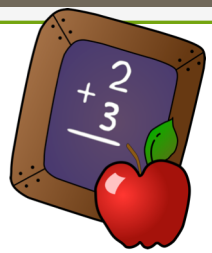
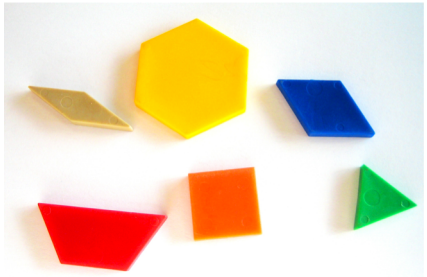
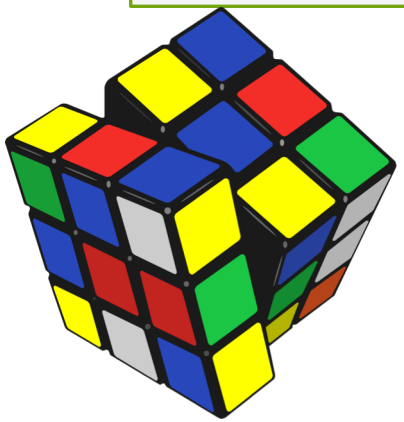


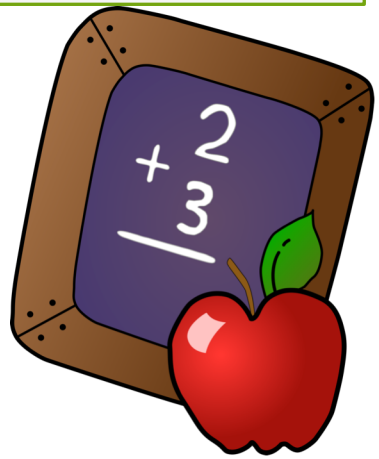
Parental Support of Math Readiness Skills: How to Promote and Optimize It

Mon, April 16, 12:25 to 1:55pm

Millennium Broadway New York Times Square, Seventh Floor, Room 7.01







Parental Support of Preschoolers' Number, Pattern, and Spatial Skills Predicts Concurrent and Later Math Knowledge

Zippert, E., & Rittle-Johnson, B.
Vanderbilt University

ies INSTITUTE OF EDUCATION SCIENCES
Grant #R305A160132

HEISING-SIMONS FOUNDATION

Why Study Early Math?

- Variation in 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)
- Better math knowledge is linked to higher career prestige and earnings, better healthcare decisions (Lipkus & Peters, 2009; Ritchie & Bates, 2013; Shapka, Domene, & Keating, 2006).

What is early math, more broadly?

Number

Algebra

Geometry

Measurement

Data Analysis and Probability

National Council for the Teachers of Mathematics, 2000/2006; Sarama & Clements, 2004

Pattern and Spatial Skills

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

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

- **Both**
  - Predict later math achievement in preschoolers (Rittle-Johnson, Zippert, Boice, in press)
  - Linked to each other (Collins and Laski, 2015)
  - Minimally emphasized in Common Core State Standards

Parents' Home Math Support

Early Math Support: **Numeracy**

- Parents report providing numeracy support up to **multiple times a week to daily** (Blevins-Knabe & Musun-Miller, 1996; LeFevre et al., 2009; Skwarchuk et al., 2014; Zippert & Ramani, 2017)
- **Formal support**
  - Direct practice with numbers (e.g., numeral naming and counting)
  - Longitudinally linked to math skills in school-aged children (e.g., Skwarchuk et al., 2014)
  - Concurrently linked to numeracy knowledge in preschoolers (e.g., Ramani et al., 2015; Skwarchuk, 2009; Zippert& Ramani, 2017)
- **Informal support**-non-learning focused activities (e.g., during play and book reading)
  - Inconsistently linked to numeracy (e.g., LeFevre et al., 2009; Hart et al., 2016)

