

# Ambiguities at the interface: production and comprehension

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# 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]<sub>DP1</sub> [der Freundin]<sub>DP2</sub> zuhörte  
 ... that the.MASC.NOM partner the.FEM.GEN/DAT friend listened  
 ... that the friend's partner listened // the partner listened to the friend

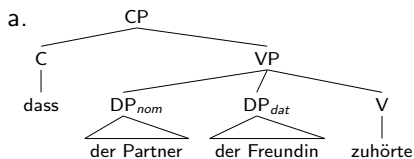
Necessary ingredients for a full ambiguity:

- 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

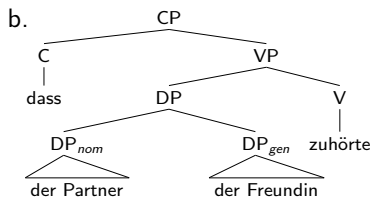
case	masc	fem	neut
nom	der	die	das
gen	des	der	des
dat	dem	der	dem
acc	den	die	das

# Ambiguous trees

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



⇒ The partner listened to the friend



⇒ The friend's partner listened

Structures as encoded in the computational LFG-grammar of German (Dipper 2003)

# Question

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)<sub>φ</sub>( der Freundin ...
- b. ... dass der Partner der Freundin)<sub>φ</sub>(...

## 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

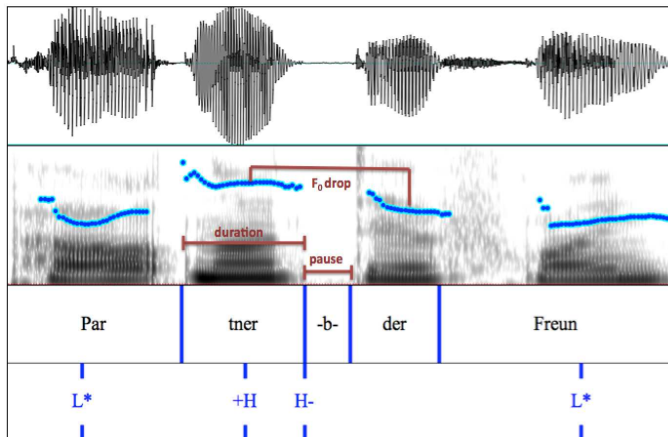
**Participants:** 15 female speakers of German

## 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.)

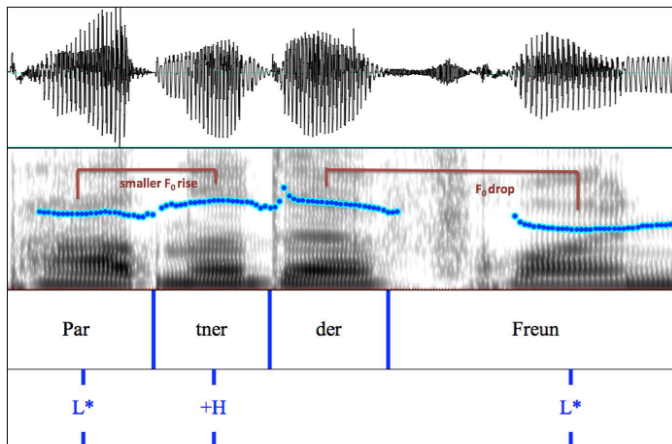
# Overall Results – A prototypical **dative**

1. Pause
2. Duration\_S2
3. Drop in  $F_0$



# Overall Results – A prototypical **genitive**

1. Smaller rise in  $F_0$
2. Drop in  $F_0$





# Overall Results – Conclusion

The acoustic cues confirm the prosodic phrasing:

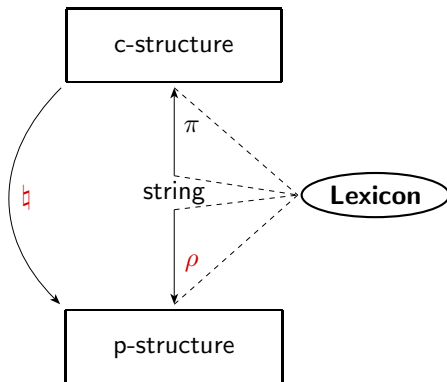
- a. ... dass der Partner)<sub>φ</sub>(der Freundin ... → *Dative*
- b. ... dass der Partner der Freundin)<sub>φ</sub>(... → *Genitive*

**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:  
*production* → MEANING ↔ ... syntax–prosody ... ↔ FORM ← *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



