



# Which Aspects of Fractions Knowledge Support Knowledge of Algebra Concepts, Procedures, and Flexibility?



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## Background and Research Question

- Some studies show that understanding fraction *magnitude* is most helpful for algebra. (e.g., Booth et al., 2014)
- Other studies show that fraction *arithmetic* drives the fractions-algebra relation. (e.g., Barbieri et al., 2021)

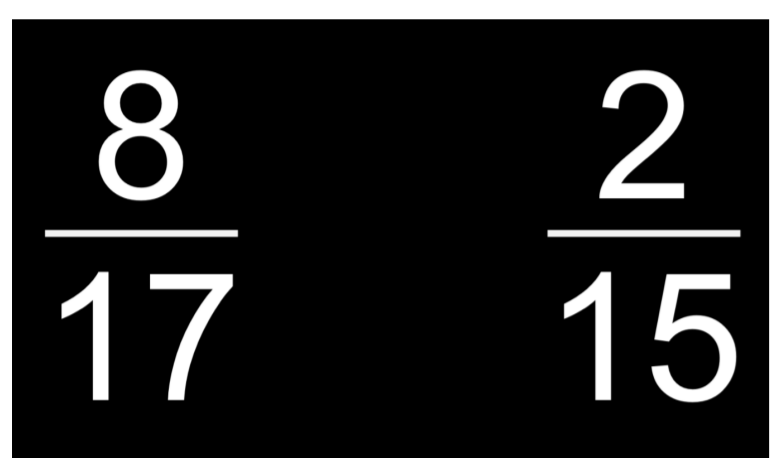
**Does it depend on which aspects of algebra knowledge?**

## Method (N = 86 Undergraduates)

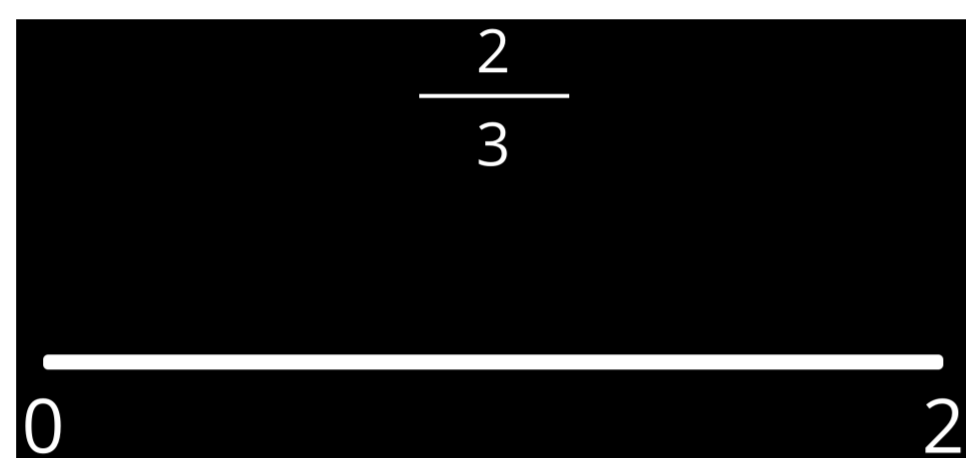
- Fraction Magnitude (Fazio et al., 2016; Hansen et al., 2015)
- Fraction Arithmetic (Kalra et al., 2020)
- Algebra Assessment (Rittle-Johnson & Star, 2008)
- Math Anxiety (MARS-R) (Hopko, 2003)
- MATH & English (ENGL) college entrance exams

## Aspects of Fractions

**Magnitude:** composite Z-score



Comparison



Number Line Estimation (0-1, 0-2, 0-5)

**Arithmetic:** % accuracy on 12 problems

$$\frac{2}{5} + \frac{5}{4} + \frac{9}{8} = \frac{3}{5} + \left(\frac{3}{10} \times \frac{4}{15}\right) =$$

$$1\frac{1}{5} - \frac{3}{5} = \frac{6}{55} \div \frac{3}{25} =$$

## Algebra Concepts (8 items)

Which example could represent a linear function?

x	-3	0	3
y	4	6	8

$\frac{5}{x} + y = -7$

x	1	3	5	3
y	4	2	0	-2

$x + \frac{2}{y} = 4$

## Aspects of Algebra

### Algebra Procedures (7 items)

Solve the equation for y. Show your work on paper and type your answer here.

$$5(y - 2) = -3(y - 2) + 4$$

### Algebra Flexibility (5 items)

Below is the beginning of Gabriella's, Jamal's, and Nadia's work in solving  $x + 7 - 3 = 12 - 2x$ .

