

MULTIMODAL NUMERICAL INTERACTIONS DURING MOTHER-CHILD PICTURE BOOK READING

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INTRODUCTION

In everyday activities, adults and children deploy a multiplicity of semiotic modes (Kress, 2010) in order to represent, communicate, and solve problems with and about numbers. Picture book reading is a source of experiences in which social and semiotic mediation intertwine to offer a meaningful and playful context for communication and reflection about numbers.

Little work has centered on the number concepts and skills that parents and their children spontaneously put into play during shared reading interactions (Anderson et al., 2005; Goldstein et al. 2016; Mix et al., 2012; Uscianowski et al., 2020). The current study builds upon these studies in a number of ways. Prior research has focused on:

- ✓ Analyzing shared reading during the first year of life and around the fourth, remaining still a deep examination of the critical period of early childhood in number development.
- ✓ Identifying parents' contributions to the reading sessions. However, children's in-the-moment cognitive engagement, such as their spontaneous focus of attention and their ways and means to participate, is as important as adults' numerical input and support.
- ✓ Analyzing the numerical content of parent-child interactions, without regard of the various semiotic modes (gestures, collections of objects and images of them, numerals and math notations) used to mediate interaction.

OBJECTIVE

The focus of the study is on the frequency and type of number talk of Argentinean mothers and their 2.5- and 4-year-old children during picture book reading.

This purpose is addressed by taking a finer-grained approach to mother-child shared numerical interactions, analyzing them as a function of children's age and the size of the sets depicted in the book (1-9).

METHOD

Participants. 23 mothers ($M_{\text{age}} = 32.22$ years) and their children, 13 2.5-year-olds ($M_{\text{age}} = 29$ months) and 10 4-year-olds ($M_{\text{age}} = 48.10$ months). The majority of the mothers had post-secondary education.

Materials and procedure. A specially designed book of cardboard pages, with sets presented in consecutively ascending order. Dyads were asked to "Share this book as you normally would".



Coding. An utterance was defined as a conversational turn or series of turns referring to a same subject, with meaningful content in the context of shared reading. For the analysis of the utterances pertaining to number, a coding system was developed considering categories that had been elaborated in previous research (Ramani et al., 2015; Saxe et al., 1987), as well as the analysis of the empirical evidence obtained by the constant comparative method (Glaser & Strauss, 1967).

Four types of numerical utterances emerged from the reading sessions and constituted the *basic categories* of the observational code. For each of these categories, we created a *subset of codes* that reflect: (a) the interplay between numerical elaborations and the semiotic modes that support them; (b) who participated in the utterance (mother, child) and how they did it.

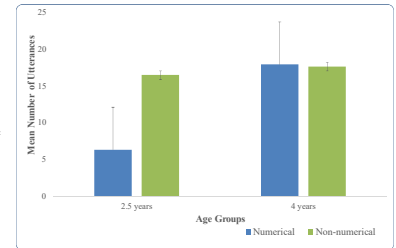
Categories	Subcategories
Recognition of numerals	Number: mothers or children use the word "number" to label any numeral. Numeral: mothers or children label a numeral with its corresponding number word.
Enumeration	Nominal: children use labels (numerical and non-numerical) to serve an enumerative function, without an intention to quantify the set. Cardinal: mothers or children use number word-to-object correspondences in a count to refer to cardinal values of sets.
Quantification	Number words: mothers or children use number words to communicate the cardinality of a set, without counting. Bimodal (number word and gesture): mothers or children use a number word together with a representational finger gesture to communicate the cardinality of a set. Global: mothers or children quantify a set as if it were a plurality, without communicating an exact cardinal value.
Comparison	Direct: mothers compare or encourage their children to compare two sets in the book based on their exact cardinal values or their global set sizes. Indirect: mothers compare or encourage their children to compare the cardinal value of a set depicted in the book with another cardinal value not depicted in the book.

RESULTS

How frequent is mother-child spontaneous talk about numbers during picture book reading, at children ages 2.5 and 4?

A mixed measures ANOVA looking at the within-subject factor of Utterance Type and the between-subjects factor of Age Group on the total number of utterances revealed:

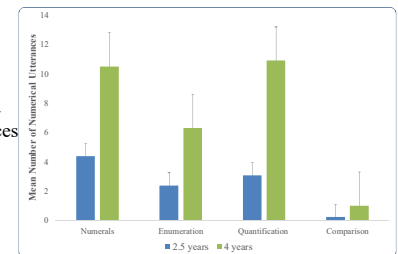
- ✓ a main effect of Utterance Type [$F(1, 21) = 20.66, p < .001, \eta_p^2 = .496$]: across age groups, dyads made significantly more non-numerical ($M = 12.10$) than numerical utterances ($M = 17.03$);
- ✓ an Utterance Type x Age Group interaction [$F(1, 21) = 23.25, p < .001, \eta_p^2 = .525$]: only 2.5-year-olds' dyads made significantly more non-numerical utterances (Bonferroni, $p < .001$); 4-year-olds' dyads made a comparable number of non-numerical and numerical utterances ($p = .856$).



