
Pronouns

2.3 “Pronoun interpretation”



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Pearl, Lisa. “Computational Cognitive Modeling for Syntactic Acquisition: Approaches That Integrate Information from Multiple Places.” *Journal of Child Language* 50.6 (2023)

The syntactic knowledge

Example: “Lisa sang to the triplets and then PRONOUN took a nap”

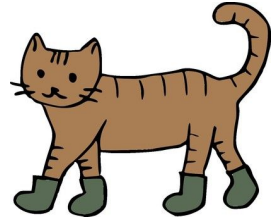


How do we interpret “PRONOUN”?

↪ Several factors:

- **Agreement information:** If the pronoun is the singular *she*, we look for a singular antecedent like *Lisa*; if the pronoun is the plural *they*, we look for a plural antecedent like *the triplets*
- **Discourse-level knowledge about the lexical items that connect the two clauses together:** Such as “and then”

The syntactic knowledge (cont.)



- In languages like Spanish, the equivalent to “and then” biases the interpretation towards the subject *Lisa* rather than the object *the triplets*
- Another factor in languages like Spanish is whether or not the pronoun is overt (i.e., pronounced)
 - Spanish is a language that allows the pronoun not to be pronounced
 - When the pronoun is not pronounced, the subject (e.g., Lisa) tends to be favored as the pronoun’s antecedent

in pronoun interpretation.) Children need to learn how to interpret pronouns of their language in context, taking these factors (and others) into account the way adult speakers of their language do.

The acquisition theory implemented in the model

Pearl & Forsythe (Forsythe & Pearl, 2020; Pearl & Forsythe, 2022)

Proposal:

- Proposed that Spanish-learning children decide how to interpret a pronoun in context by potentially considering information from their input about agreement, lexical connective items, and whether the pronoun is overt
- Based on prior theories that highlight the usefulness of this information for pronoun int





The acquisition theory implemented in the model (cont.)

Pearl & Forsythe (Forsythe & Pearl, 2020; Pearl & Forsythe, 2022)

Two options for how accurately children extract this information from their input:

1. The modeled child **has enough prior knowledge and sufficient learning abilities** to accurately extract this information, similar to the two models discussed before
2. The modeled child **does not have enough prior knowledge and sufficient learning abilities**, and in fact would inaccurately represent this information (for whatever reason: immature knowledge, immature learning abilities, and/or cognitive limitations more generally)
 - More specifically, the modeled child would **skew the probability distributions observed in the input** about these information sources



The acquisition theory implemented in the model (cont.)

Pearl & Forsythe (Forsythe & Pearl, 2020; Pearl & Forsythe, 2022)

cognitive limitations more generally). More specifically, the modeled child would skew the probability distributions observed in the input about these information sources (e.g., how often singular agreement information occurs when the pronoun's antecedent is singular). In particular, a modeled child with inaccurate representations of the information in the input could flatten a distribution (e.g., turning a 30/70 distribution into a 40/60 distribution) or sharpen a distribution (e.g., turning a 30/70 distribution into a 20/80 distribution).

- More specifically, the modeled child would skew the probability distributions observed in the input about these information sources

The acquisition theory implemented in the model (cont.)

Pearl & Forsythe (Forsythe & Pearl, 2020; Pearl & Forsythe, 2022)

Bayesian inference:

- Balances prior knowledge or biases against fit to the observed data
- The prior encodes how often a pronoun preferred a particular antecedent in children's input, irrespective of any other useful information about how to interpret that pronoun
- The fit to the observed data is about how often each information type occurs in children's input when a pronoun has a particular interpretation





The acquisition theory implemented in the model (cont.)

Pearl & Forsythe (Forsythe & Pearl, 2020; Pearl & Forsythe, 2022)

Two options for how accurately children perform this inference in the moment of deciding a pronoun's interpretation:

1. The modeled child would use all the information sources when performing the Bayesian inference calculation
2. The modeled child would ignore one or more information sources when performing that inference calculation (for whatever reason: immature knowledge, immature learning abilities, and/or cognitive limitations more generally)

The acquisition theory implemented in the model (cont.)

Pearl & Forsythe (Forsythe & Pearl, 2020; Pearl & Forsythe, 2022)

Pearl & Forsythe modeled two types of children:

1. A modeled child **without cognitive limitations**, able to (i) accurately extract and represent the probability distributions from the information sources in the input, and (ii) always use those represented probabilities during the Bayesian inference calculation
2. A modeled child **with cognitive limitations (of whatever kind)** that affected (i) the accurate representation of information in the input, (ii) the use of all that information in the Bayesian inference calculation, or (iii) both



The acquisition theory implemented in the model (cont.)

Pearl & Forsythe (Forsythe & Pearl, 2020; Pearl & Forsythe, 2022)

Main idea:



that information inaccurately, or both. Thus, the models of Pearl & Forsythe considered certain theories for children's pronoun interpretation behavior that involve cognitive limitations; the effect of those limitations is to impact either the representation of information from the input, the use of that information when deciding a pronoun's interpretation in context, or both.

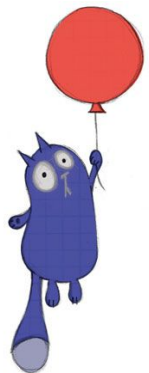
Information integrated



- Linguistic information integrated via Bayesian inference:
 - Agreement information (morphology), the lexical connectives between clauses (lexical), and whether the pronoun is pronounced (syntactic/phonological)
- These information sources are then combined using the non-linguistic learning mechanism of Bayesian inference
 - The way the information is combined can be mediated by non-linguistic factors arising from cognitive limitations: misrepresenting the information from the input and/or not using select information during Bayesian inference

Model input

- The modeled child learned from pronoun uses in Spanish speech samples involving children
- These pronoun uses involved two clauses and had the pronoun as the subject of the second clause



(e.g., *[Lisa sang to the triplets]_{clause1} and then [PRONOUN took a nap]_{clause2}*.)

Model output and evaluation



Findings:

Pearl & Forysthe found that modeled three-, four-, and five-year-olds were able to best match the interpretation preferences of actual three-, four-, and five-year-olds when cognitive limitations impacting either information representation or information use (but not both) were active. **That is, children's interpretation behavior could be captured by integrating information from agreement, lexical connectives, and whether the pronoun was pronounced as long as children either (i) always mis-perceived information from these sources in the input, leading to inaccurate information, or (ii) often ignored accurate information from these sources when deciding how to interpret a pronoun in the moment.** Importantly, children's behavior wasn't captured as well if the modeled child had both effects (inaccurate information often ignored) or neither effect (accurate information never ignored).

What we learned

What we learned. These modeling results thus offer specific explanations about **how cognitive limitations (whatever their specific source happens to be) could impact children's pronoun interpretation preferences, if children rely on these linguistic information sources.**