Early Math Support: **Spatial**

- Parents report providing spatial support at home on a **monthly basis** (Dearing et al., 2012; Hart et al., 2016)
- Types of support
  - Talk about the spatial world, including "where words" (Verdine et al., 2014; Pruden et al., 2011; Pruden & Levine, 2017)
  - Spatial games, such as puzzle and block play (Jirout & Newcombe, 2015)
- Inconsistently linked to spatial skills and numeracy knowledge when reported by parents (Dearing et al., 2012; Jirout & Newcombe, 2015; Verdine et al., 2014)

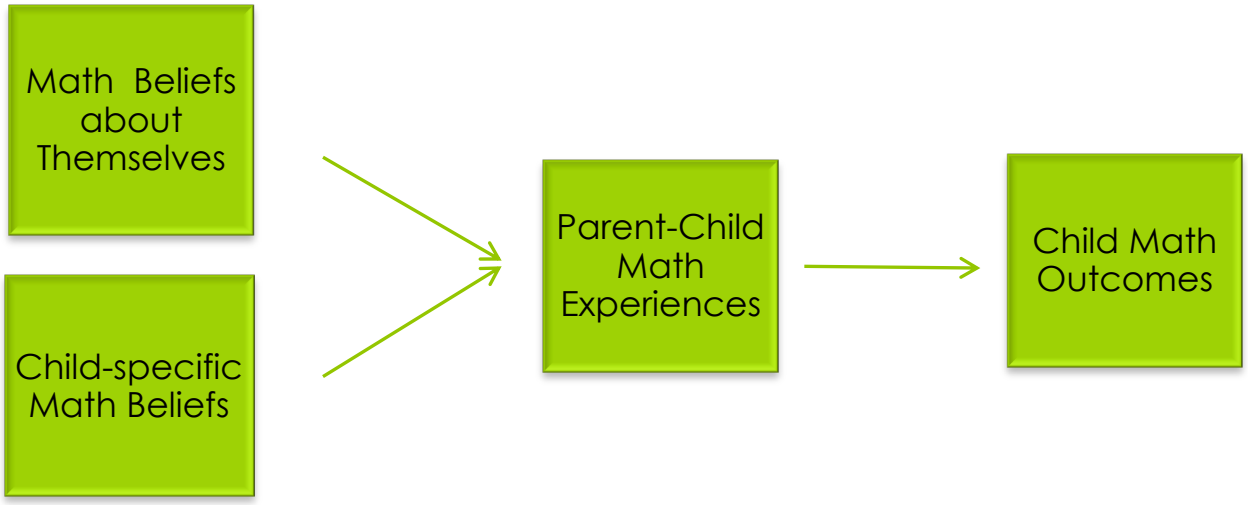
Early Math Support: **Patterning**

- Parents report providing pattern support **on a daily to weekly basis** (Huntsinger et al., 2016; Rittle-Johnson et al., 2015)
- Examples of support
  - Duplicating and extending patterns
  - Notice patterns in the environment
  - Play games involving patterns

- Parent-reported patterning support linked to pattern skills, but in a small sample (Rittle-Johnson et al., 2015)

Parent Socialization Model

(Eccles et al., 1983; Jacobs et al., 2005; Wigfield et al., 2006)



Gaps

- Research has yet to simultaneously examine and compare parent's numeracy, pattern, and spatial support
- Little is known about the role of parents' beliefs in predicting home math support more broadly
- Little is known about whether parents' broad math support is associated with children's math knowledge more broadly

Research Questions

- **Question 1**-Do parents of preschoolers provide more emphasis on numeracy than non-numeracy math support at home?
  - **Hypothesis**- Yes, given past research and emphasis in the media and availability of number-based "math" games
- **Question 2**- How do parents' beliefs relate to their support of math at home?
  - Exploratory analyses
- **Question 3-** How does parents' home support of math relate to children's math knowledge more broadly?
  - **Hypothesis**- We predict within domain links (e.g., numeracy support and numeracy knowledge at both time points)
  - Will explore cross domain relations

