Patterning skill relates to some, but not all, aspects of early math knowledge

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Goal

Examine relations between patterning skill, calculation ability, and knowledge of two key math concepts (equivalence and inversion) in children.

Background

Patterns are ubiquitous in early learning environments – especially repeating patterns like big, small, big, small.

Recent research has provided correlational and causal evidence relating patterning skill to global math achievement (e.g., Kidd et al., 2014; Papic et al., 2011; Rittle-Johnson et al., 2016).

However, there are key gaps:
(1) The number of studies documenting the pattern-math relation remains small.

(2) Most studies have assessed patterning between the ages of four and six.

(3) Most studies have relied on global measures of math achievement.

We examined the pattern-math relation for children spanning a wide age range and selected math tasks that tap calculation skill and knowledge of key concepts.

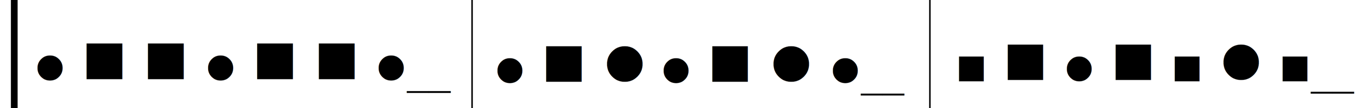
Method

36 children ranging in age from 5 to 13 (*M* age = 9.1; 47% female; 78% White) completed five tasks during two one-on-one sessions.

1. Complete a working memory task. Used the Competing Language Processing Task (CLPT).

2. Extend and explain 24 repeating patterns. Included 8 items each of three pattern types.

Same-Same	Same-Different	Different-Different
Shape: ABBABBA Size: ABBABBA	Shape: ABAABAA Size: ABBABBA	Shape: AABAABA Size: ABABABA



