RETRIEVAL INTERFERENCE IN RELATIVE CLAUSE ATTACHMENT AMBIGUITY: CROSS-LINGUISTIC EVIDENCE

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- **Statistical analysis:** Antje Sauermann (ZAS)
One of the projects of psycholinguistic research is to map out the structural guesses that the sentence processor makes, by establishing which sentence completions are easy and which are difficult for all sorts of ambiguity. From this we can hope to infer what kind of machine this processor is.

The human sentence processor’s guesses are far from random; they exhibit very consistent general tendencies. With regard to phrasal structure, what the human processor likes best is simple but compact structures, which have no more tree branches than are necessary, and the minimal tree-distance (walking up one branch and down another) between any pair of adjacent words.”

(Fodor, 1995, 220–221)
THE GOAL OF THIS PROJECT

- **Central question:**
  - what kind of initial ("on-line") information guides the parser in its ultimate ("off-line") interpretation of a globally ambiguous string.

- **Relative clause (RC) attachment construction:**
  1. to examine the interplay of spoken sentences and visual context with semantically shallow materials
  2. Cross-linguistic approach: English, Russian, Bulgarian
  3. Cross-populational: (monolingual) adults and children
RC ATTACHMENT AMBIGUITY

high attachment  low attachment

Someone shot \([_{NP1}\text{the maid}]\) of \([_{NP2}\text{the actress}]\)

\([_{RC}\text{who was on the balcony}]\).

- Universal principles of Late Closure\(^1\) or Recency\(^2\) predict preference for low attachment

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\(^1\) Frazier & Fodor (1978)
\(^2\) Gibson, Pearlmutter, Canseco-Gonzalez, & Hickok (1996)
VARIATION IN RC ATTACHMENT$^1$ (1)

High-Attaching Languages

Table 2
Summary of studies reporting HA for the languages indicated.

<table>
<thead>
<tr>
<th>HA languages</th>
<th>Mitchell et al. (2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afrikan</td>
<td></td>
</tr>
<tr>
<td>Bulgarian$^4$</td>
<td>Sekerina (2003)</td>
</tr>
<tr>
<td>Serbo-Croatian</td>
<td>Lovrin (2003)</td>
</tr>
<tr>
<td>Galician</td>
<td>Fraga et al. (2005)</td>
</tr>
<tr>
<td>German$^4$</td>
<td>Hemforth et al. (1996), Hemforth et al. (1998) and Hemforth et al. (2000)</td>
</tr>
<tr>
<td>Greek</td>
<td>Papadopoulou and Chalise (2003)</td>
</tr>
<tr>
<td>Italian</td>
<td>De Vincenzi and Job (1993, 1995)</td>
</tr>
</tbody>
</table>

Low-Attaching Languages

Table 1
Summary of studies reporting LA for the languages indicated.

<table>
<thead>
<tr>
<th>LA languages</th>
<th>Abdelghany and Fodor (1999) and Quinn et al. (2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arabic</td>
<td></td>
</tr>
<tr>
<td>Basque</td>
<td>Gutierrez-Ziardegi et al. (2004)</td>
</tr>
<tr>
<td>Bulgarian$^4$</td>
<td>Sekerina (2003)</td>
</tr>
<tr>
<td>Chinese</td>
<td>Shen (2006)</td>
</tr>
<tr>
<td>German$^4$</td>
<td>Augurzky (2005) and Murray et al. (2000)</td>
</tr>
<tr>
<td>Norwegian</td>
<td>Ehrlich et al. (1999)</td>
</tr>
<tr>
<td>Portuguese$^5$</td>
<td>Miyamoto (1999)</td>
</tr>
<tr>
<td>Romanian</td>
<td>Ehrlich et al. (1999)</td>
</tr>
<tr>
<td>Swedish</td>
<td>Ehrlich et al. (1999)</td>
</tr>
</tbody>
</table>

VARIATION IN RC ATTACHMENT (2)

- Many deviations from this predicted preference for low attachment depending on linguistic factors:
  - the type of complex NP
  - the restrictiveness of the relative clause
  - the length of the relative clause
  - presence/absence of pseudorelative clauses
  - prosody

1 De Vincenzi & Job (1993)  
2 Shaked (2009)  
3 Traxler, Pickering, & Clifton (1998)  
4 Carreiras (1992)  
5 Fernández (2003)  
7 Augurzky (2006)  
8 Stoyneshka, Fodor, & Fernández (2010)  
9 Hemforth et al. (2015)
Many deviations from preference for low attachment depending on extralinguistic factors:
- Proficiency and language history\(^1,2\)
- Working memory\(^3,4\)
- Individual variation\(^5\)

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1 Dussian & Sagarra (2007)  
2 Fernández (2003)  
3 Ferreira (2015)  
4 Swets, Desmet, Hambrik, & Ferreira (2007)  
5 Jun & Bishop (2015)
RC ATTACHMENT AMBIGUITY IN ENGLISH AND CHILDREN: OFF-LINE

- \( N = 29 \) children (\( M_{age} = 6;8 \))
- Exp. 1: Auditory Questionnaire
- Materials -- 12 grammatical sentences:
  
  The doctor recognized the nurse of the pupil who was feeling very tired.