Methods

Sample

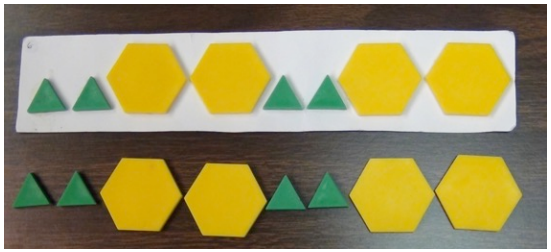
- 63 parents and their preschoolers
- Children
  - *M* = 4.5 years, *SD* = .29 *years*
  - 52% Female
  - 42.9% African American, 42.5% Caucasian or White
  - 48% Qualified for financial assistance to attend pre-K
- Parents
  - 86% mothers
  - 39.7% African American, 44.4% Caucasian or White
  - 57% of mothers held Bachelor's or graduate degrees

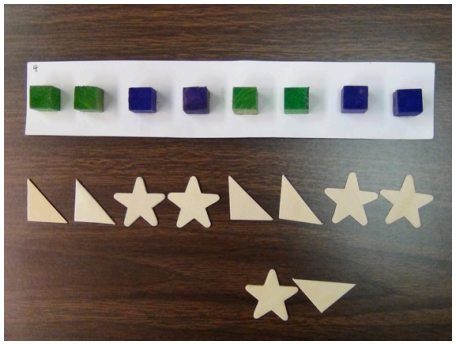
Procedure

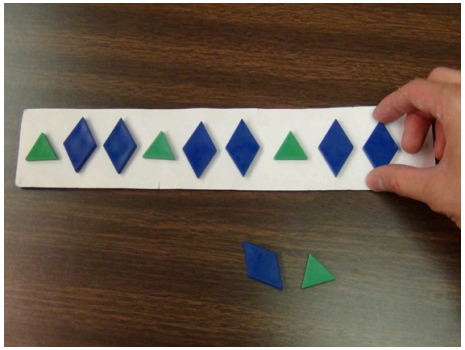
- **Time 1:** Beginning of pre-K-Child assessment and Parent Survey on Math Support and Beliefs
  - **Broad Math Knowledge** (REMA-brief; Numeracy and Geometry)
  - **Numeracy** (REMA-brief; Numeracy subsection only)
  - **Patterning skills** (Rittle-Johnson et al., 2015; Rittle-Johnson et al, in press)
  - **Spatial skills** (Visuospatial Working Memory-Corsi Block, Form Perception-DTVP-II, Spatial Visualization-Block Design)
  - **Language skills** (PVT; NIH Toolbox)
  - **Verbal Working Memory** (Backwards digit span)
  - **Parent Survey** (LeFevre et al., 2009; Galper et al., 1997; Dearing et al., 2012; Rittle-Johnson et al., 2015)
- **Time 2;** end of pre-K, 7months after Time 1
  - **Broad Math** (REMA-brief)

