

Order counts too: Both quantity and ordinal knowledge of symbolic numbers contribute to arithmetic skill for 5- to 8-year olds

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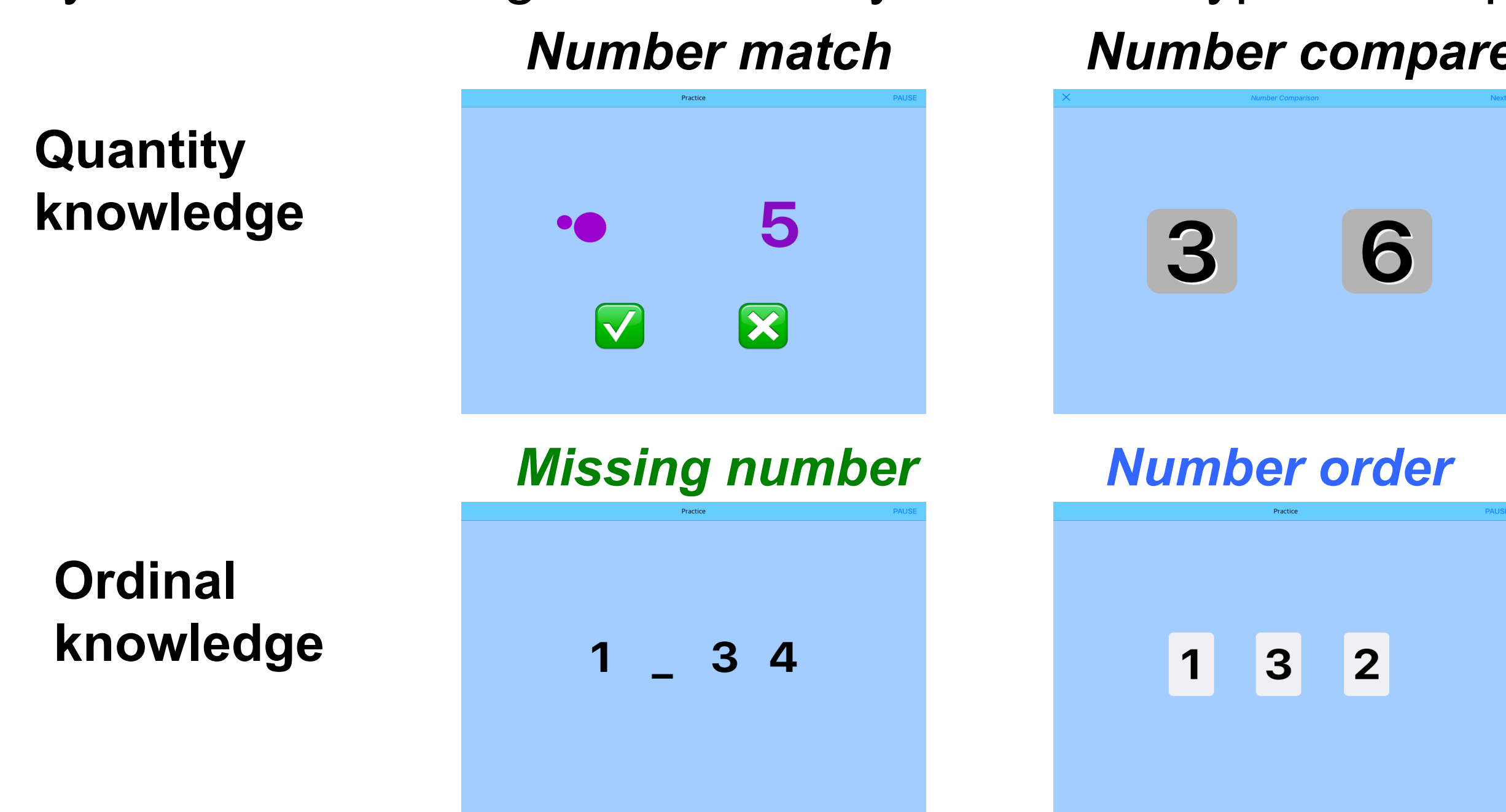
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Introduction

- Do both quantity (magnitude) and ordinal knowledge contribute to children's addition skill?
- Lyons et al. (2014) found that children's ability to judge the relative magnitude of two number symbols was a unique predictor of arithmetic skills in grade 1 and 2 whereas their ability to judge if three digits were in ascending order was a unique predictor of arithmetic skills in grades 3 to 6.
- However, the order judgment task used by Lyons et al. may not be a very sensitive measure of young children's ordinal knowledge.
- Not only was the order judgment task difficult and error prone for young children, they may use sequential **quantity comparisons** to help them decide whether numbers are in order.
- In the present research, we used two simpler ordinal tasks in an attempt to distinguish quantity from ordinal knowledge in younger children.

Method

- 70 Canadian-born children who were entering Grade 1 (n=30), Grade 2 (n=24), or Grade 3 (n=16); $M_{age} = 85$ months, 57% male.
- Note: 51 children had parents educated in China and thus our sample may have overall higher numeracy skills than typical samples.



Addition: One-minute paper-and-pencil, e.g., $2 + 5$, $7 + 8$

Results

Table 1
Partial Correlations (controlling for grade)

	1	2	3	4
1. Number match ¹	-			
2. Number compare ¹	.358***	-		
3. Missing number ¹	.384***	.624***	-	
4. Number order ¹	.371***	.757***	.706***	-
5. Addition ²	.449***	.538***	.577***	.632***

Note: *** $p \leq .001$, ** $p < .01$, * $p < .05$

1. RT on correct trials;

2. Reversed total number of correct

Table 2
Multiple Regression Analyses Predicting Addition

Predictors	β	Predictors	β
Model 1		Model 2	
Schooling ^a	-.107	Schooling ^a	-.119
Number match	.235*	Number match	.250*
Number compare	.240*	Number compare	.094
Missing number	.329**	Number order	.454**
Total R^2	.584***	Total R^2	.605***

Note: ^a The grade (1, 2 or 3) the child was to start (testing was conducted in the summer months).

Discussion

- As shown in Table 2, when **missing number** was used as the measure of ordinal knowledge (Model 1), number match, number compare, and missing number all uniquely predicted addition fluency.
- In contrast, when **number order** was used as the measure of ordinal knowledge (Model 2), number match and number order uniquely predicted addition fluency, whereas number compare did not. *Instead, number order mediated the relation between number compare and addition.*
- The number order task requires children to order numbers from smallest to largest. It is possible that this task involves sequential quantity comparison as does the ordinal judgment task used by Lyons et al. (2014). In contrast, the missing number task seems to be a more pure measure of ordinal knowledge.
- The number match task appears to uniquely capture children's mapping **between** symbols and quantities
- In summary, these results suggest that **both quantity and ordinal processing** are uniquely associated with individual differences in arithmetic skill for children as early as grade 1 when a relatively pure measure of ordinal knowledge is used.

Lyons, I. M., Price, G R., Vaessen, A., Blomert, L., & Ansari, D. (2014). Numerical predictors of arithmetic success in grades 1-6. *Developmental Science*, 1-13. <http://doi.org/10.1111/desc.12152>