On the acquisition of *either* and *too*

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How do children learn about pairs of items that are in complementary distribution?

- e.g., polarity items (NPIs and PPIs)
- Today’s talk: *either* and *too*
Roadmap

Introduction

Background

Child experiment

Adult control

Corpus study: Child-directed adult speech

Corpus study : Child speech

Discussion

Conclusion
Introduction

Background

Child experiment

Adult control

Corpus study: Child-directed adult speech

Corpus study: Child speech

Discussion

Conclusion
Meet *either* and *too*

*Either* and *too* are

- focus-sensitive
- presuppositional (additive)
- polarity sensitive
Meet *either* and *too*

(1) a. Sam is eating cake. Sam is eating ice cream *too/*either.
   b. Sam isn’t eating cake. Sam isn’t eating ice cream *either/*/too.

(2) a. Someone sneezed. Someone coughed *too/*either.
   b. No one sneezed. No one coughed *either/*/too.

(3) a. Anna left. If Mary left *too/*either, the room is empty.
   b. Anna didn’t leave. If Mary left *too/*either, the room is empty.

- NB: We will return to the status of *too* in negative sentences.
Roadmap

Introduction

Background

Child experiment

Adult control

Corpus study: Child-directed adult speech

Corpus study: Child speech

Discussion

Conclusion
What do children know about the competition between *either* and *too*?
Comparative felicity judgment task (Chierchia et al. 2001, Foppolo et al. 2012):

- **Materials:**
  - 8 target items (4 positive, 4 negative)
  - 4 filler items (2 positive, 2 negative), seen by all participants

- **Participants:**
  - 57 children aged 3-7, recruited at Boston daycares and the Museum of Science; of these, 47 L1 English acquirers completed the task.
    - 9 3-year-olds, 14 4-year-olds, 15 5-year-olds, 8 6-year-olds, 1 7-year-old (not included in data analysis)
Child experiment: Design

Figure 1: A positive target item

Narrator: This is Max.

Narrator: Max is hugging a cat.
Puppet 1: Max is hugging a dog, too.
Puppet 2: Max is hugging a dog, either.
Child experiment: Design

Figure 2: A negative target item

Narrator: This is Sam.
Narrator: Sam isn’t eating cake.
Puppet 1: Sam isn’t eating ice cream too.
Puppet 2: Sam isn’t eating ice cream either.
Figure 3: Mean rate of *either/too* selection, by polarity environment and age
Child experiment: Results

Linear mixed effects logit model of responses constructed in R using package lme4 (Bates et al. 2015) with fixed effects of polarity (pos/neg) and age (3-5/6 y.o.) shows:

- Main effects: polarity and age
  - Polarity: Children are more likely to select either in negative sentences than in positive sentences ($\Pr(> |z|) = 0.000171 ***$).
  - Age: 6-year-olds less likely to select either overall ($\Pr(> |z|) = 0.009378 **)$. They effectively stop accepting either in positive sentences.

- Interaction: polarity*age ($\Pr(> |z|) = 0.036657 *$)
  - Contribution of interaction confirmed with a likelihood ratio test ($p < 0.05$).
Child experiment: Summary

Take-home message:

- Children aged 3-5 accept both polarity items in both environments.
- Children aged 3-5 trend toward the adult grammar but do not gradually converge on categorical judgements.
- 6-year-olds abruptly learn to reject *either* in positive sentences (but continue to accept both items in negative sentences).
Have 6-year-olds mastered the adult grammar?

(4) Sam isn’t eating cake. Sam isn’t eating ice cream *?too.

- A parse where *too* takes scope over negation could be available.

(5) *

(6) PPI licensed!
Introduction

Background

Child experiment

**Adult control**

Corpus study: Child-directed adult speech

Corpus study: Child speech

Discussion

Conclusion
Do adults accept both *too* and *either* in negative sentences (with a preference for the NPI)?
MTurk felicity rating task (7-point Likert scale):

- Materials:
  - 32 target items (16 positive, 16 negative), Latin squared.
  - 40 filler items (20 positive, 20 negative), viewed by all participants.
    - Participants who did not rate at least 6 of 8 benchmarking fillers correctly were excluded.