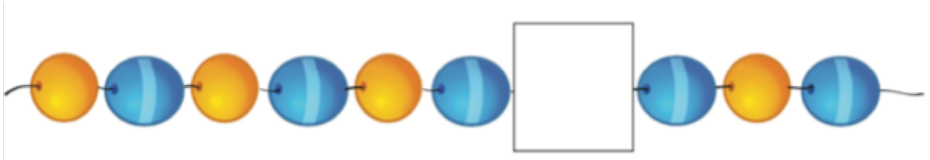
Child Ability Measures

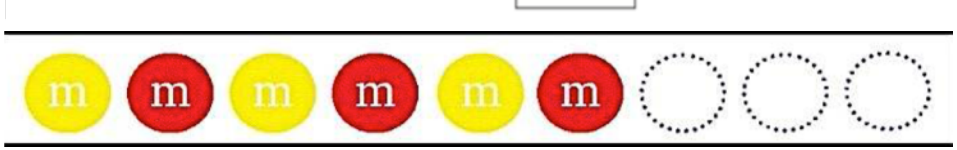
Patterning Tasks



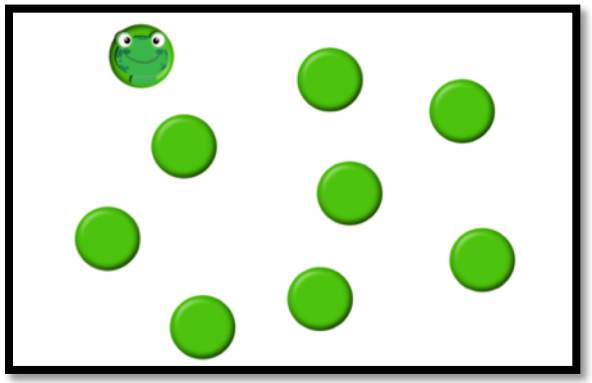


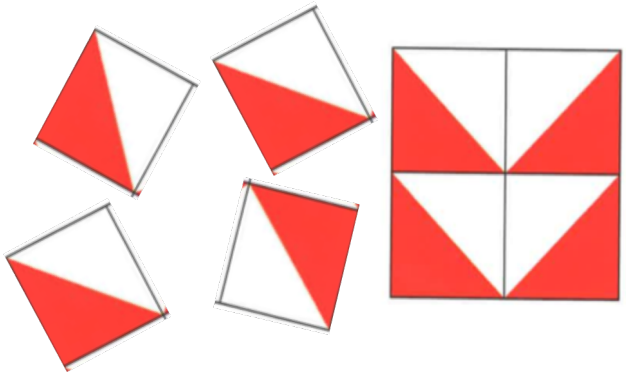


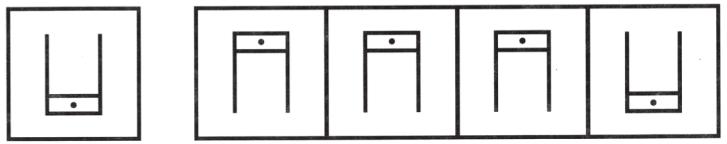




Spatial Tasks







Parent Survey

- Support (frequency of activities)
  - Numeracy (e.g., count objects, numeral ID)
  - Pattern (e.g., copy/extend patterns)
  - Space (e.g., puzzle play, spatial talk)
- Parents' Beliefs About Self and Child (7pt scales)
  - Abilities (number, pattern, space, Math, Spatial)
  - Interests (number, pattern, space, Math, Spatial)
  - Anxiety (Math, Spatial)

Results

Q1-Emphasis on Numeracy?

Activity Types	Mean	Standard Deviation
Numeracy	3.35	.75
Formal	3.10	.74
Informal	2.89	.85
Spatial	2.45	.72
Pattern	2.31	.97

0 = never,
1= once a month or less
2 = 2- to 3-times a month
3 = 1- to 2-times a week,
4 = 3- to 4-times a week,
5 = daily

- Numeracy vs. Spatial support $t(62) = 12.16$, $p < .01$, $d = 1.52$
- Numeracy vs. Pattern support $t(62) = 9.94$, $p < .01$, $d = 1.29$
- Spatial vs. Pattern support $t(62) = 1.42$, $p < .16$, $d = .19$

Q2: Parent Beliefs and Support

	Parent Support Type		
Parent Beliefs About <u>Themselves</u>	**Numeracy**	**Spatial**	**Pattern**
Ability [a]			
Math	.144	.240	.106
Spatial	.186	**.396****	**.262***
Anxiety [b]			
Math tasks	-.152	-.174	-.064
Spatial tasks	**-.275***	**-.262***	-.157
Liking [c]			
Math tasks	.050	.115	-.064
Spatial tasks	.142	**.255***	**.249**

*$p < .05$. **$p < .01$. n = 63. Correlations control for child age and language skills. [a] Ability estimates when in school and currently (1 = Not good at all, 7 = Very good). [b] 1 = Not at all anxious, 7 = Very anxious. [c] 1 = Not at all, 7 = Very much.

