Linguistic, Quantitative, and Executive Predictors of Learning Mathematics in a Second Language

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Introduction

- In Quebec, Canada, almost 15% of bilingual children aged 10-14 may be instructed in a language that is not spoken at home (Statistics Canada, 2016).
- Are children learning mathematics in a second language disadvantaged, or does a second language create an enriched exposure to mathematical concepts ? (Bialystok, 2009; Clarkson, 1992; Van Rinsveld et al., 2015).

Aims

- To understand how linguistic, quantitative, and executive precursors are implicated in second grade children's mathematical development.
- To clarify how developmental numeracy pathways are affected when the language of instruction is different from the language used in the home to first expose children to numeracy concepts.

Framework

- Pathways Model of Numeracy Development (LeFevre et al., 2010) : three cognitive precursors (linguistic, quantitative, and executive factors)

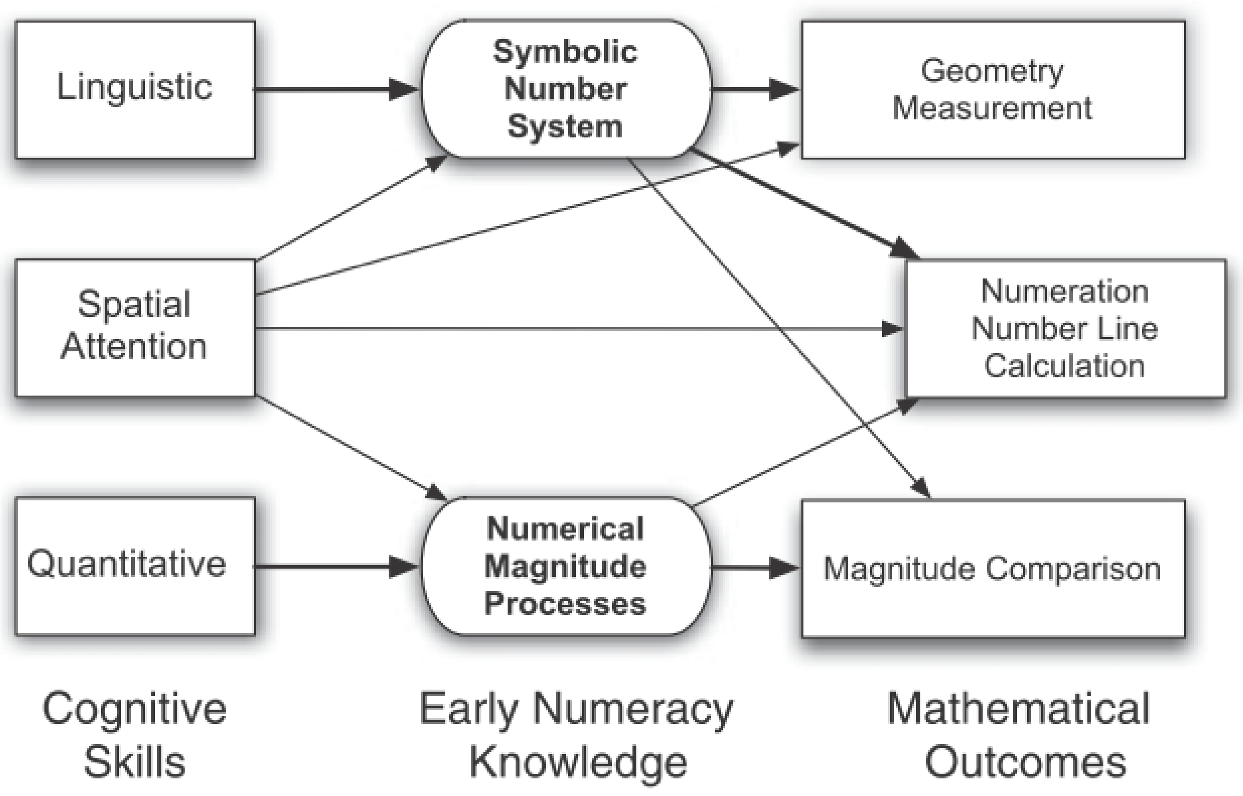

Figure 1. The Pathway model

Method

Context

- Language Learning and Mathematics Achievement (LLaMA) Project
- Collaboration with J.-A. LeFevre (Carleton University), S.-L. Skwarchuk (University of Winnipeg), J. Wylie (Queen's University Belfast), and V. Simms (University of Ulster)

Participants

- Second-grade students (*n* = 81) in 6 francophone schools in Quebec, Canada
  - Unilingual francophone (*n* = 50) receiving mathematics instruction in French
  - Bi- or multilingual (*n* = 31); Home language: English (16 students), Other (15 students)

