

Introduction

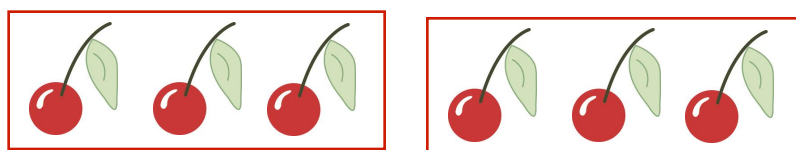
Whole Number Division: A Foundation

- Whole number division understanding supports later learning of fractions (Siegler & Pyke, 2012), and also supports high school math achievement (Siegler et al., 2012).
- Both children (Sidney & Alibali, 2013) and adults (e.g., Ma, 1999) struggle to represent fraction division concepts. They may have inadequate models of whole number division with which to support fraction division.

Do children rely on models of whole number division that would support conceptual understanding of fraction division?

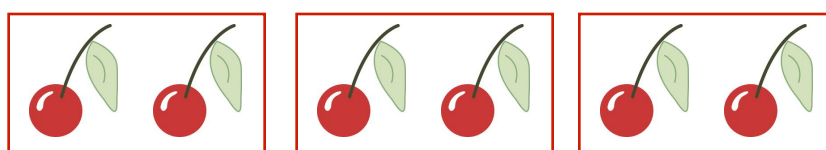
Models of Whole Number Division

Partitive $6 \div 2$ as 6 in 2 groups



- Easier with whole numbers for 5th, 7th, and 9th graders (Fischbein et al., 1985)
- May build on early sharing practices (e.g., Squire & Bryant, 2002), so more intuitive? (Correa et al., 1998)

Quotative $6 \div 2$ as 6 in groups of 2



- Easier with rational numbers (Fischbein et al., 1985)
- Hypothesized to support conceptual understanding of fraction division

Measurement: Context Matters

- Children display different levels of knowledge in different contexts (e.g., Prather & Alibali, 2009).
- Differences in contexts may also elicit variability.

Method

Participants

11 3rd-graders, 7 4th-graders, & 12 undergraduates

Study Design

- Part of ongoing study of children's *operation sense*
- Addition, subtraction, multiplication, and division of small whole numbers in three contexts
- 4 (operation) x 3 (context) = 12 problems in total
- Focus here: division trials only

Whole Number Division Contexts

| | Problem | Materials |
|-----------------------|-------------|--|
| Show with Objects | $15 \div 3$ | Counting Chips |
| Tell a Story | $25 \div 5$ | Pictures of Scenarios |
| Show on a Number Line | $18 \div 6$ | A printed number line, numbered from 0 to 20 |



Coding

- **Partitive** model: participant used given divisor as number of groups or iterations of a measurement.
- **Quotative** model: participant used given divisor as size of each group or measurement to be iterated.
- **Success**: Correct modeling of dividend, divisor, and quotient

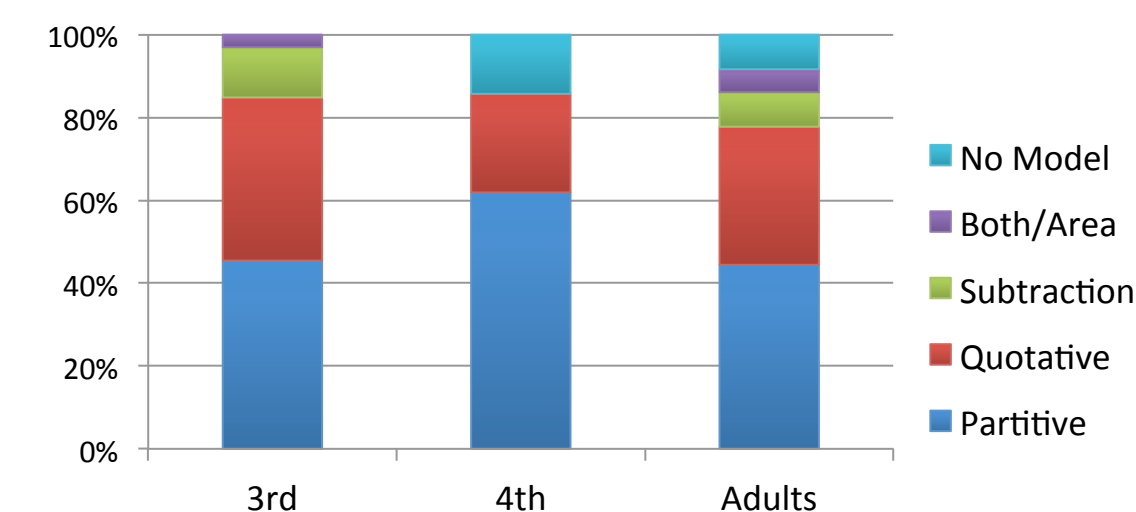
Results

Overall Success

| | 3 rd Grade | 4 th Grade | Adults | Overall |
|-------------|-----------------------|-----------------------|--------|---------|
| Object | 100% | 100% | 58% | 87% |
| Story | 45% | 88% | 75% | 67% |
| Number Line | 64% | 29% | 75% | 60% |

Reliance on Each Model Across Age Group

Participants at all ages spontaneously used both partitive and quotative models of division.