Q2: Parent Beliefs and Support

Parent Beliefs About Their Child	Parent Support Type: Numeracy	Spatial	Pattern
Ability			
Numeracy	**.359****	.218	**.259***
Spatial	**.297***	**.302***	.207
Pattern	**.345****	.140	**.319****
Interest in [b]			
Numeracy activities	**.293***	.181	**.281***
Spatial activities	.240	.218	.127
Pattern activities	**.260***	.178	.199

*$p < .05$. **$p < .01$. n = 63. Correlations control for child age and language skills. [a]Average of current ability and when in Kindergarten (1 = Not good at all, 7 = Very good), and innate ability compared to other children (1 = Much less than other children, 7 = Much more than other children). [b] 1 = Not at all, 7 = Very much.

Q3: Parents' Support and Child Abilities

Child Current, Later Ability	Parent Support Type		
	Numeracy	**Spatial**	**Pattern**
Time 1			
Broad Math Knowledge	.175	.174	.120
Numeracy Knowledge	**.310***	.157	.074
Spatial Skills	.107	.157	.028
Patterning Skills	.042	.116	-.056
Time 2			
Broad Math Knowledge	.097	.086	-.028
Numeracy Knowledge	-.030	-.071	-.197

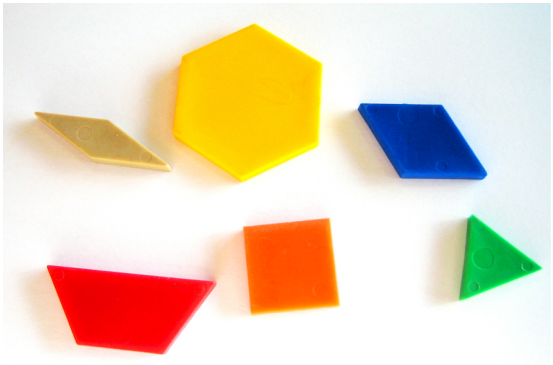
*$p < .05$. **$p < .01$. n = 61 due to 2 missing Time 2 subjects. Correlations control for child age at testing time, language skills, and paternal education level

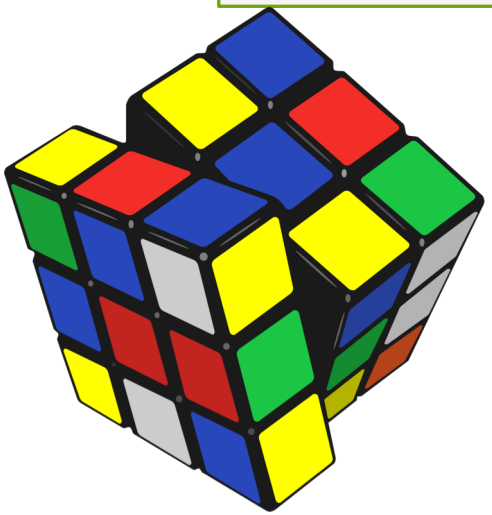
Discussion

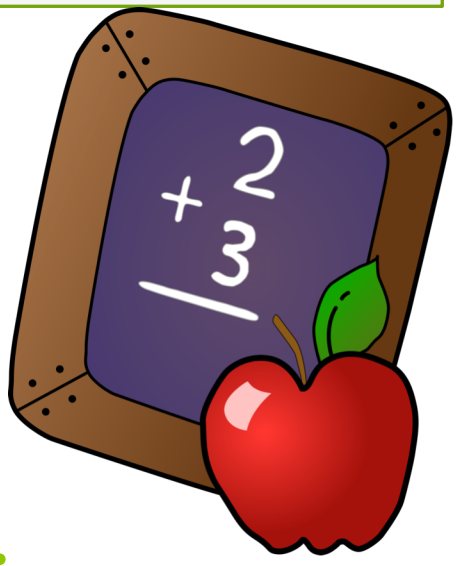
- Parents provide broad math support at home but put more emphasis on numeracy
- Parents' spatial beliefs about themselves and a range of child-specific beliefs relate to their broad home math support
- Parents contribute to their children's beginning- but not end-of the year numeracy skills, but may lack an understanding of how to support math more broadly and aiding learning of all three areas
- Perhaps parents do not recognize math as more than numbers

Future Directions

- Provide parents guidance on broadening their home math support and making their efforts count for kids broad math development
- Explore the causal role of spatial beliefs (e.g., abilities and anxieties) in parents' broad math support
- Additionally consider teacher math practices in predicting preschoolers' end-of-the-year numeracy knowledge
- Determine why longitudinal links exist between numeracy support and school-aged children's math achievement
  - Does homework scaffold parents' numeracy support?