Table 1. Sample Descriptive Statistics

	Unilingual Children	Bilingual Children	*t*-test	χ^2
Age in months	95.0 (5.4)	95.7 (4.8)	Non significant	
Gender	Male: 46% Female: 54%	Male: 35.5% Female: 64.5%		Non significant
Family Income	Very low: 20% Low: 20% Medium: 15% High: 10% Very high: 35 %	Very low: 12% Low: 22% Medium: 11% High:22% Very high: 33%		Non significant

Procedure

- Individual testing sessions (1 - 1.5 hours)
- Measures:
  - Outcomes: Number line estimation, arithmetic fluency, and word-problem solving
  - Measures: Cognitive Predictors
    - *Linguistic*: Vocabulary, reading
    - *Executive*: Verbal short-term and working memory, visuospatial short-term and working memory
    - *Quantitative*: Subitizing
  - Symbolic Math Predictors
    - *Linguistic & Quantitative*: Math vocabulary
    - *Quantitative*: Number comparison

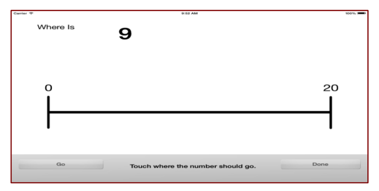

Figure 2. Number line estimation task

Results

Comparison *(t-tests)*

Table 2. Mathematics outcomes statistics

	Comparison	*t*-test
Number line position	*bilingual > unilingual*	.082
Arithmetic fluency	bilingual = unilingual	.220
Word-problem solving	bilingual = unilingual	.454

Prediction

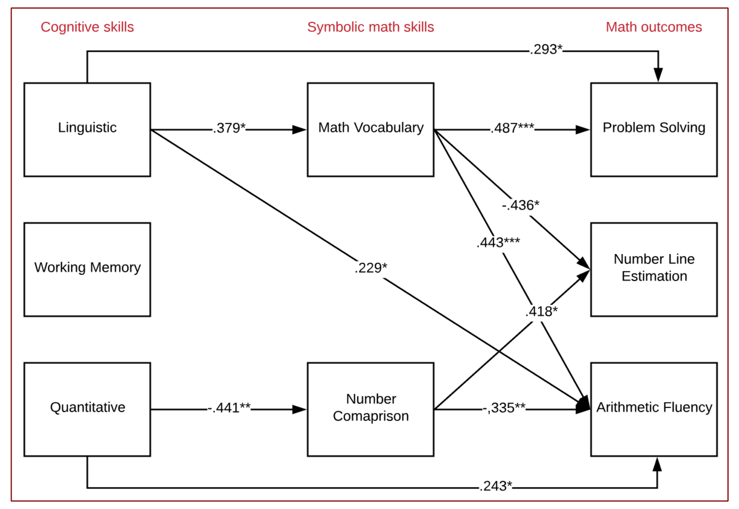

Figure 3. Unique predictors of symbolic math predictors and mathematical outcomes for children who spoke French as their first language

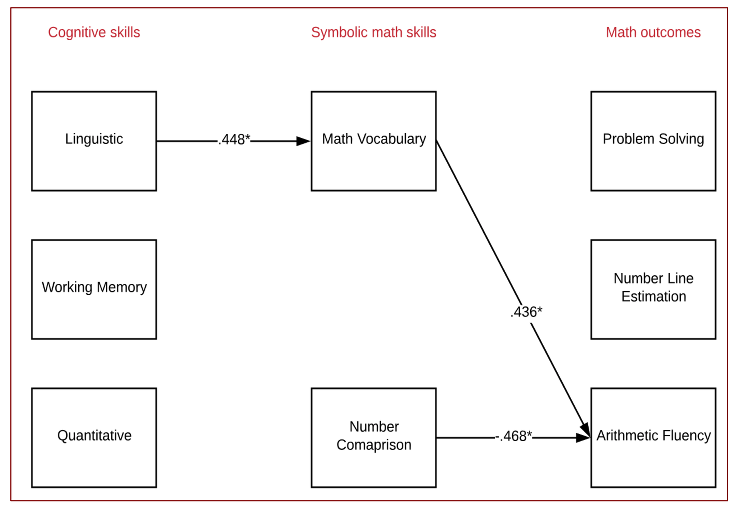

Figure 4. Unique predictors of symbolic math predictors and mathematical outcomes for children who did not speak French as their first language

Discussion

- Math vocabulary is predictive in arithmetic fluency, regardless of language group.
- Math vocabulary is predictive in number line estimation and in word-problem solving in unilingual children.
- Next steps:
  - To compare our pattern of results with those of Ottawa and Winnipeg
  - To establish developmental patterns by testing the same children one year later (2018-19)

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