Relations Between Math and Spatial Abilities for English- and Chinese-Speaking Adults

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Introduction

- Math and spatial abilities are correlated in children and adults.
- Spatial measures tested include mental rotation, visuo-spatial working memory, and spatial visualization (Mix & Cheng, 2012).
- However, there is little evidence for relationships between math and other spatial abilities, such as perspective taking skills.
- We investigated whether a spatial orientation task is related to mathematical measures varying in complexity.
- Working memory is also related to math performance, but this may vary across math tasks.
- Chinese- and English–speaking adults differ in math skill; Do the relations between spatial and working memory skills also vary across groups?

Hypotheses

- Spatial orientation will predict participants' performance on more complex math problems, such as problems that are related to fractions (Mix & Cheng, 2012), but not on one-digit or two-digit arithmetic.
- Chinese-speaking participants will rely more on phonological code to access arithmetic facts considering their familiarity with numerical calculations obtained from their educational background.

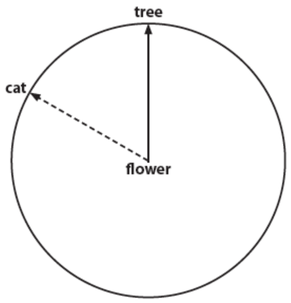
Method

Participants. 123 adults: 57 native English speakers, and 66 native Chinese speakers (N = 123).

Measures

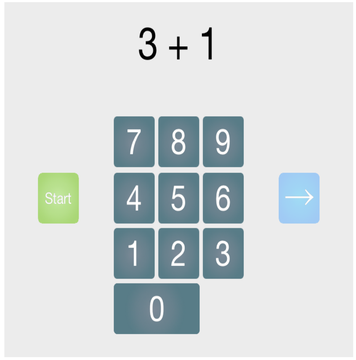
1. Spatial Orientation Test

Imagine you are standing at the **flower** and facing the **tree**. Point to the **cat**.

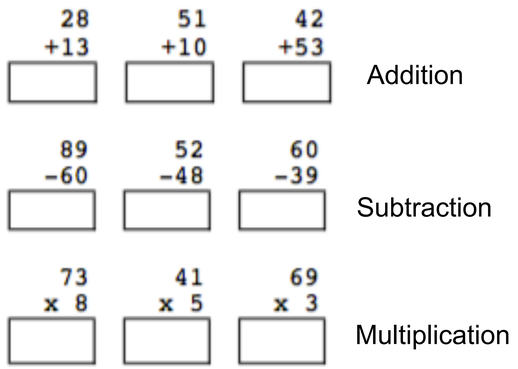


2. Working Memory tasks (digit forward, digit backward)

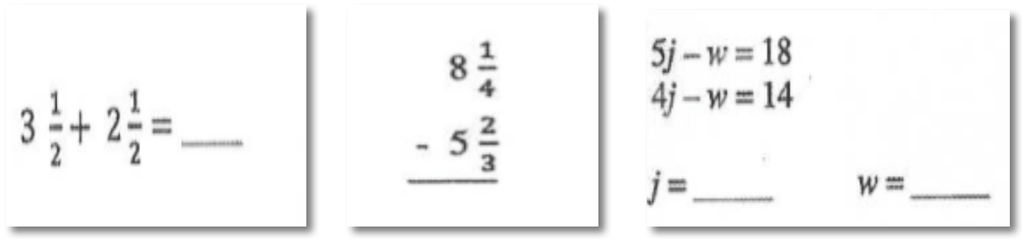
3. Simple Arithmetic Task



4. Computational Fluency Test



5. Brief Math Assessment.



Results

Table 1: Regression Analyses Predicting Different Math Measurements Varying in Complexity for English Native Speakers

	Dependent Variables		
Predictors	Simple Arithmetic	Computational Fluency Test	Brief Math Assessment
Spatial Orientation (absolute error)	-.005	-.18	**-.24*** (p = .06)
Digit Forward	-.02	.07	.09
Digit Backward	.16	**.32***	**.29***

* p < .05. Values are standardized beta coefficients.

Table 2: Regression Analyses Predicting Different Math Measurements Varying in Complexity for Chinese Native Speakers

	Dependent Variables		
Predictors	Simple Arithmetic	Computational Fluency Test	Brief Math Assessment
Spatial Orientation (absolute error)	.01	-.05	**-.25***
Digit Forward	**-.33***	**.38***	**.25***
Digit Backward	.23	**.23*** (p = .06)	.13

* p < .05. Values are standardized beta coefficients.

Discussion

- Spatial orientation task predicted only the most complex math measure (i.e., Brief Math Assessment) for both groups, possibly because both measures require proportional reasoning.
- In all three math tasks, the performance of Chinese-speaking participants was related more strongly to the phonological loop than to the central executive, whereas that of English-speaking participants was only related to the central executive. This pattern may reflect differences in familiarity and automaticity of math problem solving across the two cultural groups.

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