# Syntactic Bootstrapping of Mental State Verbs in Mandarin-Speaking Children

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## Introduction

- How do children learn the meaning of mental state verbs like want or think? One potential strategy is syntactic bootstrapping: Inferring word meanings by detecting regularities in their grammatical structures (Gleitman, 1990; Landau & Gleitman, 1985).
  - Desire verbs take non-finite clauses: "I want to go swimming."
  - Belief verbs take sentential complement clauses: "I think it's raining outside." (Harrigan et al., 2019)
- The case of Mandarin Chinese: less overt morpho-syntactic markers for this regularity
  - Belief verbs take sentential complement; Desire verb arguments are often verb phrases without a subject, aspect or modal marker - but they are also optional in sentential complements
  - Corpus analysis of children's language input shows that there is distributional syntactic distinction between desire verbs and belief verbs in Mandarin (Huang et al, 2022) – But can children actually learn from this distinction?
- De Villiers and Pyres (2002) suggests that the mastery of the complement structure is a precursor, and even likely a prerequisite, of theory of mind. However, later studies have yielded mixed results in replicating this finding (Grosse Wiesmann et al., 2017; Durrleman et al., 2022).

- **Hypotheses:**
  - 1. Mandarin-speaking children use syntactic information to infer the meaning of novel mental state verbs.
  - 2. Children's understanding of complement structure positively correlates with their theory of mind.

## Methods

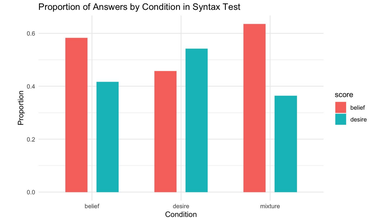
- Participants: 30 Mandarin-speaking children, mean age = 51 months (4.3 years), half of which were girls.
- Procedure:
- **Training phase** – each child heard a story in which a pseudoword appeared 12 times
  - Desire group: pseudoword appeared in desire-type syntax, followed by verb phrases
  - Belief group: pseudoword appeared in belief-type syntax, taking sentential complements as argument
  - Mixture group: alternating desire-type & belief-type syntax
  - Followed by comprehension questions to make sure children paid attention
- **Testing phase**
  - Syntax test: "Which sentence sounds better?"
    - Wo *binsa* wanju zai guizi li. -> I *pseudoword* the toy is in the closet.
    - Wo *binsa* ba wanju fangjin guizi. -> I *pseudoword* (to) put the toy in the closet.
  - Semantics test:
    - Present two short video clips, one depicting a belief scenario, another depicting a desire scenario.
    - A puppet comments on the video using the pseudoword, e.g., "The girl *pseudoword* the cake is in the fridge."
    - Experimenter: "which video is the puppet talking about?"

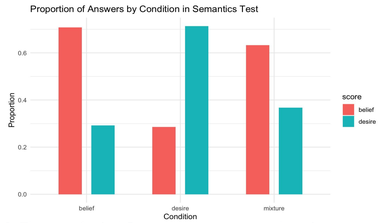
- **Mental state vocabulary**
  - To probe children's prior knowledge of mental state terms, we used a narrative elicitation task adopted from Fuste-Herrmann et al (2006). After reading a wordless picture book, *Frog, Where Are You?* (Mayer, 1969), children were instructed to recount the story to the experimenter as they flipped through the pages. Utterances involving mental state terms in children's speech were coded by type (unique words) and token (total words).
- **False belief understanding**:
  - the unexpected content task, and the change-of-location task, were used to measure children's theory of mind (Wellman et al., 2001)
- **Complement comprehension:**
  - A complement comprehension task adopted from De Villiers and Pyres (2002) was used to test children's understanding of the complement structure independent of their mental state verb vocabulary.
  - In each trial, the child heard a non-mental-state sentence with a sentential complement clause and was asked to report the content of the clause, e.g., "he said there's a monster under his bed. Actually, it was the neighbor's dog. What did he say?"
  - There were 3 false complement trials and 3 true complement trials.

## Results

Hypothesis 1: Syntactic bootstrapping

- Children in the belief condition had 58% belief responses in the syntax test and 71% in the semantics test. Children in the desire condition chose desire responses 54% of the time in the syntax test and 62% of the time in the semantics test. Children in the mixture condition had 64% belief responses in the syntax test and 63% in the semantics test.
- One-way ANOVA showed that children's responses differed between groups in the semantics test ($F(2,22)= 5.93$, $p<0.01$) but not in the syntax test ($F(2,24)=0.99$, $p=0.38$). Post-hoc analyses on responses in the semantics test revealed that the mixture group and the belief group differed significantly from the desire group.




Hypothesis 2: Theory of mind & complement comprehension

- Pearson's r showed no correlation between false-belief task performance and complement comprehension task performance (false complements: $r(23)=0.26$, $p=0.24$; true complements: $r(22)=0.26$, $p=0.24$).
- Mental state vocabulary did not correlate with false-belief task performance.
- Age was the only predictor of false-belief task performance ($r(25)=0.43$, $p=0.03$).
- Linear regression shows that performance in false complement task predicted performance in the syntax and semantic tests, independent of age (syntax test: $F(1,12)=6.29$, $p=0.028$; semantics test: $F(1,11)=5.415$, $p=0.04$ ).

## Discussion

Main findings:

- Supports syntactic bootstrapping in Mandarin: Children used syntactic information to learn novel mental state verbs
  - Complement comprehension was associated with interpretation accuracy – further support for the role of syntax
- No evidence for the link between mental state verb learning and theory of mind: complement comprehension and mental state vocabulary did not correlate with false belief task performance.

Discussion:

- Children who received mixture syntax preferred belief interpretation.
  - Belief is the default for mental state verbs?
  - Children bootstrapped the novel word as polysemous, thus preferred a belief interpretation when the test sentence (puppet's comment) were belief-type syntax
- Children were not accurate in bootstrapping the meanings of the novel verb.
  - More exposure? / Need additional cues?
  - Less committed when the input is vaguer?

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