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Preschoolers' Conceptions of Zero

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References:

Introduction and Background:

Background:

- Zero is often overlooked in numerical cognition research because of its delayed and unique development
- Existing research suggests children develop an understanding of zero after they develop an understanding of small counting numbers. (Cohrssen et al., 2024; Hartmann et al., 2022; Krajcsi et al., 2021; Merritt & Brannon, 2013; Nieder, 2016; Pixner et al., 2018; Wellman & Miller, 1986).
- Existing stage theories (Wellerman & Miller, 1986; Krajcsi et. al., 2021; Nieder, 2016) fail to account for individual differences in the order of development across the various sub-concepts of zero and the presence of partial understanding within stages.

Research questions:

- Is children's conceptualization of zero distinct from that of natural numbers?
- Is children's concept of zero multidimensional or unidimensional?
- Are the dimensions underlying the zero-concept continuous or categorical?
- How do children develop conceptualizations of zero? Does this development differ from natural number concept development?

Hypotheses:

- Zero differs conceptually from small positive numbers
- Zero conceptions develop behind those of small positive numbers
- Zero is a multidimensional concept
- Sub-concepts of zero are continuous
- Dimensions of zero become more correlated as age increases.

If the hypotheses are supported, there will be evidence for a new model explaining how children develop the zero concept that challenges the existing stage theories.

Method:

Participants

~100 three- and four-year-olds attending local preschools and daycares.

Procedure

~30-minute video-recorded interview, including several tasks

Materials (Tasks designed to measure specific subconcepts):

- **Number Metaknowledge:** Participants are asked the question "What is a number?" and will be asked, "Is (zero/one/ten/nothing/doggy/W) a number?"
- **Word-to-numerosity mapping:** Participants will be asked to identify the number of objects on the table from three down to zero. Participants will also complete a make-*N* task in which they are asked to put *N* (one through ten) objects in a container
- **Symbol-to-numerosity mapping**: Participants will be asked to match a number symbol card to a card with the corresponding number of objects on it (0 to 3) without counting aloud
- **Word-to-symbol mapping:** Participants will complete an electronic-based task in which they will be asked to name numerals ranging from zero to nine that appear on the screen.
- **Numerosity magnitude representation:** Participants will complete an electronic-based task where they will be shown two sets of objects containing zero to three objects and will be asked which set has more objects.
- **Number word magnitude representation:** Participants will be asked, "Which is more, [number A] or [number B]?" with the possible numbers ranging from zero to three.
- **Numeral magnitude representation:** Participants will complete an electronic-based task in which they will be shown two numerals at once and will be asked to say which one is more, with the possible numerals spanning from zero to three.

Planned Analyses:

•For each task, **descriptive statistics** (mean, standard deviation) will be calculated on the children's scores in both age groups.

•**To test the hypothesis that conceptions of zero lag behind conceptions of small positive numbers, a within-groups t-test** for both age groups will be calculated to determine the difference between children's mean accuracy on zero trials and their mean accuracy on positive number trials for each applicable task. If children are found to be significantly more accurate on the positive number trials than on the zero trials for one or both of the age groups, this hypothesis will be supported.

•**To test the hypothesis that the sub-concepts of zero become more correlated to each other with age, a Pearson's correlation coefficient will be calculated between tasks for each age group.** These coefficients will be compared to see if there is a stronger correlation for the older age group.

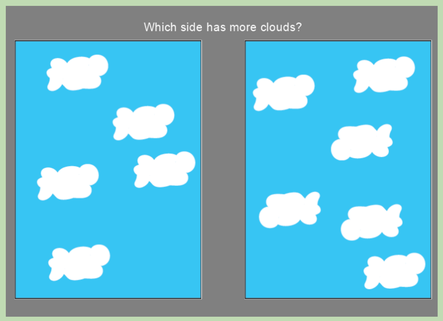
Personal Reflections:

• To contribute to this research project, I recruited local preschools and daycares to participate in the study. I coordinated communication, answered questions, and gathered data needed to prepare for data collection.

• I also contributed by creating study stimuli and a list of questions for a Q&A used for recruitment.

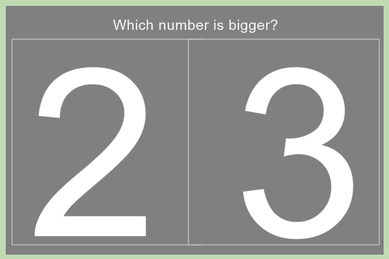
• I participated in weekly lab meetings to collaborate and provide feedback to fellow lab members.

• Through UROP, I gained firsthand experience about how psychology research is conducted and written. I've improved upon skills such as communication, teamwork, and creativity.

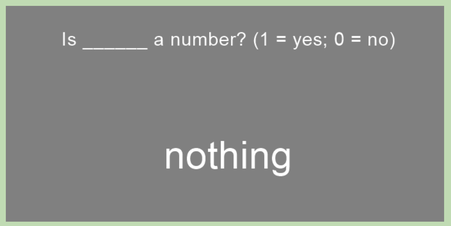


Numerosity Magnitude Representation online task trial

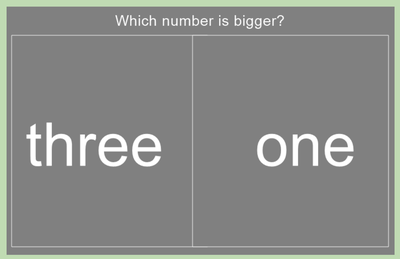
Word-to-symbol mapping online task trial



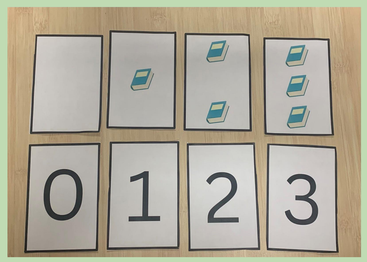
Numeral Magnitude Representation online task trial



"Is it a number?" Number Metaknowledge online task trial



Number Word Magnitude Representation online task trial



Cards used in the Symbol-to-Numerosity Mapping task trial