Ambiguities at the interface: production and comprehension

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DGfS 2017 – AG 6
Prosody within LFG

- Frequent mismatches between syntactic and prosodic phrasing
- If given an non-ambiguous string, prosody will never ‘change’ syntax:
  
  I like ambiguities

This talk:

- Look at cases where ‘prosody matters’:
  
  fully ambiguous sentences (produced in a production study)

- Discuss two perspectives: production and comprehension
  
  Comprehension: from form to meaning (prosody → syntax)
  Production: from meaning to form (syntax → prosody)

- Analysis at the syntax–prosody interface in LFG
The genitive/dative ambiguity

Ambiguous structures:

(1) ... dass [der Partner]_DP₁ [der Freundin]_DP₂ zuhörte
    ... that the.masc.NOM partner the.fem.gen/dat friend listened
    ... that the friend’s partner listened // the partner listened to the friend

Necessary ingredients for a full ambiguity:

- an **intransitive verb**, which optionally allows for a dative object.
- a **feminine second DP**

→ syncretism between the feminine form of the dative and the genitive

<table>
<thead>
<tr>
<th>case</th>
<th>masc</th>
<th>fem</th>
<th>neut</th>
</tr>
</thead>
<tbody>
<tr>
<td>nom</td>
<td>der</td>
<td>die</td>
<td>das</td>
</tr>
<tr>
<td>gen</td>
<td>des</td>
<td>der</td>
<td>des</td>
</tr>
<tr>
<td>dat</td>
<td>dem</td>
<td>der</td>
<td>dem</td>
</tr>
<tr>
<td>acc</td>
<td>den</td>
<td>die</td>
<td>das</td>
</tr>
</tbody>
</table>
Ambiguous trees

This results in two possible syntactic structures (c-structures):

a. CP
   C
   dass
   \[\text{DP}_{\text{nom}}\]
   der Partner
   \[\text{DP}_{\text{dat}}\]
   der Freundin
   V
   zuhörte

⇒ The partner listened to the friend

b. CP
   C
   dass
   \[\text{DP}\]
   der Partner
   \[\text{DP}_{\text{gen}}\]
   der Freundin
   V
   zuhörte

⇒ The friend’s partner listened

Structures as encoded in the computational LFG-grammar of German (Dipper 2003)
Are there prosodic indicators that help to disambiguate these structures?

- Are there indicators for a prosodic break between the two DPs?
  → partly identified in previous studies, e.g., Gollrad et al. (2012)
- Are there other indicators in the speech signal?
  ⇒ for a **concrete** analysis at the prosody-syntax interface the exact nature of each of these indicators is needed.
The experiment – Design

Hypothesis:
   a. ... dass der Partner)ϕ( der Freundin ...
   b. ... dass der Partner der Freundin)ϕ(...

Stimuli:
   6 ambiguous and 6 unambiguous structures hidden in a larger text.
   12 unambiguous structures (second DP was masculine)
   9 fully ambiguous structures, provided with a context

Participants: 15 female speakers of German

Data analysis
   18 of the 450 sentences were discarded because there was no discernable pitch
   Remaining files were manually annotated using Praat (Boersma and Weenink 2013): Syllablewise for duration, pauses and pitch value
   Statistical analysis of the different phonetic cues was done with a linear mixed effects regression model (LMER) (with subject and item as crossed random factors and the two conditions (genitive and dative) as fixed factors.)
Overall Results – A prototypical dative

