Language Correlates of Achievement in Children with Math Difficulties

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OBJECTIVE

To evaluate the differential impact of two language factors on two different math achievement outcomes in school-aged children with math difficulties, some of whom also have spina bifida.

INTRODUCTION

BACKGROUND

- Many factors predict math performance; language is one such factor [4, 5], but there are inconsistencies in the relations between specific language variables and specific math outcomes.
- **Vocabulary and verbal fluency** are important language variables to measure; they both relate to math skills. Vocabulary helps students understand the semantic meaning of problems [3, 9], and verbal fluency relates to the ability to recall math facts from memory [10, 11].
- **Math fluency and word problem solving** are important math achievement outcomes to observe. They both predict successful development of more advanced math that is required for academic success [2, 5].
- **Focusing on children with math difficulties is important.** They are students for whom understanding language contributions to math is likely to be most relevant. Children with spina bifida meningomyelocele (SBM) are known to have substantial difficulties with math, even relative to reading difficulty [1, 3], though it is unknown if their math profile is similar or different from other children with math difficulties without SBM.

HYPOTHESES

- For this study, it was expected that verbal fluency would be a stronger unique predictor than vocabulary of math fluency, and conversely, that vocabulary would be a stronger unique predictor than verbal fluency of word problem solving. Both relations were expected to hold even in the context of known strong predictors of math performance (e.g., number line estimation).

METHODS

PARTICIPANTS

This study is part of a research project in the Developmental Neuropsychology Laboratory at the University of Houston, in which data was collected over the course of two years.

Sixty-eight participants were screened, though only 19 received the measures used in this study. Data from these children with math difficulties between the ages of 7 and 10 were analyzed.

- 7 were female, 12 were male.
- 6 had spina bifida myelomeningocele (SBM), 13 were neurodevelopmentally intact with math difficulties.
- 9 were Hispanic, 5 were African American, 4 were Caucasian, and 1 was of mixed race.

MEASURES AND ANALYSIS

Measures are listed in Table 1.

Table 1. Measures

Domain	Construct	Measures
Language	Verbal fluency	NIH EXAMINER [8]
Language	Vocabulary	WASI-II [13]
Math	Math fluency	KTEA-3 [7]
Math	Word problem solving	Pennies Test [6]
Math	Number line estimation (NLE)	Whole Number Line Estimation [12]

Preliminary analysis were performed to meet assumption of analysis and justify predictive analyses, which included comparing students with math difficulty, with and without spina bifida. Then, we computed zero-order correlations, followed by partial correlations (using number line estimation and age as covariates). All analyses were conducted with SAS software (Copyright ©2012 SAS Institute Inc.).

RESULTS

- Preliminary analysis showed that children with and without SBM performed comparably in all tasks (see Table 2).

Table 2. Effects of group classification on variables

Variable	F value of Group	Pr > F
Verbal Fluency	2.24	0.153
Vocabulary	2.5	0.132
Math Fluency	0.15	0.702
Word Problem Solving	0.49	0.493
NLE	1.61	0.222

Table 3 provides zero-order associations and partial correlations.

- Verbal fluency predicted math fluency more strongly than it did word problem solving among zero-order correlations. However, after controlling for age and NLE, the relation of verbal fluency to math fluency declined (from r = 0.34 to 0.23), whereas its relation to problem solving increased (from r = 0.01 to -0.20).
- Vocabulary was a moderate predictor of both math fluency and word problems among the zero order correlations, but as with verbal fluency, these relations were reduced after controlling for age and NLE, for both math fluency (from r = 0.37 to 0.24) and word problem solving (from r = 0.33 to 0.16).

Table 3. Zero order and partial correlations

	1. Verbal Fluency	2. Vocabulary	3. Math Fluency	4. Word Problems
1. Verbal Fluency	-	**0.17**	**0.23**	**-0.20***
2. Vocabulary	0.16	-	**0.24**	**0.16**
3. Math Fluency	0.34	0.37	-	**0.48***
4. Word Problems	0.01	0.33	0.67**	-
5. NLE	-0.45	-0.14	-0.48*	-0.44
6. Age	-0.07	0.37	0.39	0.45

*p<.049; **p<.009

CONCLUSIONS AND LIMITATIONS

- There was little difference between children with and without spina bifida on these measures, when selected for math difficulties.
- **Word knowledge and the ability to recall verbal facts from memory are related to math performance, but these relations were generally diminished in the presence of strong covariates.** There was not strong evidence that these language factors were differentially predictive of these particular math outcomes.
- Results stress the importance of considering the relative impacts of various neurocognitive factors for math.
- The small sample size was a factor in terms of the above correlations being significant. Future studies with larger samples are needed to further generalize these results.

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