Recursion in German intonation phrase structure

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1. Introduction

The Prosodic Hierarchy:

utterance (υ)
|
intonational phrase (ι) (here: i-phrase)
|
phonological phrase (φ) (here: p-phrase)
|
prosodic word (ω)
|
foot (Ft)
|
syllable (σ)

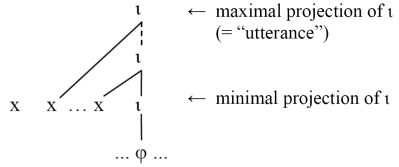
The Strict Layer Hypothesis:
"a category of level *i* in the hierarchy immediately dominates a (sequence of) categories of level *i-1*" (Selkirk 1984:26), where syllable is category 1, foot is category 2, and so forth.

Constraints on prosodic domination (Selkirk 1995):
(where C^n = some prosodic category)

i.	Layerdness	No C^i dominates a C^j, j > i
ii.	Headedness	Any C^i must dominate a C^{i-1} (except if $C^i = \sigma$)
iii.	Exhaustivity	No C^i immediately dominates a constituent C^j, j < i-1
iv.	**Nonrecursivity**	**No C^i dominates C^j, j = i**

Prosodic recursion:
Ladd 1986,1996; Wagner 2005; Ito & Mester 2007, 2010; Selkirk 2009a, 2009b; Féry 2010; Féry & Schubö 2011; among others

Prosodic projection structures (Ito & Mester 2007, 2010):



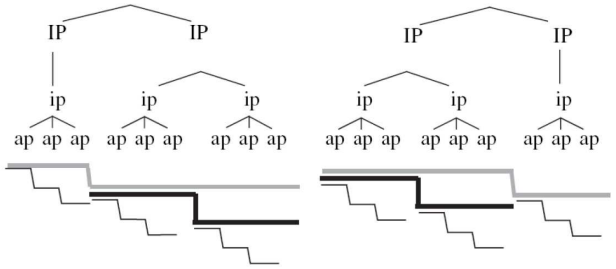
This study:
- Examine German i-phrase structure in regard to recursion
  - Does prosodic recursion exist in German?
  - If so, how does it emerge?
- Revisit data of prior work (Féry & Truckenbrodt 2005) and argue for prosodic recursion of i-phrases
  - Hypothesize about the emergence of recursion
    - General syntax-prosody-mapping principle
    - Communicative device for disambiguation
- Experiment on i-phrase realization
  - Acoustic analysis of complex clause configurations shows that i-phrase recursion is a general syntax-prosody-mapping principle
- Phonological representation: interface account in the framework of OT (Prince & Smolensky 1993)

2. Background

German prosody:
- intonation language
- autosegmental-metrical model (Pierrehumbert 1980):
  - local events account for global intonation contours
  - GToBI (Grice & Baumann 2002):
    - prenuclear pitch accents: H*, L*, L*+H, L+H*
    - nuclear pitch accents: H+L* (final i-ph.), L*+H (non-final i-ph.)
    - boundary tones: L-, H-, L%, H%
- Prosodic structure (above ω):
  - p-phrase: one pitch accent plus L- or H- edge tone
  - i-phrase: one or more p-phrases plus L% or H% edge tone
    - right-headed: nuclear pitcht accent on the rightmost p-phrase
  - (utterance: one or more i-phrases)
- H targets of pitch accents define register levels by introducing phrasal reference lines (Truckenbrodt 2002)
- The reference line of the initial p-phrase defines the register level of the i-phrase (Truckenbrodt 2002)
- reference line lowering on the level of the i-phrase
  - embedded register levels (Truckenbrodt 2002):
    - downstep applies to adjacent reference lines on the same prosodic level
- i-phrase detection:
  - reference line lowering (partial reset)
  - nuclear pitch accent, optionally targeting the i-phrase reference line (nuclear upstep)
  - H-H% boundary tone, targeting the i-phrase reference line
  - L-H% boundary tone, targeting the (lowered) reference line of the following i-phrase
  - L% boundary tone
- i-phrase prediction:
  - two constraints in free ranking (Truckenbrodt 2005):
    - Align(CP, R; i-phrase, R)
      The right edge of a CP must coincide with the right edge of an i-phrase
    - Wrap-CP
      Each CP is contained in a single i-phrase

Hierarchical organization and tonal scaling (Féry & Truckenbrodt 2005):

- F0 analysis of clause configurations:
  - A but [B and C]
  - [A and B] but C
  - where A, B, and C are main clauses
- realized as answers to a context providing question
- reproduction of an experiment on English by Ladd (1988):
  - [A and B] but C:
    [Alan is a stronger campaigner *and* Ryan has more popular policies] *but* warren has a lot more money



The deeper the steeper (TDTS):
Downstep among sister-nodes is relatively stronger for constituents relatively lower in the hierarchical [prosodic] representation.