1. Pause
2. Duration \_S2
3. Drop in F\_0
Overall Results – A prototypical genitive

1. Smaller rise in $F_0$

2. Drop in $F_0$
The acoustic cues confirm the prosodic phrasing:

a. ... dass der Partner)φ(der Freundin ... \( \rightarrow \) Dative

b. ... dass der Partner der Freundin)φ(... \( \rightarrow \) Genitive

**Question:** How does the communication at the interface look like?
Introduction to LFG

- Lexical Functional Grammar (LFG, Bresnan and Kaplan (1982))
- Rich lexicon – strong lexicalist hypothesis (only fully formed words enter the syntactic tree)
- Modular – ‘structures’ represent different levels of linguistic information, e.g.,
  - c(onstituent)-structure: linear and hierarchical organisation of a string
  - f(unctional)-structure: abstract functional organisation
- Levels are positioned between the two notions of FORM and MEANING:
  \[ \text{production} \rightarrow \text{MEANING} \leftrightarrow \ldots \text{syntax–prosody} \ldots \leftrightarrow \text{FORM} \leftarrow \text{comprehension} \]
- Levels are related via projection functions
- Strong in syntax and semantics, not much on prosody or postlexical phonology (p-structure)
The syntax–prosody interface

\[ \begin{align*} 
\xi & : \text{The Transfer of structure} \rightarrow \text{Information on syntactic and prosodic grouping is exchanged (higher constituents of the prosodic hierarchy)} \\
\rho & : \text{The Transfer of vocabulary} \rightarrow \text{Associates morphosyntactic and phonological information on lexical elements and projects them to their respective structures} 
\end{align*} \]
A dative in production
1. Multidimensional lexicon

<table>
<thead>
<tr>
<th>concept</th>
<th>s-form</th>
<th>p-form</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARTNER</td>
<td>$\text{N} \ (\uparrow \text{PRED}) = \text{‘Partner’}$</td>
<td>SEGMENTS $\ /p\ a\ t\ n\ e/\ $</td>
</tr>
<tr>
<td></td>
<td>$(\uparrow \text{NUM}) = \text{sg}$</td>
<td>METRICAL FRAME $\ (\text{‘}\sigma\sigma\text{’})_{\omega} \ $</td>
</tr>
<tr>
<td>ARTICLE</td>
<td>$\text{D} \ (\uparrow \text{PRED}) = \text{‘der’}$</td>
<td>SEGMENTS $\ /d\ e\ e/\ $</td>
</tr>
<tr>
<td></td>
<td>$(\uparrow \text{NUM}) = \text{sg}$</td>
<td>METRICAL FRAME $\ (\sigma)_{\omega} \ $</td>
</tr>
<tr>
<td></td>
<td>$(\uparrow \text{GEND}) = \text{fem}$</td>
<td>$\ $</td>
</tr>
<tr>
<td></td>
<td>$(\uparrow \text{CASE}) = {\text{gen}</td>
<td>\text{dat}}$</td>
</tr>
</tbody>
</table>

Table: Lexical entries for der and Partner.

- Modular: strict separation of module-related information
- each lexical dimension can only be accessed by the related module of language
- Translation function: Once a dimension is triggered, the related dimensions can be accessed as well and the information can be instantiated to the related modules
- Surface representation: fully fledged forms, but dynamic generation is assumed
2. The P-diagram: Representation of P-structure

Transfer of vocabulary:
- Lexical phonological information is transferred to p-structure syllablewise.
- Information is stored in the P-diagram.

<table>
<thead>
<tr>
<th>PHRASE</th>
<th>((\sigma)_{\omega})</th>
<th>((\sigma)_{\omega})</th>
<th>((\sigma)_{\omega})</th>
<th>((\sigma)_{\omega})</th>
<th>((\sigma)_{\omega})</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEX_STRESS</td>
<td>-</td>
<td>prim</td>
<td>-</td>
<td>-</td>
<td>prim</td>
</tr>
<tr>
<td>SEGMENTS</td>
<td>/de\textsuperscript{e}/</td>
<td>/pa\textsuperscript{g}/</td>
<td>/tne/</td>
<td>/de\textsuperscript{e}/</td>
<td>/f\textsuperscript{\textae}n/</td>
</tr>
<tr>
<td>VECTORINDEX</td>
<td>S\textsubscript{1}</td>
<td>S\textsubscript{2}</td>
<td>S\textsubscript{3}</td>
<td>S\textsubscript{4}</td>
<td>S\textsubscript{5}</td>
</tr>
</tbody>
</table>