  Who was feeling tired? -- the nurse the pupil

- Results: Low Attachment preference was at chance for children
  
  - Adults: 41%
  - Children: 46.5%

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RC ATTACHMENT AMBIGUITY IN ENGLISH AND CHILDREN: ON-LINE

- Exp. 2: Self-paced listening

- Materials:

  The doctor recognized the nurse/s of the pupil/s who was/were feeling very tired.

- Accuracy of responses:

  -- higher accuracy for LA (of-NP2) in low-span children

<table>
<thead>
<tr>
<th>Group</th>
<th>of-NP1 (%)</th>
<th>of-NP2 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>77</td>
<td>60</td>
</tr>
<tr>
<td>Children with high span</td>
<td>64</td>
<td>59</td>
</tr>
<tr>
<td>Children with low span</td>
<td>55</td>
<td>68</td>
</tr>
</tbody>
</table>
THE PRESENT STUDY: MOTIVATION

- Most experiments have been conducted with:
  - Semantically “deep” materials (e.g., “the maid of the actress”)
  - In the written modality (but cf. Felser et al., 2003)
- English is low-attaching whereas Russian\(^1,\!^2\), Bulgarian\(^3\), and German\(^4,\!^5\) show an inconsistent pattern of attachment preferences
- A cross-linguistic project that includes English, Bulgarian, and Russian, and compares adults and children

1 Sekerina (1997; 2004)  
2 Fedorova, 2008  
4 Hemforth et al. (1996; 1998; 2000; 2015)  
5 Augurzky (2006)
## Method: Participants

<table>
<thead>
<tr>
<th></th>
<th>English</th>
<th>Bulgarian</th>
<th>Russian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults ((N=123))</td>
<td>21</td>
<td>69</td>
<td>33</td>
</tr>
<tr>
<td>Children ((N=76))</td>
<td>14 ((\text{M}_{\text{age}}=5;5))</td>
<td>33 ((\text{M}_{\text{age}}=5;5))</td>
<td>29 ((\text{M}_{\text{age}}=6;1))</td>
</tr>
<tr>
<td>Location:</td>
<td>New Jersey</td>
<td>Sofia</td>
<td>Moscow</td>
</tr>
</tbody>
</table>
**METHOD: DESIGN AND MATERIALS**

- **Design:**
  - The same spoken sentence is combined with 1 of the 3 visual displays: Unamb Low, Unamb High, Ambiguous
  - 9 experimental and 21 fillers

- **Dependent measures:**
  - Accuracy (Unambiguous) and preference (Ambiguous) in naming color
  - [RTs in naming the color]
  - [Eye movements (the Visual World Paradigm)]
Here’s a yellow triangle and a pink triangle. They have different colored tips. What color is the tip of the triangle that has an umbrella in the middle?
RESULTS (ACCURACY): UNAMBIGUOUS LOW

Correct answer: “green”

Adults – at ceiling
Main effect of Age: Children make more errors than adults
RESULTS (ACCURACY): UNAMBIGUOUS HIGH

Correct answer: “blue”

<table>
<thead>
<tr>
<th></th>
<th>Unambiguos</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>97.3%</td>
<td>70.7%</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td>81.7%</td>
<td></td>
<td>63.7%</td>
</tr>
</tbody>
</table>
RESULTS (PREFERENCE): AMBIGUOUS

High attachment answer: “blue”
Low attachment answer: “green”

Preferences

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>66.3%</td>
<td>25.0%</td>
</tr>
<tr>
<td>Children</td>
<td>43.3%</td>
<td>30.0%</td>
</tr>
</tbody>
</table>
ADDITIONAL EVIDENCE FOR THE LOW ATTACHMENT ADVANTAGE (1)

Unambiguous High: “Whole-Object” Errors

<table>
<thead>
<tr>
<th>Language</th>
<th>Adults</th>
<th>Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgarian</td>
<td>0.01%</td>
<td>11.7%</td>
</tr>
<tr>
<td>English</td>
<td>18.7%</td>
<td>29.3%</td>
</tr>
</tbody>
</table>

“Whole-Object” Unambiguous Errors
- Low
- High
ADDITIONAL EVIDENCE FOR THE LOW ATTACHMENT ADVANTAGE (2)

Unambiguous High

Unambiguous Low
DISCUSSION (1)

- A tentative explanation for the “whole-object” errors that are particularly pervasive in children is retrieval interference:

  ... | the tip | of | the triangle | that ___ has an umbrella...

  [target]          [intruder]

  { encoding }   {retrieval}

- The retrieval processes do not distinguish the serial order of candidates. The RC attachment construction is a syntactic structure that demands reliable serial order discrimination, but where NP1 and NP2 cannot be distinguished except by serial order (but cf. case morphology in Russian?)

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High attachment in the visual context paired with the auditory modality taxes cognitive resources and results in cognitive load
  - In the Unambiguous High condition → “whole-object” errors in accuracy
  - In the Ambiguous condition → High is computationally more difficult

Regardless of the general attachment preference in the language (low-attaching English and high-attaching Russian and Bulgarian)

Affects both adults and children (more difficult for children)

Cognitive factors must be more systematically controlled before the psycholinguistic debate of universal parsing strategies is settled.
THANK YOU!
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