What is the nature of the numerical talk dyads put into play while reading the book? Are there differences in numerical talk as a function of children's age?

A mixed measures ANOVA revealed:

- ✓ a main effect of Number Utterance Type [$F(3, 63) = 12.82, p < .001, \eta_p^2 = .379$]: across age groups, there were a few instances of comparison utterances ($M = 0.27$), significantly less than recognition of numerals ($M = 4.79$), quantification ($M = 3.51$), and enumeration utterances ($M = 3.51$) (Bonferroni, p 's $< .001$).



- ✓ a Number Utterance Type x Age Group interaction [$F(3, 63) = 2.85, p = .044, \eta_p^2 = .120$]. In the 2.5-year-olds' group, follow-up analyses did not indicate significant differences between the four types of numerical talk (Bonferroni, p 's $> .05$). In the 4-year-olds' group, there were significant differences between comparison and the other three types of number talk (p 's $< .001$), without differences between recognition of numerals, quantification and enumeration (p 's $> .05$).

Recognition of numerals	4-year-olds' utterances about numerals involved using the corresponding number word for each number symbol ($M_{\text{Numerical}} = 1.20$; $M_{\text{Nonnumerical}} = 5.70$) [$t(9) = -3.55, p = .006$]; these dyads used significantly more numeral labels than 2.5-year-olds' dyads [$t(21) = -2.66, p = .014$].
Enumeration	In the 4-year-olds' group, there were less nominal ($M = 0.30$) than cardinal enumerations ($M = 4.80$) [$t(9) = -3.95, p = .003$]. Comparisons between age groups indicated differences in cardinal enumeration [$t(21) = -3.88, p = .001$], and not in nominal enumeration [$t(21) = 1.43, p = .165$].
Quantification	With age, there was an increase in the number of quantifications, particularly bimodal (2.5 and 4 years, $M = 0.31$ and 4.80, respectively) and global quantifications ($M = 0.77$ and 3.20). However, there was not an increase in the quantification utterances with number words ($M = 0.46$ and 0.30).

Does numerical talk during picture book reading varies as a function of set sizes, categorized as small (1-3), medium (4-6), and large (7-9)?

A mixed measures ANOVA looking at the effects of Set Size, Number Utterance Type, and Age Group on the total number of numerical utterances revealed:

- ✓ a main effect of Set Size [$F(2, 42) = 7.41, p = .002, \eta_p^2 = .261$]: across types of numerical utterances and age groups, dyads talked more about small collections ($M = 0.63$) than medium ($M = 0.43$) (Bonferroni, $p = .017$) and large ones ($M = 0.44$) ($p = .022$).
- ✓ a significant interaction between Set Size, Number Utterance Type and Age Group [$F(14, 294) = 2.44, p = .003, \eta_p^2 = .104$]. Follow-up comparisons showed an impact of set size in:
 - Recognition of numerals in the 2.5-year-olds' group: the label 'number' was more frequent with small ($M = 0.76$) than with medium ($M = 0.07$) ($p = .024$) and large sets ($M = 0$) ($p = .006$).
 - Recognition of numerals, enumeration and quantification in the 4-year-olds' group. The recognition of each specific 'numeral' was more frequent with small ($M = 3.30$) than with medium ($M = 1.30$) ($p = .016$) and large sets ($M = 1.10$) ($p = .008$). Cardinal enumeration was more frequent with medium ($M = 2$) and large ($M = 2$) than with small sets ($M = 0.80$) (p 's $= .001$ and $.007$). Quantification was higher with large sets ($M = 1.10$) than with small ones ($M = 0.10$) ($p = .004$).

References
Anderson, A., Anderson, J., & Shapiro, J. (2005). Supporting multiple literacies: Parents' and children's mathematical talk within storybook reading. *Mathematics Education Research Journal*, 16(3), 5-26.
Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Aldine.
Goldstein, A., Cole, T., & Cordes, S. (2016). How parents read counting books and non-numerical books to their preverbal infants: An observational study. *Frontiers in Psychology*, 7, 1100.
Kress, G. (2010). *Multimodality: A social semiotic approach to contemporary communication*. Routledge.

Mix, K., Sandhofer, C., Moore, J., & Russell, C. (2012). Acquisition of the cardinal word principle: The role of input. *Early Childhood Research Quarterly*, 27, 274-283.
Ramani, G., Rowe, M., Eason, S., & Leech, K. (2015). Math talk during informal learning activities in Head Start families. *Cognitive Development*, 35, 15-33.
Saxe, G., Guberman, S., & Gearhart, M. (1987). Social processes in early number development. *Monographs of the Society for Research in Child Development*, 52(2), 162.
Uscianowski, C., Almeida, M. V., & Ginsburg, H. (2020). Differences in the complexity of math and literacy questions parents pose during storybook reading. *Early Childhood Research Quarterly*, 50, 40-50.