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

Zippert, E., & Rittle-Johnson

Department of Psychology and Human Development

Peabody College, Vanderbilt University

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

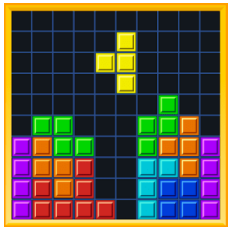
Data Analysis and Probability

National Council for the Teachers of Mathematics, 2000/2006; Sarama & Clements, 2004

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

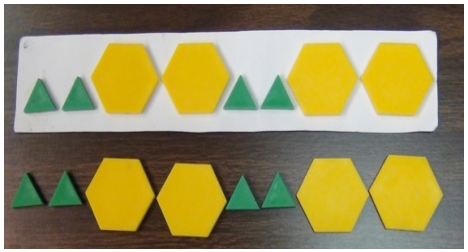
- **Aim 1**-Examine relations between pattern and spatial skills in preschoolers
- **Aim 2**-Determine how both skills predict math knowledge at the beginning and end of the preschool year

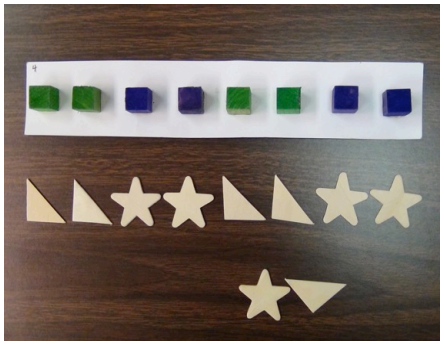
Methods and Procedure

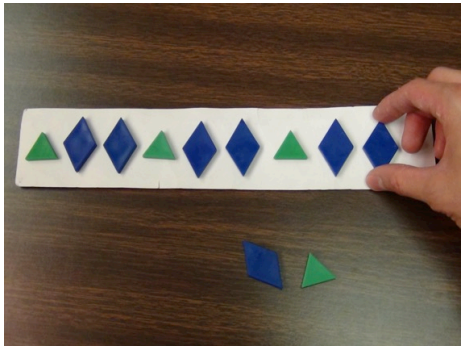
- **Sample**
  - 73 preschoolers (M_{age}= *4 yrs, 7 months)*
  - 57.5% Female; 46.6% African American, 42.5% White
  - 55% Qualified for financial assistance to attend preK
- **Time 1:** beginning of pre-K
  - **Patterning skills** (Patterns with shapes, and pictures)
  - **Spatial Skills** (Visuospatial 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)

