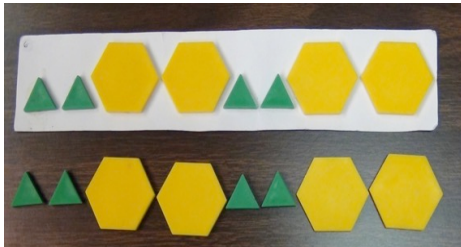
- **Patterning skills** (Patterns with shapes, and pictures)
- **Spatial Skills** (Visuospatial Working Memory-Corsi Block Task, Form Perception-DTVP-II, Spatial Visualization-Block Design WPPSI)
- **Math** (REMA-brief; Numeracy, Geometry, and Pattern items)
- **Language-Receptive Vocabulary** (PVT; NIH Toolbox)
- **Verbal Working Memory** (backwards digit span)

## ○ **Time 2;** end of pre-K, ~7months later

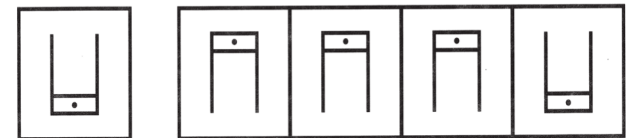
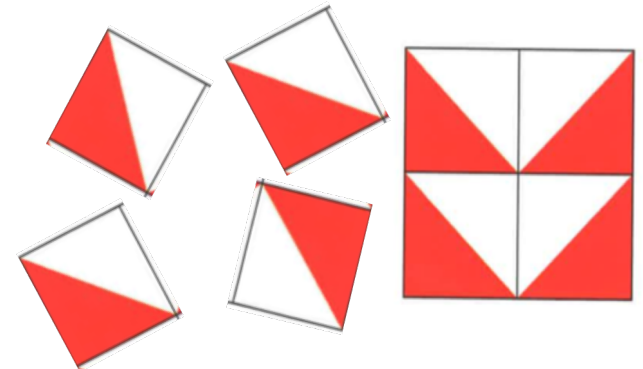
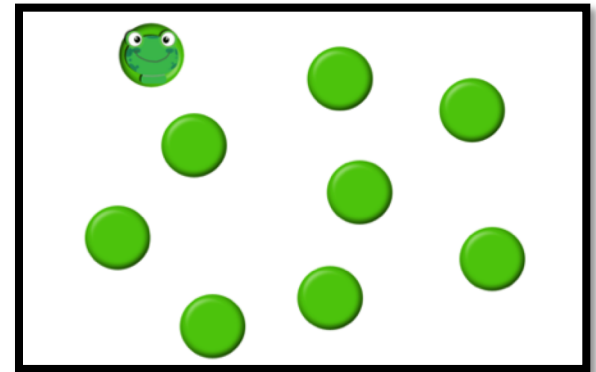
- **Math** (REMA-brief)

# Measures

## Patterning Tasks



## Spatial Tasks





# Results

# Aim 1: Relations Between Pattern and Spatial Skills

Correlations of Composite Skills	
	Spatial
Pattern	.59**
Spatial	.37*

\*  $p < .05$ , \*\*  $p < .01$

Correlations above the diagonal are zero-order correlations

Correlations below the diagonal control for child age, language skills, and working memory.

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## Aim 2: Pattern and Spatial Skills Predict Math at Time 1

Measure	<i>B</i>	$\beta$	$\Delta R^2$
<b>Controls</b>			<b>.44**</b>
<i>Age</i>	-.03(.28)	-.01	
<i>Verbal Ability</i>	.01(.01)	.11	
<i>Verbal WM</i>	.16(.07)*	.26	
<b>Spatial Skills</b>			<b>.09*</b>
<i>Visual-Spatial WM</i>	.02(.04)	.05	
<i>Form Perception</i>	.03(.02)	.14	
<i>Spatial Visualization</i>	.03(.03)	.11	
<b>Pattern Skills</b>			<b>.07**</b>
<i>Patterns with shapes</i>	.04(.04)	.10	
<i>Patterns with pictures</i>	.20(.07)**	.30	

## Aim 2: Pattern and Spatial Skills Predict Math at Time 2

Measure	<i>B</i>	$\beta$	$\Delta R^2$
<b>Controls</b>			.38**
<i>Age</i>	.52(.30) <sup>†</sup>	.17	
<i>Verbal Ability</i>	.01(.01)	.10	
<i>Verbal WM</i>	.05(.08)	.07	
<b>Spatial Skills</b>			.10**
<i>Visual-Spatial WM</i>	.08(.04) <sup>†</sup>	.20	
<i>Form Perception</i>	.01(.02)	.07	
<i>Spatial Visualization</i>	.05(.03)	.15	
<b>Pattern Skills</b>			.09**
<i>Patterns with shapes</i>	-.04(.05)	-.09	
<i>Patterns with pictures</i>	.28(.08)**	.40	

# Aim 2: Pattern and Spatial Skills

## Predict Math at Time 2 with T1 Math

Measure	<i>B</i>	$\beta$	$\Delta R^2$
<b>Controls</b>			.57**
<i>Age</i>	.52(.27) <sup>†</sup>	.17	
<i>Verbal Ability</i>	.00(.01)	.05	
<i>Verbal WM</i>	-.02(.07)	-.04	
<i>Math Knowledge T1</i>	.43(.12)**	.42	
<b>Spatial Skills</b>			.03
<i>Visual-Spatial WM</i>	.07(.04) <sup>†</sup>	.18	
<i>Form Perception</i>	.00(.02)	.01	
<i>Spatial Visualization</i>	.03(.03)	.11	
<b>Pattern Skills</b>			.04*
<i>Patterns with shapes</i>	-.05(.04)	-.13	
<i>Patterns with pictures</i>	.19(.07)*	.28	

# Discussion

- Preschoolers' pattern and spatial skills are moderately correlated
- Pattern and spatial skills predict math at the beginning and end of preK
- Only pattern skills predict *growth* in math knowledge
- Both pattern and spatial skills should be considered in theory and state standards on early math development.

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