

## Introduction

In terms of cognition and arithmetic, rational numbers have not been studied as closely as integers. Most studies on fractions and decimals involve comparison tasks, whereas percentages are discussed extremely rarely in the literature. Despite this gap, rational numbers are a part of daily life.

In a 2016 pilot, we studied how participants answered mixed rational-whole multiplication questions involving fractions and percentages, formatted as:

x of y

Where x is a rational number, and y is a whole number. While the design of this pilot was flawed, it raised several interesting questions.

- 1. Are different rational number formats processed differently? 2. How does the problem size effect (PSE) present in rationals?
- 3. Do these two factors interact?

Because these questions are underexplored in the literature, we conducted a more complete investigation of the processing of differing rational number formats.

## Method

**Participants**: 36 students (50% female) completed 54 problems presented on a computer screen. Latencies, errors, eye-movements, and solution strategies were recorded. Standard math ability tests were also completed.

**Problem Set**: The problems took the form 'x of y'. A set of 54 problems was constructed using three variables:

- Three rational number formats (fraction / decimal / percentage)
- Six sizes of proportion (0.1, 0.25, 0.5, 0.6, 0.75, 0.9)
- Three sizes of *y*-value (20, 40, 60)

Example questions: 75% of 40, 0.1 of 20, 6/10 of 60

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# Fractions, Decimals, Percentages: **Rational Numbers in Cognitive Arithmetic**

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## Results

- No main effect of format, but
  - Small proportion proble
  - Largest PSE for fract
- Large proportion problems larger whole-number opera
  - The PSE was related
  - Effects mediated by co
- A complication: strategy us
  - Strategy choice varie also converted betwee
- When the participants' first lasted longer than on a per
  - Supports the view that process than decima Cordes, 2017).



□Fraction □Decimal □Percentage

### http://carleton.ca/cacr/math-lab/



& Discussion			
out		12 -	F
lems were easier as fractions (Fig	g. 1)		
tions (Fig. 1); smallest for perc	ents	10 -	
s were more difficult when paired with a and (Fig. 2)		8 -	
to the sizes of both operands			
onceptual knowledge, rather than speed		6 -	
sage was broad $\rightarrow$ 5+ distinct strategies			
ed across formats, and participants en formats on the fly. (Fig. 3)		4 -	
t fixation was on a fraction, that fixation rcentage.		2 -	
t <b>fractions may be more difficu</b>	lt to	0	
als/percentages (DeWolf et al., 2014;	Hurst &	v	
Simplify Logic Full-co	omput ati on	12 -	
e 3. Strategy choice varied by format.		10 -	





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Format



Error bars: 95% CI

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