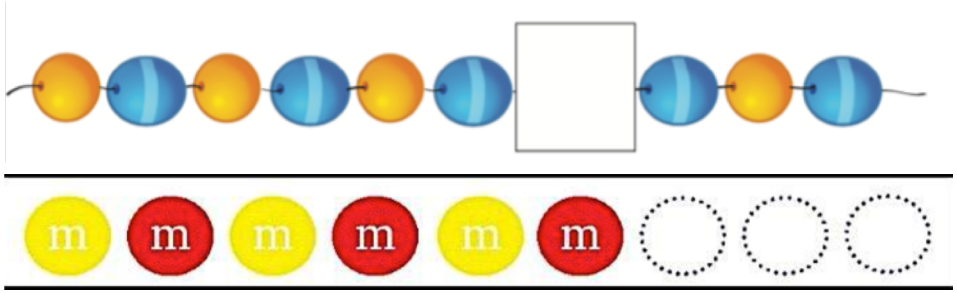
Measures

Patterning Tasks

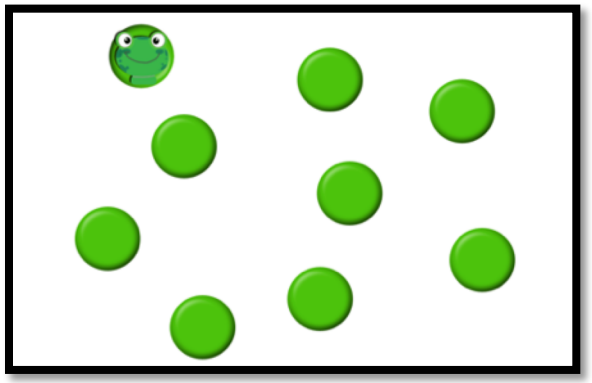


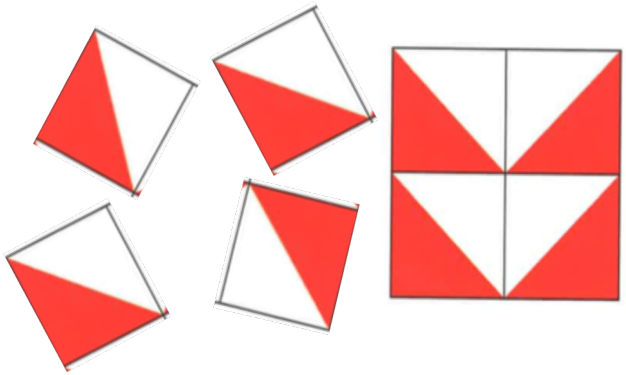


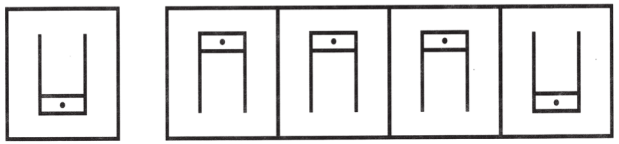




Spatial Tasks







Results

Aim 1: Relations Between Pattern and Spatial Skills

	Correlations of Composite Skills	
	Pattern	**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.

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

Measure	*B*	β	ΔR^2
Controls			**.44****
Age	-.03(.28)	-.01	
Verbal Ability	.01(.01)	.11	
Verbal WM	.16(.07)*	.26	
Spatial Skills			**.09***
Visual-Spatial WM	.02(.04)	.05	
Form Perception	.03(.02)	.14	
Spatial Visualization	.03(.03)	.11	
Pattern Skills			**.07****
Patterns with shapes	.04(.04)	.10	
Patterns with pictures	.20(.07)**	.30	

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

Measure	*B*	β	ΔR^2
Controls			.38**
Age	.52(.30)†	.17	
Verbal Ability	.01(.01)	.10	
Verbal WM	.05(.08)	.07	
Spatial Skills			.10**
Visual-Spatial WM	.08(.04)†	.20	
Form Perception	.01(.02)	.07	
Spatial Visualization	.05(.03)	.15	
Pattern Skills			.09**
Patterns with shapes	-.04(.05)	-.09	
Patterns with pictures	.28(.08)**	.40	

Aim 2: Pattern and Spatial Skills Predict Math at **Time 2 with T1 Math**

Measure	*B*	β	ΔR^2
Controls			.57**
Age	.52(.27)†	.17	
Verbal Ability	.00(.01)	.05	
Verbal WM	-.02(.07)	-.04	
Math Knowledge T1	.43(.12)**	.42	
Spatial Skills			.03
Visual-Spatial WM	.07(.04)†	.18	
Form Perception	.00(.02)	.01	
Spatial Visualization	.03(.03)	.11	
Pattern Skills			.04*
Patterns with shapes	-.05(.04)	-.13	
Patterns with pictures	.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.

Thanks!!

- Our generous funders
- Children's Learning Lab
  - Bethany Rittle-Johnson
  - Danielle Bice
  - Katherine Boice
  - Vanderbilt research assistants
- Schools, parents, and children

Children's Learning Lab
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