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Background

- Whether abstract, combinatorial thought can exist in the absence of language is highly debated.¹⁻⁴
 - The **disjunctive syllogism** is a logical reasoning process that requires combinatorial thought.



- **Evidence** on whether young children can use the disjunctive syllogism appears **mixed**.⁵⁻⁷
 - In a **non-linguistic task**, where children searched for a reward across 4 possible locations after seeing that one location was empty, 3- to 5-year-olds succeeded but 2.5-year-olds failed.⁵
 - Such failures may suggest that very young (i.e., “pre-linguistic”) children do not yet have the logical concepts of disjunction (OR) and negation (NOT).
 - However, in a **linguistic version of the same task**, where cues to “emptiness” were conveyed with a negative statement (e.g., X is not in A), even 2.5-year-olds succeeded.⁶
 - Such successes may suggest that language (linguistic negation) facilitates the construction of the logical (negative) premise.

Current Study

- Does the modality of cues to “emptiness” (verbal vs. visual) affects children’s ability to reason with the disjunctive syllogism?
 - Systematic manipulation of the differences between the two prior studies.

Methods

Participants

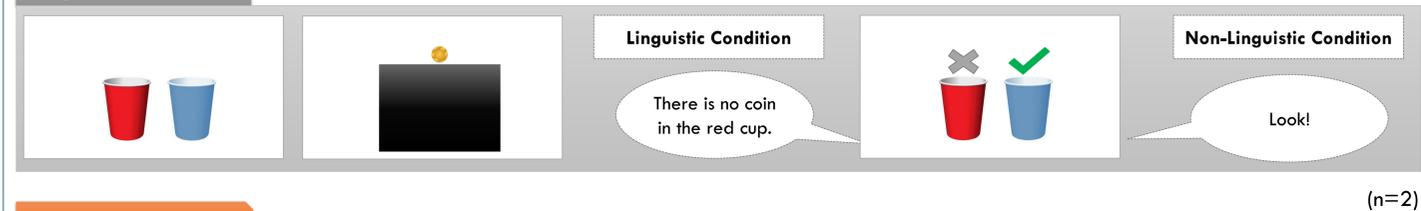
18 **2.5-year-olds** (M = 32.3 months, range = 27.3–35.6); 30 **3-year-olds** (M = 41.5 months, range = 36.0–47.5);
23 **4-year-olds** (M = 53.6 months, range = 48.6–59.8)

Training Trials

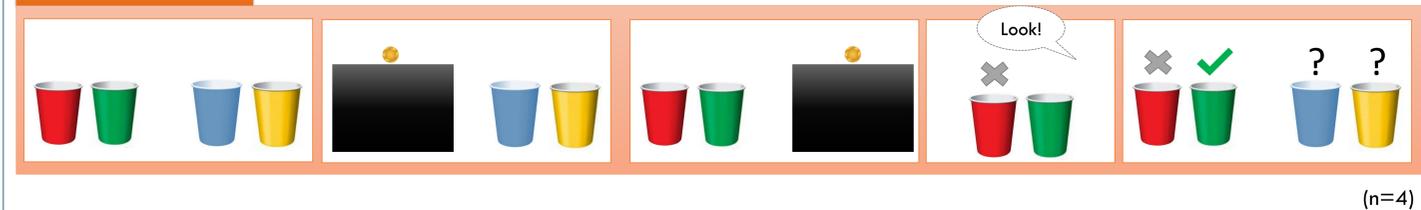


Negation Trials

between-subjects

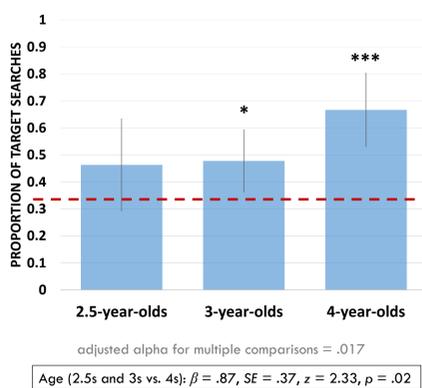


Test Trials

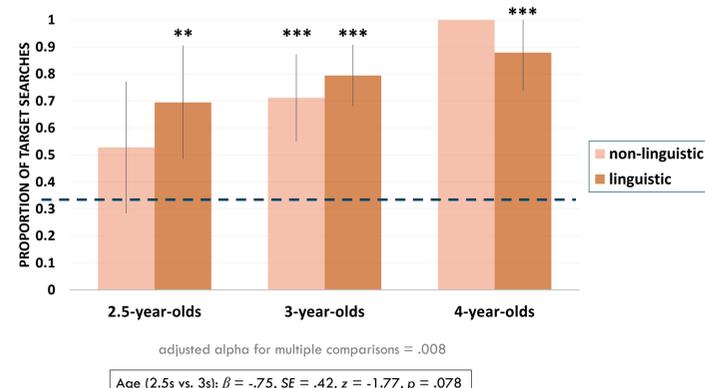


Results

TRAINING TRIALS



TEST TRIALS



Significance levels: *** $p < .001$, ** $p < .008$, * $p < .017$.

References

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(2) Davidson, D. (1982) Rational animals. *Dialectica*, 36, 317–327. (3) Fodor, J. A. (1975). *The language of thought*. Cambridge, MA: Harvard University Press. (4) Leahy, B. P. and Carey, S. E. (2020) 'The Acquisition of Modal Concepts', *Trends in Cognitive Sciences*, 24(1), 65–78. (5) Mody, S., & Carey, S. (2016). The emergence of reasoning by the disjunctive syllogism in early childhood. *Cognition*, 154, 40–48. (6) Grigoroglou, M., Chan, S., & Ganea, P. A. (2019). Toddlers' understanding and use of verbal negation in inferential reasoning search tasks. *Journal of Experimental Child Psychology*, 183, 222–241. (7) Cesana-Arlotti et al. (2018). Precursors of logical reasoning in preverbal human infants. *Science*, 359, 1263–1266. (8) Jaswal, V. K., Croft, A. C., Setia, A. R., & Cole, C. A. (2010). Young children have a specific, highly robust bias to trust testimony. *Psychological Science*, 21(10), 1541–1547. (9) Ma, L. & Ganea, P. A. (2010). Dealing with conflicting information: Young children's reliance on what they see versus what they are told. *Developmental Science*, 13, 151–160.

Conclusion

- Children above the age of 3 (but not younger) **successfully reasoned over certainty**, with this ability still developing over preschool years.
 - In training trials, 3- and 4-year-olds (but not 2.5-year-olds) chose the target cup significantly above chance.
 - 4-year-olds performed significantly better than 3- and 2.5-year-olds.
- The **modality of cues** to “emptiness” (verbal vs. visual) **affected younger (but not older) children’s reasoning** with the disjunctive syllogism.
 - 2.5-year-olds chose the target cup significantly above change when presented with a linguistic cue (i.e., a negative statement), but at chance when presented with a visual cue (i.e., an empty cup).
 - Older children showed above chance performance in both conditions.
- Providing children with a negative proposition **verbally** rather than visually led to increased certainty in the relevant premise “NOT A”, thus leading to increased certainty in the conclusion.
 - If early successes in disjunctive reasoning tasks rely on probabilistic choices over multiple hypotheses, which are adjusted based on available evidence,⁴ linguistic evidence, as more reliable than visual evidence,⁸⁻⁹ led to higher degree of certainty in younger children’s guesses.

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