- Compact model imitating the linear nature of the speech signal over time.
- Structured syllable-wise (but doesn’t have to be).
- Each syllable receives a feature vector associating the syllable with a number of values referring to a number of attributes.
3. Transfer of structure

Transfer of vocabulary complemented by the Transfer of structure:
Information on prosodic structuring projected to p-structure by means of syntactic structuring (cf. Selkirk (2011)'s match theory)

⇒ From here onwards subject to the phonology-phonetics interface
Intermediate summary

Fairly straightforward from the viewpoint of production:

1. Transfer of vocabulary
   - Relates syntactic terminal nodes to the corresponding phonological forms
   - Transfers phonological information syllablewise into p-structure

2. Transfer of structure
   - ‘Translates’ syntactic structure into prosodic structure
   - Adds this information to p-structure
The dative in **comprehension**

From the viewpoint of comprehension, the p-diagram looks slightly different:

- Takes the speech signal divided into syllables as a starting point.

![Diagram with columns labeled PHRASE, SEMIT._DIFF, PAUSE, P._DURATION, DURATION, FUND. FREQ., VALUE, VECTORINDEX, and an annotation](image)

- Is it enough to just reverse the annotation?

\[ \text{Is it enough to just reverse the annotation?} \]

\[ \overline{\text{T}(\star)}S_{\text{max}} \overset{\text{PHRASE}}{\Rightarrow} \overset{\text{c}}{\text{c}})_{\text{PhP}} \]

\[ \overset{\text{c}}{=} \overset{\text{c}}{\text{c}} \rightarrow \text{‘must equal’} \]
The dative in comprehension

In the case of syntactic ambiguities, syntax could ‘check’ p-structure to see whether a phonological phrase boundary is present:

\[ \begin{array}{c}
\text{VP} \\
\downarrow \\
\text{DP}_{\text{nom}} \quad \text{DP}_{\text{dat}} \quad \text{V} \\
\downarrow \\
\text{φ}(T(\ast))_{S_{\text{max}}} \text{PHRASE}=c \)_{\text{PhP}} \\
\text{der Partner} \quad \text{der Freundin} \quad \text{zuhörte}
\end{array} \]

→ If (and only if) a PhP boundary is present, the syntactic structure is parsed
However ....

Revisiting the results, looking at the individual speakers ...

For the **dative**:

- Pause (40%)
- Duration (47%)
- $F_0$ reset (40%)

→ 33% of the speakers did not show any specific encoding in production!
⇒ **Hard** constraints cannot be applied!
‘Likelihood’

Can be resolved by adding ‘OT-like’ constraints, marking the preferred option (=ranking):

$$\text{DP}$$
$$\{(\#(T(\ast))) S_{max} \text{ PHRASE} \rangle =_{c} \text{PhP}$$
$$\text{PhPbreak} \in o^*$$
$$|((\#(T(\ast))) S_{max+1} \text{ PHRASE}) \neq \text{PhP}\}$$

- If ‘PhP’ present, prefer this structure
- Else: parse it anyway
- Unless: there is a preference mark in the genitive construction
  
→ Softening of constraints via OT-like marks allow for the necessary flexibility
Conclusion

- Syntactic analysis of German dative/genitive case leads to ambiguities
- German speakers disambiguate dative and genitive constructions by means of prosody

→ **The production** of a dative is relatively straightforward at the syntax-prosody interface

- However, the annotations cannot be simply reversed: up to 33% of the speakers do not produce the necessary acoustic cues to indicate a PhP

⇒ From the perspective of **comprehension**: If checking for prosodic phrasing becomes necessary, soft constraints are an absolute necessity.
Thank you!

Questions?

comments, suggestions, ...?