Gabriella's way: Subtract 3 from 7: $x + 4 = 12 - 2x$	Jamal's way: Add 2x to both sides: $3x + 7 - 3 = 12$	Nadia's way: Subtract (7 - 3) from both sides: $x = 8 - 2x$
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To start solving this problem, which way(s) may be used?

## Hypotheses

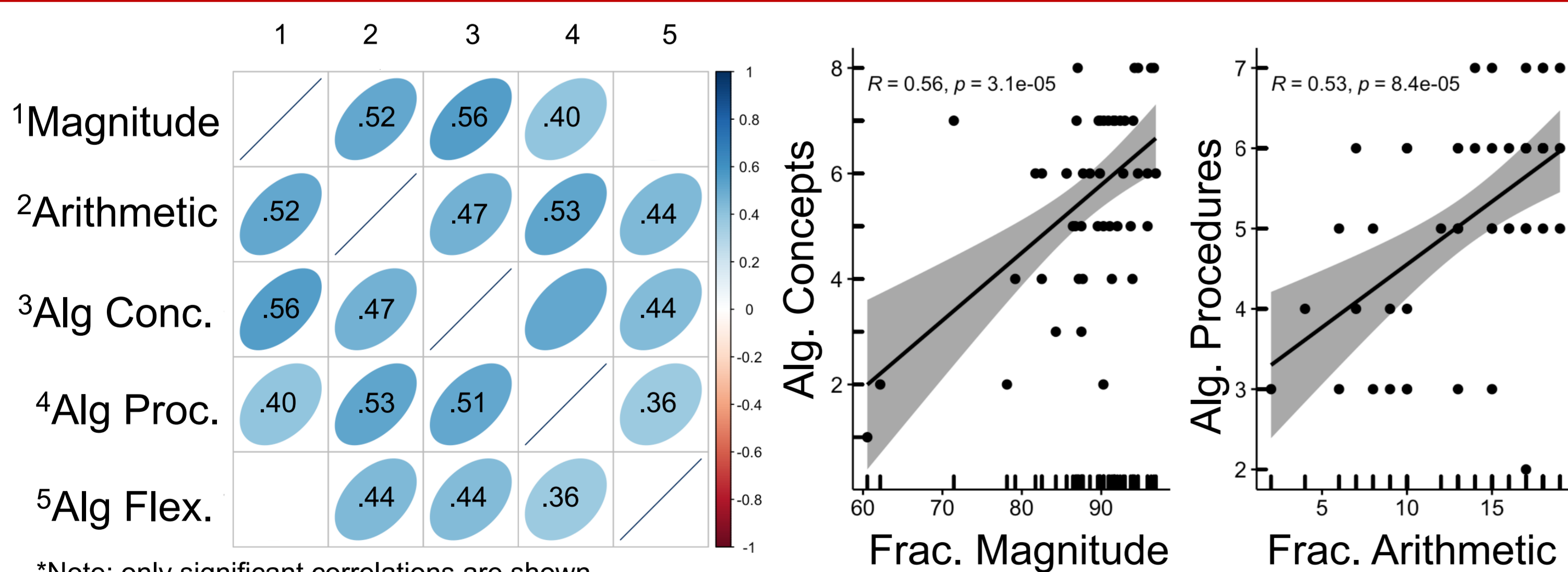
### 1. Magnitude → Algebra Concepts

- To understand fraction magnitudes, students must have strong conceptual knowledge of fractions.
- Fraction magnitude knowledge predicts algebra performance (Booth & Newton, 2012) & learning (Booth et al., 2014)

### 2. Arithmetic → Algebra Procedures & Flexibility

- Fraction arithmetic and algebra problem-solving require similar skills and are associated. (Barbieri et al., 2021; Hurst & Cordes, 2018)
- Flexible fraction arithmetic skills may support algebraic flexibility.

