



How First Graders with Low Language Skill Solve Math Word Problems

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Abstract

- Using an existing videotaped data set, we identified, described, and coded strategies that 20 first graders with low oral language skill used to solve basic arithmetic word problems. To establish reliability, a second student coded 20 percent of the files. Children's strategies and future directions will be discussed.

Background

- Many preschool and kindergarten children enter school with a basic concept of numerical quantity and relationships between sets (Gelman & Gallistel, 1978; Griffin, 2003; Jordan, Levine & Huttenlocher, 1995).
- Arithmetic word problems are difficult for all children; even more so for children with low oral language skill (Cowan, Donlan, Newton, & Lloyd, 2005; Samelson, 2009).
- To solve an arithmetic word problem successfully, a child must:
 - process and comprehend the linguistic message
 - access background knowledge of the relationships between sets of numbers
 - determine the underlying problem structure/schema
 - select a solution strategy and calculate the solution
- Prior research has demonstrated that children generate a wide variety of strategies to solve problems and depending on the nature of the task and the goals of the child certain strategies are "selected" and used (Siegler, 2005).
- Children tend to resort to preferred default strategies when they are not sure how to interpret a word problem (Cummins, 1991).
- Strategies and errors reported in the literature for typically developing children included:
 - Wrong operation error, given number error, wrong assignment error (Cummins, 1991).
 - Correct answer, calculation error, given number error, miscellaneous, no response (De Corte et. al., 1985).
- This project is an extension of prior research (Samelson, 2009).
 - Nine first graders with low-normal oral language skill (LN) and 11 with a diagnosis of language impairment (LI) listened to and then solved arithmetic word problems presented under four scaffolding conditions:

Traditional Wording: Duck ate 7 ice cream cones. He ate 3 fewer ice cream cones than Bunny. How many ice cream cones did Bunny eat?

Traditional Wording + Gesture: Present left hand cupped, palm up over Duck (scripted to 'Duck ate 7 ice cream cones'). Present right hand cupped, palm up and move to meet the left hand (scripted to 'ate 3 fewer ice cream cones' or 'ate 3 more ice cream cones'). Move both hands, cupped together, over to Bunny (scripted to 'How many ice cream cones did Bunny eat?').

Reworded: Duck and Bunny were eating ice cream cones. You need to figure out how many ice cream cones Bunny ate. Duck ate 7 ice cream cones. Bunny ate 3 more ice cream cones than Duck ate. How many ice cream cones did Bunny eat?

Reworded + Gesture: Same gestures as Traditional Wording + Gesture. In addition, point to Bunny while saying 'You need to figure out how many ice cream cones Bunny ate.'

- Anecdotal evidence suggested that both rewording and gesture scaffolds influenced the solution strategies that first graders chose to use.

Aims & Methods

To date, no one has described the solution strategies employed by children with low oral language skill while they solve basic arithmetic word problems.

Aims:

- Identify, describe, and code the strategies that first graders in the lowest quartile of oral language skill used to solve basic arithmetic word problems
- Establish the reliability of the coding system.

Methods:

- The primary investigator viewed 40 video files, described the children's solution strategies and errors, and then expanded an existing coding system.
- Three sources of evidence were used to describe and code the strategies and errors:
 - The child's verbal 'answer' to each problem
 - The child's explanation of how he/she solved the problem
 - Any strategies observed in the child's use of the manipulatives that were provided for each problem.
- The principal investigator and second author collaborated to reach agreement on a set of 9 codes.
- A second undergraduate student, trained in coding arithmetic word problem tasks, independently recoded a randomly selected subset of the 40 video files (8 files, representing 20 percent of the data).
- Point-to-point agreement between the principal investigator and the independent coder was calculated for each of the coding categories.



Selected References:

- Cowan, R., Donlan, C., Newton, E. J., & Lloyd, D. (2005). Number skills and knowledge in children with specific language impairment. *Journal of Educational Psychology, 97*(4), 732-744.
- Cummins, D. D. (1991). Children's interpretations of arithmetic word problems. *Cognition and Instruction, 8*(3), 261-289.
- De Corte, E., Verschaffel, L., & Dewin, L. (1985). Influence of rewording verbal problems on children's problem representations and solutions. *Journal of Educational Psychology, 77*(4), 460-470.
- Gelman, R., & Gallistel, C. (1978). *The Child's Understanding of Number*. Cambridge, MA: Harvard University Press.
- Samelson, V. M. (2009). *The influence of rewording and gesture scaffolds on the ability of first graders with low language skill to solve arithmetic word problems*. Unpublished doctoral dissertation, University of Iowa.
- Siegler, R. S. (2005). Children's learning. *American Psychologist, 60*, 769-778.

Results & Discussion

Results:

- The following 9 strategies and errors were identified and coded:
 - Accurate conceptualization of the problem – The child shows a conceptually accurate understanding of his/her solution/strategy.
 - Calculation/count errors - The child makes an error in counting or calculating his/her response.
 - Wrong operation errors - The child subtracts instead of adding.
 - Wrong assignment errors - The child assigns an incorrect number to one of the characters.
 - Given-number strategy - The child provides one of the numbers given in the problem as his/her response.
 - Zero strategy** - The child's response is "0" for problems containing the wording "fewer than".
 - Question-first strategy** - Under the reworded + gesture condition, the child assigns a random quantity before hearing the rest of the problem.
 - Remainder strategy** - The remainder of the manipulatives are assigned to the second character.
 - Unknown strategy - Specific strategy could not be identified.

** Bolded strategies were not previously identified in the literature.

- Reliability: An inter-rater reliability analysis using the Cohen's Kappa statistic was performed (Kappa = 0.825, $p < 0.001$). This result represents a very good level of reliability.

Anecdotal Observations:

- Under the reworded condition when "You need to figure out how many..." was read, some children quickly assigned a random quantity of manipulatives to the character named. This observation led to the identification of the question-first strategy
- Under the traditional wording condition, some children, upon hearing "fewer than", chose "0" as their answer. Some children even answered "0" without hearing the rest of the word problem. This observation led to the identification of the zero strategy.

Future Directions:

We were able to construct a coding scheme that reliably identified the children's solution strategies and errors, which will now allow us to test the following hypotheses:

- Children with low oral language skill will choose different strategies to solve basic math word problems than typically developing children .
- Children with low oral language skill will use a greater variety of strategies than children who are typically developing.
- Under the traditional wording with no gesture condition, children with low oral language skill will interpret "fewer than" as meaning zero.

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