# Language facilitates 2.5-year-olds' reasoning by the disjunctive syllogism

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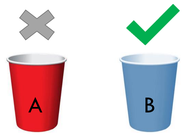
## Background

**Reasoning by elimination** is a logical process of becoming increasingly sure of an answer as you eliminate other possibilities.

- Children successfully pass reasoning by elimination tasks when information about "emptiness" is conveyed **visually** or **verbally:**
  - Children successfully pick the location containing a reward (B) once they **see** that the other location (A) is empty[1-2] or they hear a **negative** statement (e.g., "The toy is not in A").[3-5]




However, it is unclear whether children succeeded in these tasks by using the **disjunctive syllogism** or simpler reasoning strategies.[6]

- In a task targeting disjunctive reasoning, only children older than age 3 succeeded but 2.5-year-olds failed.[6]
  - Perhaps children younger than 3 cannot represent logical disjunction (OR) and negation (NOT).


### Current Study

- Do young children have a sophisticated understanding of negation which they can apply in reasoning with the disjunctive syllogism?
  - Older two-year-olds who solved simple reasoning by elimination tasks by comprehending negative statements[3-5] may not have had a fully developed (logical) understanding of negation.

## Methods

**Participants**

24 **2.5-year-olds** (M = 32.3 months, range = 27.3–35.6) and 27 **3-year-olds** (Mage = 41.5 months, range = 36.0–47.5)

**Training Trials**


(n=3)

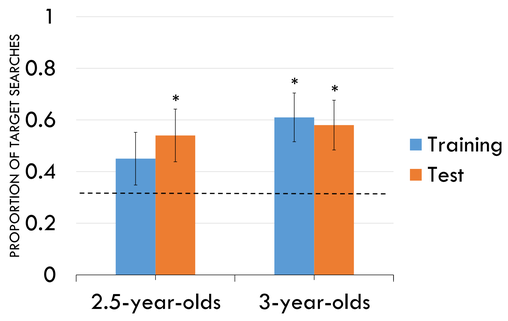
**Negation Trials**


(n=2)

**Test Trials**


(n=4)

## Results




- **Training trials:** 3-year-olds but not 2.5-year-olds performed significantly above chance.
- **Test trials:** Both 3- and 2.5-year-olds performed significantly above chance.
- **Omnibus test:** No difference in overall performance across age groups and trial type.

| Effects | Estimate | SE | z |
|---|---|---|---|
| Intercept | 0.20 | 0.17 | 1.17 |
| Trial Type (Training vs. Test) | -0.15 | 0.29 | -0.50 |
| Age (2.5- vs. 3-year-olds) | 0.44 | 0.29 | 1.53 |
| Trial Type (Training vs. Test): Age (2.5- vs. 3-year-olds) | 0.54 | 0.46 | 1.16 |

## Conclusion

- Children have a **robust understanding of negation,**[3-5] which they can apply to logical reasoning since a very young age.
  - In test trials that required children to reason with the disjunctive syllogism, both 3- and 2.5-year-olds chose the target cup significantly above chance.
- Providing **cues** to "emptiness" **linguistically** facilitated children's reasoning with the disjunctive syllogism.
  - In our linguistic version of the 4-cups task, 2.5-year-olds showed signs of engaging in disjunctive syllogism, while in the non-linguistic version of the task[6] only children older than 3 succeeded.
- Providing children with a negative proposition **verbally** rather than visually may have given them more direct access to the relevant premise "NOT A".
  - Having to construct the same premise from visual evidence of "emptiness" may have been a less reliable source of evidence, leading to incorrect predictions about the location of the reward.[7-8]

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