- Participants:
  - 51 L1 U.S. English-speaking adults.
    - 6 excluded, leaving data from 45 participants.
Figure 4: A positive target item
Adult control: Design

Figure 5: A negative target item
Adult control: Results

Figure 6: Z-scores of ratings
Statistics:

- Maximally-specified convergent linear mixed effects model of z-scored ratings constructed in R using package lme4 (Bates et al. 2015), with fixed effects of polarity (pos/neg) and polarity-item (either/too), reveals a significant polarity by polarity-item interaction ($p < 0.001$ ***).
  - *Either* is judged more acceptable in negative than in positive sentences; the opposite is true for *too* ($t = 76.00$).
- *Too*-neg appears to cluster with *either*-pos.
Our take:

- Adults exhibit more or less categorical behaviour in our task.
- Between ages 5 and 6, it appears that children learn only half of the adult system.
Roadmap

Introduction

Background

Child experiment

Adult control

Corpus study: Child-directed adult speech

Corpus study : Child speech

Discussion

Conclusion
Corpus study: Child-directed adult speech

- Do children hear *either* more than *too*?
- Is the evidence available to children about NPI licensing clearer than the evidence about PPI licensing?
Corpus study: Child-directed adult speech

Procedure:

- Custom R scripts extracted every instance of additive *either* and *too* from CHILDES corpora of typically-developing children spoken by: Mother, Father, Sister, Brother, Aunt, Uncle, Grandmother, Grandfather, Family Friend, Teacher, Adult.
- Each token was coded for polarity of environment.
## Corpus study: Child-directed adult speech

<table>
<thead>
<tr>
<th>Polarity item</th>
<th>Total</th>
<th>Positive</th>
<th>Negative</th>
<th>Unclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Either</td>
<td>701</td>
<td>28 (3.99%)</td>
<td>670 (95.58%)</td>
<td>3 (0.43%)</td>
</tr>
<tr>
<td>Too</td>
<td>7896</td>
<td>7782 (98.56%)</td>
<td>103 (1.30%)</td>
<td>11 (0.14%)</td>
</tr>
</tbody>
</table>

- 23 of the 28 positive *either* tokens were sentences like *Me either!*, uttered in response to a negative antecedent.
- 42 of the negative *too* tokens were sentences like *Don’t I get some too?*, following a positive antecedent.
Corpus study: Child-directed adult speech

Take-home message:

- The input is overwhelmingly categorical.
- Children encounter very little potentially confusing evidence.
Roadmap

Introduction

Background

Child experiment

Adult control

Corpus study: Child-directed adult speech

Corpus study : Child speech

Discussion

Conclusion
Corpus study: Child speech

Procedure:

- Same as above, except extracted tokens spoken by target child.
### Corpus study: Child speech

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<th>Negative</th>
<th>Unclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Either</td>
<td>242</td>
<td>22 (9.09%)</td>
<td>210 (86.78%)</td>
<td>10 (4.13%)</td>
</tr>
<tr>
<td>Too</td>
<td>5059</td>
<td>5007 (89.95%)</td>
<td>42 (0.83%)</td>
<td>10 (0.20%)</td>
</tr>
</tbody>
</table>

- 18 of 22 positive *either* tokens were sentences like *Me either!*, uttered in response to a negative antecedent.
Figure 7: Children’s cumulative productions of *either* and *too*
Take-home message:

- Children’s production, like the input, is categorical.
- The growth curve in production has the same shape for both items.
Discussion

Several surprising findings:

- Comprehension lags behind production.
- Comprehension exhibits non-categorical trending in the direction of the adult grammar between ages 3 and 5.
  - This trending remains stable in the face of accumulating evidence.
- Comprehension of NPI either becomes adult-like at age 6 without corresponding mastery of PPI too.