3. Solve 3 standard arithmetic problems.

2 + 4 + 5 + 2 = __

4. Solve and explain 6 equivalence problems.

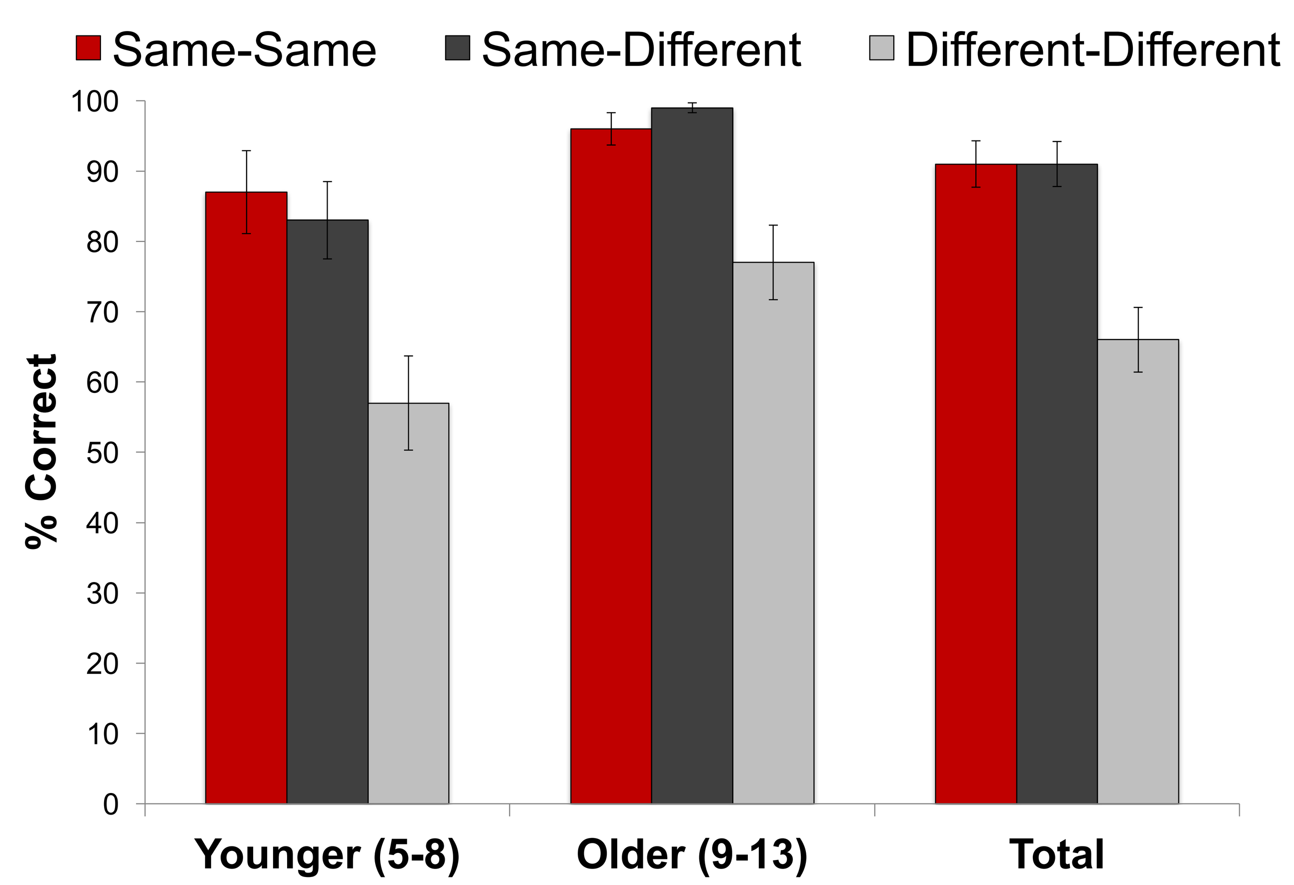
3 + 4 + 6 = 3 + __

5. Solve and explain 6 inversion problems.

4 + 7 – 7 = __

Results

Pattern Performance



Explanation Type	Example	SS	SD	DD	All
Match an Instance	After the other square there was a circle too	19	22	19	20
Labels in Order	It goes big square, little circle, little circle	40	42	30	38
Names Size/Shape	It has squares and circles in it	6	3	11	7
Pattern Word	I followed the pattern	7	7	7	7
Vague	By looking behind	11	9	14	11
No Response	Shrugs	17	16	19	17

Math Performance

Calculation Skill was high (*M* = 75%, *SD* = 36%). Based on the number of arithmetic and inversion problems solved with exact accuracy.

Concepts Score was low (*M* = 29%, *SD* = 37%). Based on inversion problems solved with a conceptual shortcut and equivalence problems solved with a conceptually-correct strategy.

Pattern-Math Relations

Patterning predicted calculation skill but not concepts scores.

Variable	*B*	*SE B*	ß
Predicting Calculation (R^2 = .60)			
Intercept	75.62	3.85	
Age	15.10	4.65	.42**
Working Memory	-0.93	4.53	-.03
Patterning	18.64	4.83	.51***
Predicting Concepts (R^2 = .26)			
Intercept	27.78	5.21	
Age	17.26	6.29	.48**
Working Memory	3.85	6.12	.11
Patterning	2.46	6.54	.07

Summary

Children did well on the pattern task – though performance was weaker on different-different trials. Older children outperformed younger children.

Children exhibited high calculation skill, but low knowledge of key concepts.

Patterning performance predicted calculation skill over and above age and WM. However, it did not predict knowledge of concepts (equivalence and inversion).

Conclusions

Theories of early mathematics learning should foreground the central role of patterning for some, but not all, aspects of early math knowledge.

Patterning may be more relevant for math knowledge that is acquired gradually via the extraction of predictable sequences in objects and numbers (like calculation skill) rather than acquired as a one-shot chunk of knowledge that one "has" or not (like concepts).

Educators should consider teaching patterns both directly (extend a pattern made out of different shapes) and indirectly (organize arithmetic practice to highlight key patterns).