Can adult mathematics-related input facilitate the acquisition of number concepts by young children?

The Mathematics Education Forum

The Fields Institute

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Mathematics Concepts & Language

- Early mathematics representations are linked to mathematics language
  - Numerosity and knowledge of count words (e.g., Huttenlocker et al., 1994; Jeong & Levine, 2005)
  - Cardinal word principle is learned after acquiring the meanings of
    - *One* by 2.5 years old
    - *Two* by 3.0 - 3.5 years old
    - *Three* by 3.5 - 4.0 years old (Wynn, 1990; 1992)

Adult Input & Concept Acquisition

- General vocabulary growth is correlated to the amount of language input received (e.g., Hart & Risley; Naigles & Hoff-Ginsberg, 1995)
- Understanding of mental states is correlated to the maternal use of mental verbs (Adrian, Clemente, & Villanueva, 2007; Tardif & Wellman, 2000)
- Preschoolers' growth of mathematical knowledge is correlated to the amount of mathematical input by teachers (Klibanoff et al., 2006)
- Parental mathematical input is related to 4- and 5-year-olds' level of number knowledge using parental checklists (e.g., LeFevre, Clarke & Stringer, 2002)

Current Study

- To investigate the role of adult mathematics-related input in the development of number concepts
  - The relationship between adults' use of mathematics words and young children's acquisition of these words and cardinal concepts
  - The quality and quantity of adult mathematical input and child's gender
  - Adult mathematics-related input is predictive of children's mathematical learning potential

Current Study: Objectives

- To provide a systematic investigation of the mechanism of early mathematical learning across developmental stages (12 – 39 months)
  - Adult input as well as children's acquisition
  - Naturalistic observations and experimental comprehension methodology (Intermodal Preferential Looking method)
  - Language comprehension precedes language production (e.g., Naigles, 2002)

Current Study: Objectives

- To investigate whether the amount of “math talk” by adult is one mechanism to facilitate mapping between the non-verbal and verbal representational systems for numerosity
  - Infants <12 months: use non-verbal system

    => Use visual ability to discriminate numerosity
  - Children > 3 years: use verbal system
    - ⇒ Use linguistic labels to represent counting concepts
- How do children map between the verbal and non-verbal numerical systems?

Study 1: Naturalistic Observations

- Design: Age (12-18, 19-25, 26-32, 33-39 months) x Gender (boys and girls)
- N = 120 (15 boys and 15 girls in each age group)
- Each child-caregiver dyad will be recorded for a 45-min home visit (30-min free play and 15-min joint picture-book reading)
  - A standard set of toys will be provided
  - Two books (Annie's One to Ten" by Murphy & "Monster Math Picnic" by MacCarone)

Study 1: Naturalistic Observations

- Speech will be transcribed and coded for mathematical input
  - Frequency of counting objects
  - Asking for the number of things in a set with/without counting them
  - Gestures such as pointing
- Caregivers will be asked to complete a questionnaire
  - the types of activities they usually engage in with their children
  - demographics

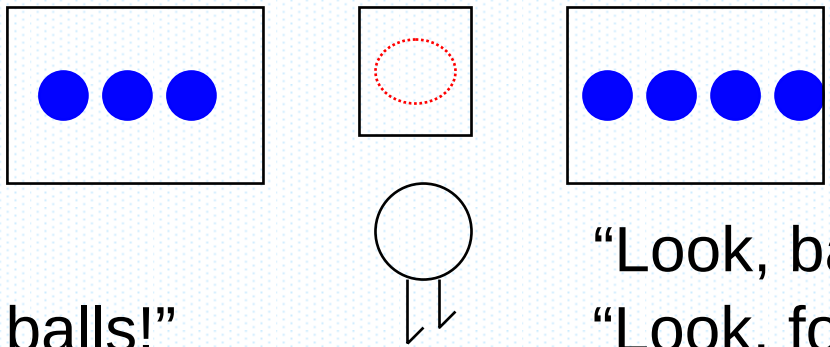
Study 1 : Expected Results

- Differences in quality and quantity in adult "math talk"
  - Differences affect children's acquisition of mathematical concepts
- Differences in adult "math talk" with boys and girls?
  - 4-year-old boys > 4-year-old girls in number sense (Jordan et al., 2006)
  - No gender differences in young infants < 12 months (e.g., Spelke, 2005)

=> Socialization in mathematics learning?

Study 2: Intermodal Preferential Looking

- Children from Study 1 will participate
  - To investigate the role of possible differential mathematical input on early mathematical competence



"Look, balls"
"Look, three balls!"

"Look, balls"
"Look, four balls!"

"Where are the three balls?

Which referent (three or four balls) does the child attach the linguistic label to?

Study 2: Expected Results

- Enhance our understanding of early mathematical development during the early years
  - When young children understand number concepts using linguistic cues
  - Language comprehension precedes language production (e.g., Naigles, 2002)
  - ⇒ Mathematical comprehension may precede mathematical production
- Studies used Habituation method difficult to determine the role of language input
  - No language input is needed

Study 2: Expected Results

- An opportunity to determine whether gender differences in number sense exist between 12 and 39 months of age
  - Habituation studies with infants ✘
  - Production studies with > 3-year-olds ✓
- It is possible that adult mathematical input varies significantly between boys and girls
  - Early socialization of gender differences in mathematical performance

Conclusions

To understand the earliest precursors
of how and why
some children become good at
mathematics whereas others fail to do so.