Exploring Syntactic Effects on Children's Large Number Generativity

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Introduction

Large exact number acquisition has been shown to rely on the use of language and formal mathematical schooling:

- The Pirahã Amazonian tribe do not have number words or singular-plural distinction in their language and cannot represent large numbers exactly (Frank et al., 2008)
- The Mundurukú, have number words up to only five - while they can accurately approximate groups of objects above their numeral range, they are unable to provide exact numbers for those objects (Tosto et al., 2014).

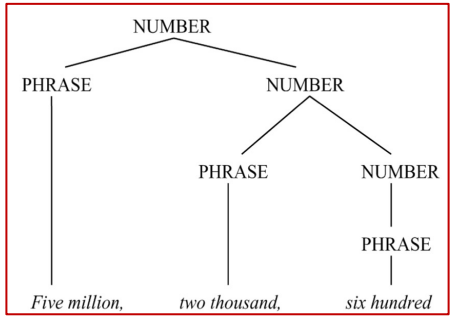
Study Aim: Determine the influence of the numeration system on children's large number representation and generation across development

Numerical Syntax

Provides an algebraic representation of large numbers

- **multiplicative merge:** merge between a number and multiplier (ex. three thousand)
- **additive merge:** merge between a phrase and a number (ex. thirty-three)

Phrase Structure Rules (Hurford, 2007):

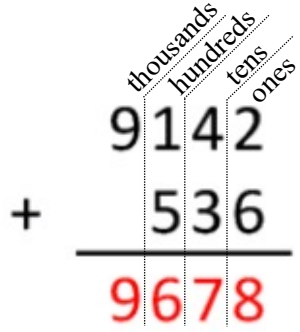


Arabic Numerals

Provides an algorithmic representation of large numbers

- Arabic numerals are based on a place value system
- This allows children to isolate power dimensions (ones, tens, hundred, etc.), making mathematical operations easier

Dimensional Representations:



Methods

- An online asynchronous study was shared on a scientific platform Lookit!
- *N*=91 (age: 4-8 years).

Arabic (8 Trials):

"write a larger number!"

Verbal (8 Trials):

"say a larger number!"

Results

Figure 1.
Do children change the syntactic structure of the probe in their response? (ex. 500 → 501)

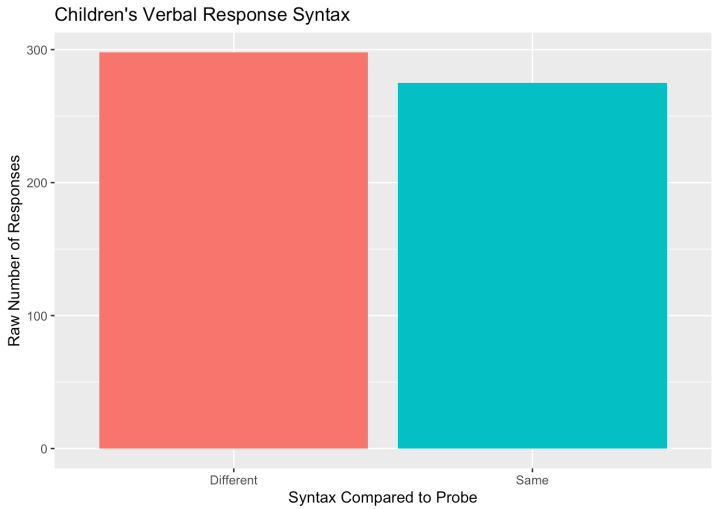
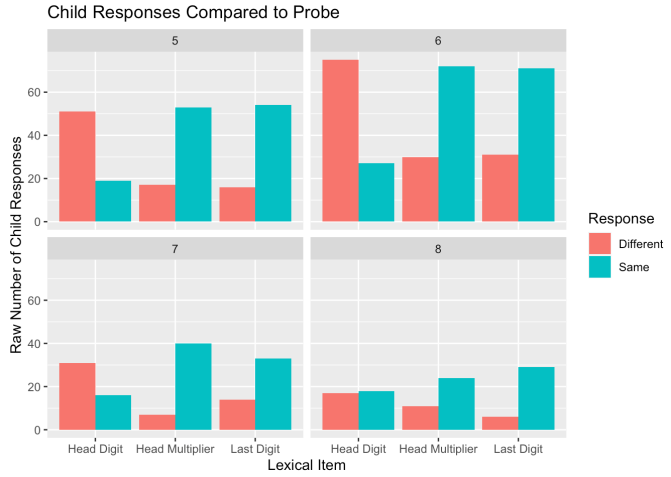


Figure 2.
When children keep the syntactic structure the same, what do they change? (ex. head digit: 500 → 600)



Conclusions

- Many children retain the syntax of the probe indicating a linguistic representation of numbers.
- Children are more likely to change the head digit than the head multiplier or last digit when they retain the same syntactic structure ($X^2 = 139.17$, df = 2,

Future Directions

- Future analysis may include computing conditional probabilities for child response given probe (ex. # of additive merges, multiplicative merges, etc.)
- Plans for more causal methods - training on complex numerical syntax to see if that influences and assists earlier acquisition of large number concepts.

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References

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- Frank, M. C., Everett, D. L., Fedorenko, E., & Gibson, E. (2008). Number as a cognitive technology: Evidence from Pirahã language and cognition. *Cognition*, *108*(3), 819-824.