## Results: Correlations

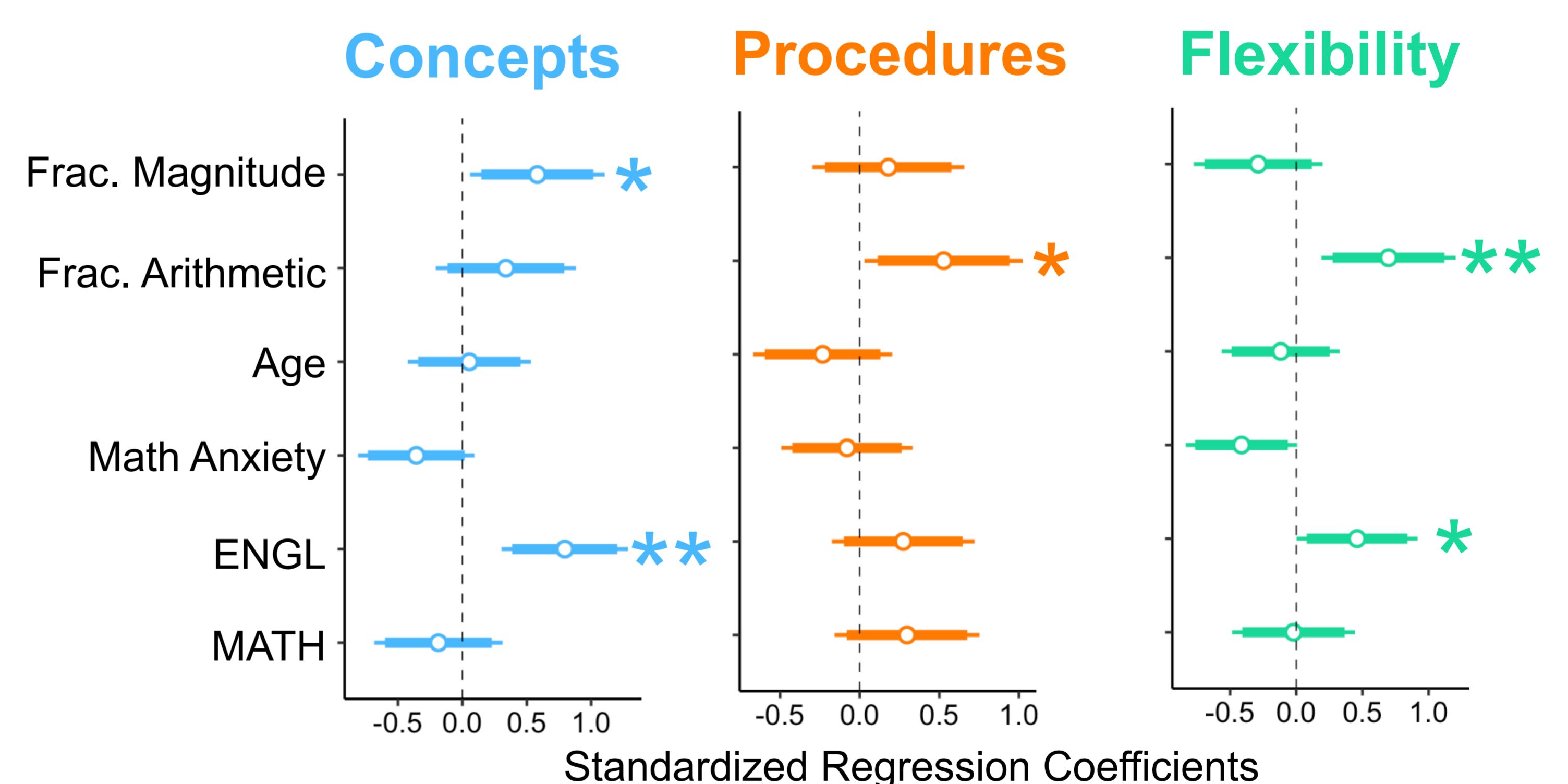


\*Note: only significant correlations are shown.

Almost all fractions & algebra tasks were correlated.

## Results: Predicting Algebra

Controlling for age, math anxiety, and overall math and English achievement, which fractions scores still predict algebra scores?



- Fraction *magnitude* scores predicted *conceptual* knowledge of algebra ( $p = .03$ ).
- Fraction *arithmetic* predicted algebraic *flexibility* ( $p = .04$ ) and *procedural* knowledge ( $p < .01$ ).

## Discussion

- College students' fractions knowledge predicted algebra scores, but these relations were specific rather than global.
- Fraction magnitude knowledge and arithmetic proficiency may influence algebra through distinct mechanisms.
- English scores had a stronger effect on algebraic concepts and flexibility than fractions or math achievement.
- More work is needed to understand (1) the development of these relations and (2) the mechanisms driving them.