How can we explain this learning trajectory?
Comprehension-production asymmetry:

- Usually goes in the opposite direction!
- Not obviously amenable to stories that have been told about other cases with this profile (see, e.g., ?).
Non-categorical trending behaviour in comprehension:

- What grammar produces it?
- The trending cannot be due to differences in informativity (see Foppolo et al. 2012).
  - Structural complexity might be an alternative.
The stability and the sudden change:

- Why does it appear to be insensitive to the accumulation of evidence?
- What changes at age 6?

⇒ This may represent another case for an argument from the Abundance of the Stimulus for encapsulated learning (cf. Babyonyshev et al. 2001).
A preliminary sketch:

- The meanings of *either* and *too* must both be compatible with both environments.
  - E.g., Ahn’s (2015) approach
Towards an analysis:

- Assume a modification of Ahn’s (2015) analysis of *either/too*.
  - Instead of Chierchia’s O/E operators, use *exh* and covert *EVEN* to deal with alternatives.

\[(7) \ [\text{either}] (q)(p) = \lambda w: q \in \text{ALT}(p). \ q(w) \lor p(w)\]

\[(8) \ [\text{too}] (q)(p) = \lambda w: q \in \text{ALT}(p). \ q(w) \land p(w)\]
Toward an analysis:

- Assume that children are adult-like in their use of $exh$ (Chierchia et al. 2001).
  - $Exh$ is restricted to environments where it leads to strengthening.
Toward an analysis:

- Assume that children aged 3-5 cannot access the lexicon when building alternatives but 6-year-olds can (Tieu et al. 2016).
- Before age 6, (some) children strengthen disjunction to a conjunctive meaning (Singh et al. 2013).

(9) 5-year-old grammar

a.  $\text{ALT}(p \lor q) = \{p \lor q, p, q\}$

b.  $\text{exh exh}(p \lor q) = (p \lor q) \land \neg \text{exh}(p) \land \neg \text{exh}(q) = (p \land q)$

(10) 6-year-old grammar

a.  $\text{ALT}(p \lor q) = \{p \lor q, p, q, p \land q\}$

b.  $\text{exh}(p \lor q) = (p \lor q) \land \neg(p \land q)$

scalar implicature
Acceptable, appropriate structures on hypothetical grammar for 3-5-year-olds:

**Positive sentences**
- \( p \text{ too} \)
- \( \text{EVEN} p \text{ too} \)
- \( \text{EXH} \text{ EXH} p \text{ either} \)

**Negative sentences**
- \( \text{NEG} p \text{ either} \)
- \( \text{EVEN} \text{ NEG} p \text{ either} \)
- \( \text{EXH} \text{ EXH} \text{ NEG} p \text{ either} \)
- \( \text{NEG} \text{ p too} \)
- \( \text{EVEN} \text{ NEG} p \text{ too} \)
- \( \text{EXH} \text{ EXH} \text{ NEG} p \text{ too} \)
Acceptable, appropriate structures on hypothetical grammar for 6-year-olds:

**Positive sentences**

- $p$ **too**
- $\text{EVEN} \quad p$ **too**

**Negative sentences**

- $\text{NEG} \quad p$ **either**
- $\text{EVEN} \quad \text{NEG} \quad p$ **either**
- $\text{NEG} \quad p$ **too**
- $\text{EVEN} \quad \text{NEG} \quad p$ **too**
Roadmap

Introduction

Background

Child experiment

Adult control

Corpus study: Child-directed adult speech

Corpus study: Child speech

Discussion

Conclusion
Conclusion

We have seen that:

● Children aged 3-5 accept both items in both environments but trend in the direction of the adult grammar.
● 6-year-olds appear to master one item (either) before the other (too).
● Production is ahead of comprehension.
• We need a theory of *either* and *too* that allows them to express the same meaning for children aged 3-5.
• We need a learning theory that predicts some sensitivity to environment without making use of evidence accumulation over an extended period of time and allows for an abrupt change of the grammatical system in one half of the paradigm but not the other.


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