Precursor Math Skills and Arithmetic Performance: Comparing Bilinguals and Monolinguals

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Research Questions

1. How do foundational skills (digits, number words, quantities) relate to each other?
2. How do foundational skills correlate with arithmetic performance?
3. Do monolinguals and bilinguals process math foundational skills and arithmetic differently?

Introduction

4th grade Math national assessment scores comparing English Language Learners (ELLs) with English speakers

- Above disparity due to complicated grammar and low-frequency words in test items
- Research comparing math processing in monolinguals and bilinguals
  bilinguals slower when transferring calculations between languages
  no research on comparing foundational skills, or connections between them
- Language processing in bilinguals
  explained by the Bilingual Interactive Activation Plus (BIA+) model shown below
  no need for this in monolinguals

Before Experiment

- Language Exposure & Proficiency Questionnaire
- Number production test to check knowledge

Experiment

- 10 foundational skill relation tasks
- 1 single digit arithmetic task

Measures

- Behavioral variables
  reaction time
  accuracy
- Eye-tracking variables
  fixation time and count
  overview looking and dwell time
  pre-response processing time

After Experiment

- Math Processing and Strategies Survey

Methods

Figure 1: Quantity ↔ Auditory Number Word Task

Figure 2: Auditory Number Word ↔ Digit Task

Figure 3: Quantity ↔ Digit Task

Figure 4: Digit ↔ Visual Number Word Task

Methods (continued)

Figure 5: Arithmetic Task

Participants

Primary language of math instruction matters

Expected Results

- The above trajectory is based on this order:
  1. Basic quantity knowledge (1-4) is innate
  2. Children hear number words at home (TV)
  3. They learn to write numbers in school
  4. They learn to spell number words

- Foundational skills and arithmetic performance will be correlated in the same order as above:
  - Early skills will be strongly correlated
  - Late skills will be weakly correlated

- Bilinguals who learned math in English will have faster or similar processing to U.S. monolinguals due to better metalinguistic awareness

- Bilinguals will react slower than monolinguals due to additional processing (BIA+ model)

References