3. Revisiting Féry & Truckenbrodt (2005):

- same phonetic correlates for the prosodic categories ip and IP (ip = intermediate phrase, IP = intonation phrase or i-phrase):
  - relative reference line lowering
  - targets of H% boundary tones
  - targets of upstepped L*+H nuclear accents
- no distinctive phonetic correlate for the prosodic category Utterance in German (cf. Ito & Mester 2010)
- reanalysis following Ladd (1996) for English (cf. Féry 2010):

The emergence of prosodic recursion:

- i-phrase structure mirrors syntactic structure:
  - a general mapping requirement of the syntax-prosody interface?

- branching depends on the context:
  - [A and B] but C vs. A and [B but C]
  - syntactic structure reflected by prosodic structure only in cases with several branching possibilities?
    - recursion of i-phrases is required to signal the correct syntactic branching
    - if only one possibility of branching is given, syntactic structure is not reflected in i-phrase structure and recursion does not emerge

Hypothesis 1: Recursion in the hierarchical organization of German i-phrases is a general outcome of the syntax-prosody-mapping. It results from the requirement for prosodic structure to reflect syntactic structure.

Hypothesis 2: Recursion in the hierarchical organization of German i-phrases emerges only in cases with several branching possibilities.

4. Experiment

Stimuli:

- complex clause configurations with unambiguous branching
- predicted to cause three i-phrase boundaries (at the lowest level)

[Subj. [RelCl.] Predicate] *and* [Subj. Pred.]
( )( )( ) i-phrase
( )( ) i-phrase ?

[Subj. Pred.] *and* [Subj. [RelCl.] Predicate]
( )( )( ) i-phrase
( )( ) i-phrase ?

[Subj. Pred.] *and* [Subj. Pred.] *and* [Subj. Pred.]
( )( )( ) i-phrase

Example:
Die Kellner, die die Gläser gestohlen haben, wollen den Herren die Weine bringen, und die Jungen wollen die Beeren sammeln.

'The waiters who stole the glasses want to bring the wines to the men, and the boys want to collect the berries.'

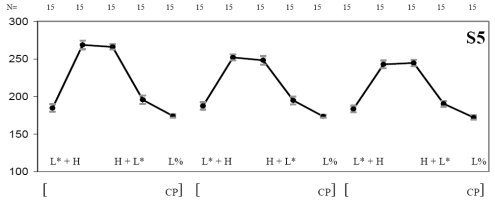
Methods:

- stimuli: 3 structure conditions, 2 length conditions, 5 sentences = 30 items
- procedure:
  - five female native speakers
  - visual presentation of stimuli
  - instruction to read the sentences as natural as possible
  - audio recording in a soundproof booth
  - three repetitions per speaker
- tokens:30 items, 5 speakers, 3 repetitions = 450 recorded tokens
- acoustic analysis:
  - collection of F0 values with Praat (script and manual correction)

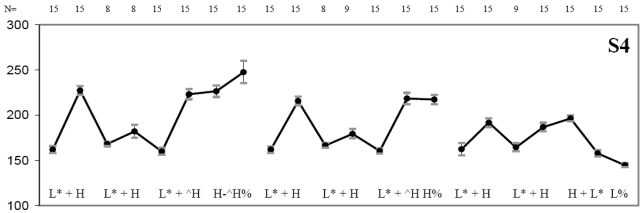
- pools of absolute values for each speaker, 95% confidence intervals
- transformation of F0 values:
  transformed value = (absolute value – lowest value) / (highest value – lowest value)
- pools of transformed values for all speakers, 95% confidence intervals

Results:

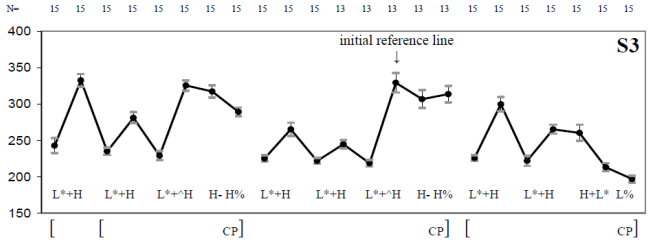
baseline:



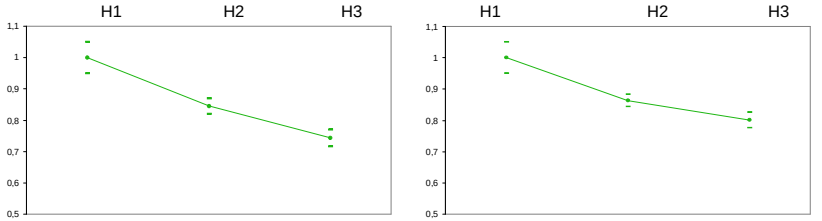
complex right:



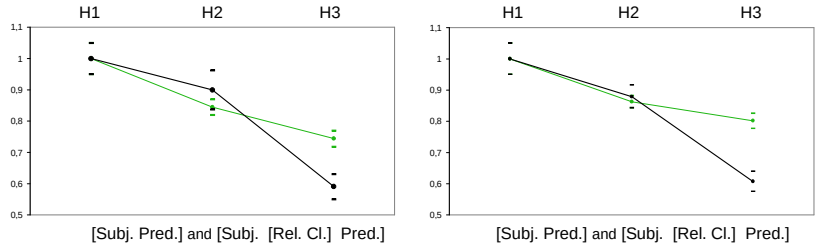
complex left:



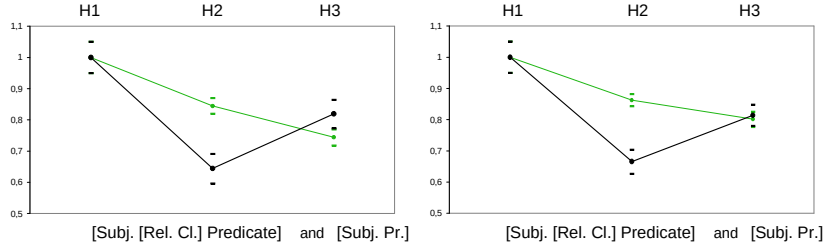
baseline: all speakers (n=75) SHORT LONG



complex right: all speakers (n=75) SHORT LONG



complex left: all speakers (n=75) SHORT LONG



- same lowering patterns of reference lines as in the data of Féry & Truckenbrodt (2005)
- nuclear upstep on the initial reference line (when the complex clause is on the left)

Phonological Representation:

- baseline: gradual lowering suggests a flat i-phrase structure
- complex right: steep lowering of the final reference line suggests a right-branching i-phrase structure (TDTS)
- complex left: partial reset of the final reference line suggests a left-branching i-phrase structure (TDTS), nuclear upstep suggests the presence of the initial reference line
- highest prosodic constituent: i-phrase (not Utterance), following Ito & Mester (2010)
- Hypothesis 1 confirmed

- root clauses are mapped on corresponding i-phrases
- embedded clauses cause i-phrase boundaries to their right

Interface model:

- Truckenbrodt's (2005) grammar cannot account for recursive i-phrases

	[[[ ]][ ]]	Align-R (CP, IP)	Wrap (CP, IP)
a.	((( )( ))( ))		
b.	(( )( )( ))		
c.	(( )( ))	*!	

- Modification of Wrap-CP according to Ito & Mester's (2007, 2010) model:

Wrap (CP, i-phrase$_{min}$)
Each CP is contained in a single minimal i-phrase

	[[[ ]][ ]]	Wrap (CP, i-phrase$_{min}$)	Align-R (CP, i-phrase)
a.	((( )( ))( ))	*!	
b.	(( )( )( ))	*!	
c. →	(( )( ))		*

- constraint that maps each constituent with root status in syntactic structure to a matching i-phrase in prosodic structure:
  Align-L-R (Root, i-phrase)
  The left and right edge of a constituent with root clause status must coincide with the left and right edge of a single i-phrase
- similar to the constraint Align-CommaPhrase (Selkirk 2005)
- remniscient of a Match Constraint (Selkirk 2009a,b)
- formulated according to Alignment theory (Selkirk 1996)
- but alignment of both edges

	[[ ]] [ ]	Align-R (CP, i-phrase)	Wrap (CP, i-phrase$_{min}$)	**Align-L-R (Root, i-phrase)**
a. →	(( )( )) ( )		*	
b.	( )( ) ( )		*	*!
c.	( ) ( )	*!		

	[[ ][ ]] [ ]	Align-R (CP, i-phrase)	Wrap (CP, i-phrase$_{min}$)	**Align-L-R (Root, i-phrase)**
a. →	(( )( )) ( )			
b.	( )( ) ( )			*!
c.	( ) ( )	*!		**

- recursion exists in the prosodic structure of German i-phrases
  - a general outcome of the syntax-prosody-interface
- i-phrase structure mirrors syntactic structure of complex clause configurations
- match requirement of syntactic root constituents and i-phrases
  - Align-L-R (Root, i-phrase)

  - similar to Align-CommaPhrase (Selkirk 2005)
  - remniscient of a Match constraint (Selkirk to appear)
    - requires a match of constituents
    - differs in that it only refers to root clauses
    - not formulated in terms of Match because a standard Alignment constraint (Align-CP) and a (modified) Wrap constraint (Wrap (CP, i-phrase$_{min}$)) are required
- right edge requirement of CPs and i-phrases
  - Align-R (CP, i-phrase)
- recursive i-phrase structures emerge when root constituents contain other constituents that cause i-phrase boundaries
- the system of prosodic projection structures (Ito & Mester 2007, 2010) is expedient in order to account for prosodic recursion
- both Alignment and Match type constraints are required for a syntax-prosody-interface model of German i-phrase structure

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