The Influence of Prosody and Ambiguity on English Relativization Strategies

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SRCs vs. NSRCs

- The guy who/that likes me just smiled
- The guy who/that I like just smiled

**Complexity:**
Distance between ‘filler’ and ‘gap’
Unbounded dependencies potentially complex
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NSRCs and Ambiguity

- The guy who I think you want e? to succeed e? just smiled
- The guy who I want e? to think that the boss will succeed e?

succeed = win / replace, intrans / trans

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Universal Darwinism

1. Linguistic Variation +
2. Language Acquisition +
3. Linguistic Selection =
4. Linguistic Evolution
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Linguistic Selection

1. Learnability – frequency, interpretability, learning bias...
2. Expressiveness – economy of production, memorability, prestige...
3. Interpretability – ease of perception, resolution of ambiguity...
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A Lexicon Fragment

who(m)  (N\N)/(S/NP)
I       S/(S\NP)
want    ((S\NP)/NP)/VP  (S\NP)/VP
succeed (S\NP)/NP     S\NP
...
Combinatory Categorial Grammar

**Forward Application (FA):**

\[
\frac{X/Y \ Y}{X} \quad \frac{\lambda \ y \ [X(y)] \ (y)}{X(y)}
\]

**Backward Application (BA):**

\[
\frac{Y \ X\ Y}{X} \quad \frac{\lambda \ y \ [X(y)] \ (y)}{X(y)}
\]

**Forward Composition (FC):**

\[
\frac{X/Y \ Y/Z}{X/Z} \quad \frac{\lambda \ y \ [X(y)] \ \lambda \ z \ [Y(z)]}{\lambda \ z \ [X(Y(z))]}
\]
A Derivation

who   want
(N\N)/(S/NP)  ((S/NP)/NP)/VP
------------  FC
(S/NP)/VP
------------  FC
((N\N)/S)/VP

who I want e to succeed

(N\N)/S
<table>
<thead>
<tr>
<th>Stack Cells</th>
<th>Lookahead</th>
<th>Input Buffer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

(\textit{who}) $(\textit{N/N})/(S/NP)$ (\textit{you want}) $(S/NP)/VP$ to $VP/(S/NP)$ $S/VP$

Costs / cell

4 2

3 \textit{Shifts}, 1 \textit{Reduce} to reach this configuration

\textbf{Onset} of the shift-reduce ambiguity at the first potential gap
Working Memory Cost Metric

After each parse step (Shift, Reduce, Halt):

1. Assign any new Stack entry in the top cell (introduced by Shift or Reduce) a cost of 1 multiplied by the number of CCG categories for the constituent represented (Recency)

2. Increment every Stack cell’s cost by 1 multiplied by the number of CCG categories for the constituent represented (Decay)

3. Push the sum of the current costs of each Stack cell onto the Cost-record (complexity at each step, sum = tot. Complexity)
Optimal Ambiguity Resolution

- **Default Parsing Preference**: Prefer Shift over Reduce when Lookahead item can be integrated with cell 1 by Reduce
- Predicts preference for more costly late gap analysis (contra Gibson, 1998)
- This is the optimal strategy if the extrasyntactic information required to override the default action is available at the onset of the ambiguity
- Other things being equal, we expect languages and usage to evolve via linguistic selection for **Interpretability** using the optimal strategy
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Structural vs. Lexical Preferences

- The guy who you wanted to give the present to Sue refused
- The guy who you asked to give the present to Sue refused

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P((S\backslash NP)/VP \mid \text{want}) >> P(((S\backslash NP)/NP)/VP \mid \text{want})
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\[
P((S\backslash NP)/VP \mid \text{ask}) << P(((S\backslash NP)/NP)/VP \mid \text{ask})
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Gibson ‘98 vs. Us

1. I gave the guy who you wanted e? to give the books to e? three books

2. The guy who you think you want e? to succeed e? just smiled

On-line resolution at onset + late gap predicts 1) GP, 2) not-GP
On-line resolution at onset + early gap predicts 2) also mild GP:

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Marking the ‘outer’ RC boundary

- I gave the guy who you wanted to give the books to *tath* three books
- I wouldn’t give the guy who was reading *tath* three books
- I wouldn’t give the guy who was reading three books *tath* another one

Resolves some ambiguity at cost of increased complexity if *tath* is (S|XP)\(\langle\text{N}\rangle\), as this introduces an additional unbounded dependency with the modifiee – not attested typologically (Kuno ’74, Hawkins ’94).
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Prosodic Boundaries

- PBs occur at ‘outer’ ends of RCs (e.g. Venditti, Jun & Beckman ’96)
- PBs are exploited on-line during interpretation (e.g. Warren ’99)
- Actual gaps are always marked by PBs?
  - Intonational/Major PB if coincides with outer end (e.g. Nagel et al., ’94)
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- The guy who you wanna succeed || just smiled
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Complexity Hierarchy

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- (unambiguous NSRCs < ambiguous NSRCs)
- (short NSRCs < long NSRCs)
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BNC (90+10M) and SEC (50K)

- Automatically parsed (RASP)
- Extract and categorize wh-SRCs/NSRCs
- Manually analyse sample of that(-less) RCs
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Ambiguity & Prosody
Corpus/Usage-based Predictions

Results

1. Ambiguous non-actual medial gaps not marked by PBs (35/35 egs)
2. Ambiguous actual medial gaps are marked with inter./minor PBs (39/40 egs)
3. SRCs/NSRCs: 6.9/1 (sp), 6.4/1 (wr), $\chi^2_1 = 3.2, p = 0.07$
4. Unambig/Ambig NSRCs: 4.4/1 (sp), 6.3/1 (wr), $\chi^2_1 = 1.61, p = 0.20$
5. Long/Short: av. lgth 2.81 (sp), 4.07 (wr), t-test, $p = 0.0005$
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1. Trade-off between en/de-coding (grammar) and inference
2. Parallel coding reduces ambiguity without increasing complexity or inference (predicting typological facts)
3. Optimal strategy creates linguistic selection for lgs & utts. which are organised to support it
4. On-line overriding of default late gap preference correctly predicts location of PBs in ambiguous NSRCs
5. Written and spoken usage reflects the predicted costs
6. Are ambiguous medial attachment NSRCs in writing resolved at onset by lexical, semantic or contextual information?
7. Direct testing of on-line processing of ambig. NSRCs with(out) appropriate PBs
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Not quite the end


Questions?