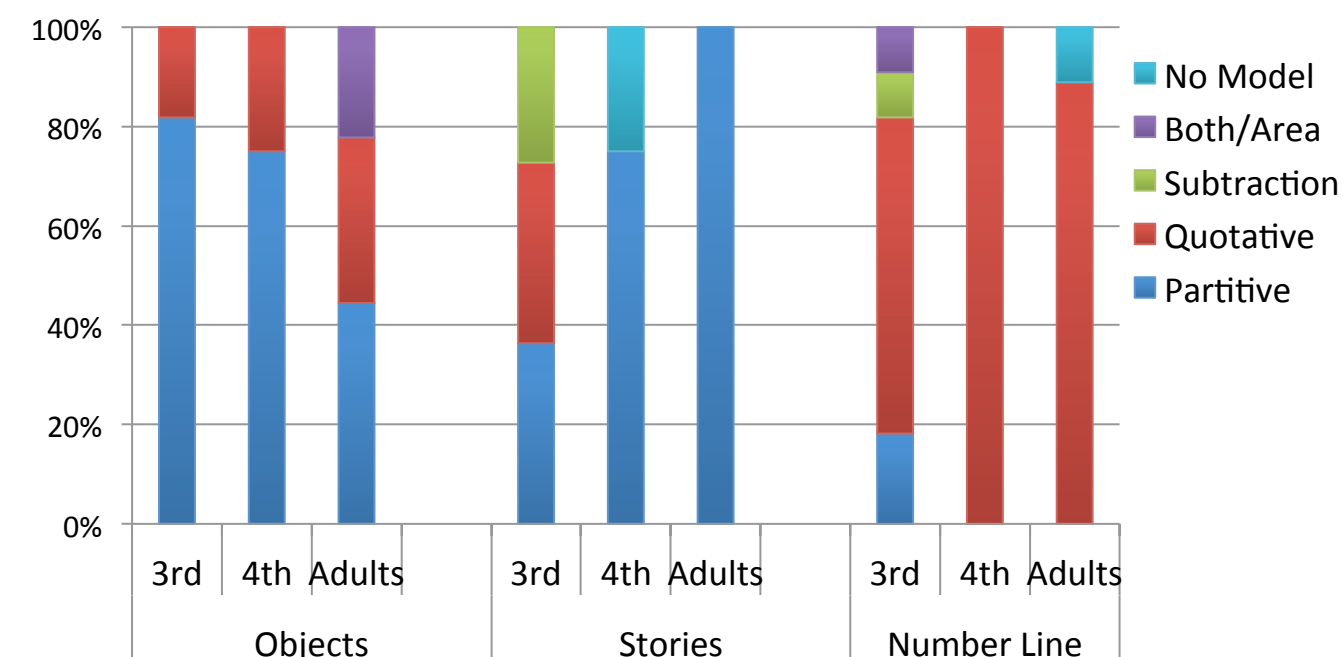


Consistency in Model Use Across Contexts

- No 3rd grader relied consistently on a single model.
- 3/7 4th graders relied only on a partitive model.
- 3/12 adults relied on a single model across contexts: one partitive, one quotative, and one subtraction.

Variability in Model Use Across Tasks

- Developmental difference in model use across contexts



Discussion

Consistency or Variability?

- Contrary to previous findings (e.g., Squire & Bryant, 2002), most participants did not consistently rely on the partitive model for whole number division.
- Even the youngest children drew on quotative models across a variety of contexts, and demonstrated variability in their knowledge.
- In the easier, object context, older participants relied on the quotative model more often than younger children.
- In the more difficult, story context, older participants relied on a partitive model, and were much more successful.
- Finally, the number line context supported quotative models more than the other contexts.

Implications

Do children rely on models of whole number division that would support fraction division?

- Yes! Many children spontaneously drew on **both** partitive and quotative models of division.
- Fraction division instruction could be designed to better draw on children's existing models of division.
- Number lines may help children better understand quotative or measurement division. Assessing children's understanding in multiple contexts allowed us to see this.

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