$\hbar$ : The **Transfer of structure** → Information on syntactic and prosodic grouping is exchanged (higher constituents of the prosodic hierarchy)

$\rho$ : The **Transfer of vocabulary** → Associates morphosyntactic and phonological information on lexical elements and projects them to their respective structures

# A dative in **production**

# 1. Multidimensional lexicon

concept	s-form	p-form
PARTNER	N (↑ PRED) = 'Partner' (↑ NUM) = sg	SEGMENTS /p a <sup>ː</sup> t n e/ METRICAL FRAME ('σσ) <sub>ω</sub>
ARTICLE	D (↑ PRED) = 'der' (↑ NUM) = sg (↑ GEND) = fem (↑ CASE) = {gen  dat}	SEGMENTS /d e <sup>ː</sup> / METRICAL FRAME (σ) <sub>ω</sub>

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:

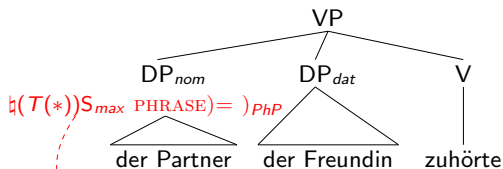
- Lexical phonological information is transferred to p-structure syllablewise
- Information is stored in the P-diagram

...	...	...	...	...	...	...
PHRASE	$(\sigma)_\omega$	$(\sigma$	$\sigma)_\omega$	$(\sigma)_\omega$	$(\sigma$	$\sigma)_\omega$
LEX_STRESS	-	prim	-	-	prim	-
SEGMENTS	/de <sup>e</sup> /	/pa <sup>h</sup> /	/tne/	/de <sup>e</sup> /	/fʁɔœn/	/din/
VECTORINDEX	<b>S<sub>1</sub></b>	<b>S<sub>2</sub></b>	<b>S<sub>3</sub></b>	<b>S<sub>4</sub></b>	<b>S<sub>5</sub></b>	<b>S<sub>6</sub></b>

- 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*)



...	...	...	...	...	...
PHRASE	$(\sigma)_\omega$	$(\sigma \quad \sigma)_\omega$	$\text{) }_{PhP}$	$(\sigma)_\omega$	$(\sigma \quad \sigma)_\omega$
SEGMENTS	/de <sup>e</sup> /	/pa <sup>u</sup> /	/tne/	/de <sup>e</sup> /	/fʊɔɔ̃n/
VECTORINDEX	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>6</sub>

⇒ 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

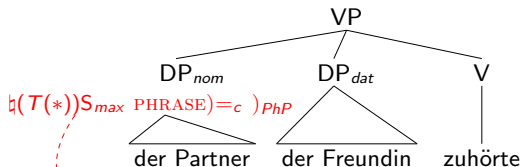
↑ PHRASE	↑	-	-	) <sub>PhP</sub>	...	↑ interpretation
SEMIT._DIFF		..	-1.3	4.8	...	↓
PAUSE		-	-	3	...	
P._DURATION		-	-	0,058	...	signal
DURATION		0,12	0,22	0,16	...	↓
FUND. FREQ.		178	165	218	...	
VALUE		[de <sup>e</sup> ]	[pa <sup>h</sup> t]	[ne]	...	
VECTORINDEX		S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	... →

- Is it enough to just reverse the annotation?

$$\begin{aligned} \downarrow (T(*)S_{max} \text{ PHRASE}) =_c )_{PhP} \\ =_c \rightarrow \text{'must equal'} \end{aligned}$$

# The dative in comprehension

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



...	...	...	...	...	...	...
PHRASING	$(\sigma)_\omega$	$(\sigma$	$\sigma)_\omega) \text{ PhP}$	$(\sigma)_\omega$	$(\sigma$	$\sigma)_\omega$
SEGMENTS	/de <sup>e</sup> /	/pa <sup>b</sup> /	/tne/	/de <sup>e</sup> /	/fʊɔœn/	/dɪn/
VECTORINDEX	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>5</sub>	S <sub>6</sub>

→ 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<sub>0</sub> 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):

DP

$$\{(\mathfrak{h}(T(*))S_{max} \text{ PHRASE}) =_c \text{ PhP} \\ \text{PhPbreak} \in \mathfrak{o}^*\}$$

$$\{(\mathfrak{h}(T(*)) S_{max+1} \text{ PHRASE}) \neq \text{ PhP}\}$$

- 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, ...?