

Linguistic prominence and loudness: a systematic comparison between lexical word stress, sentence accent and vocal effort



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**Or shorter:
Is there lexical stress without
accent?**

**And if YES
Is this difference cued by
loudness?
Evidence from German**

Lexically stressed vs. unstressed

Stressed segments
/ˈleː/ in **L**ena

vs. unstressed

/le/ in **L**enor

- longer
- vowels more peripheral
- louder: more energy in the higher frequency regions (subglottal pressure)

also in deaccented position
when sentence accent is
neutralized???

- YES: Sluijter (Dutch)
- YES: Sluijter (Dutch)
???: Campbell (AmEngl)
- YES: Sluijter (Dutch)
NO: Campbell (AmEngl)
Fant (Swedish)

➔ Very inconsistent

➔ No data on German

Three main questions concerning lexical stress without accent

1. Does this distinction cause a different tune-text alignment?

analysis of f0-synchronisation

2. Are there supralaryngeal (non-tonal) differences?

duration and formant analysis

3. Are there vocal effort differences?

analysis of glottal pulses

Corpus: Stress

	Stressed [+S]	Unstressed [-S]
/ le /	Lena <i>/ˈle:nə/ person's name</i>	Lenor <i>/leˈnɔə/ washing powder</i>
/ ze /	Sehnen <i>/ˈze:n̩/ sinews</i>	Senat <i>/zeˈnɑ:t/ senate</i>

Corpus: Focus

Question-Answer paradigm

FOCUS [+F]

[+S]: Q: Wolltest Du Dir Friedas Buch ausleihen?

A: Nein, ich wollte Lenas Buch ausleihen.

[-S]: Q: Kaufst Du Omo oder Lenor bei Schlecker?

A: Ich kaufe Lenor bei Schlecker.

NON-FOCUS [-F]

[+S]: Q: Wie findest Du Lena?

A: Ich hasse Lena und ihre Schusseligkeit.

[-S]: Q: Wäschst Du nicht gern mit Lenor und Omo?

A: Ich hasse Lenor und Omo.

Corpus: vocal effort

Sentences with focused and stressed test sequences were spoken in 3 loudness conditions:

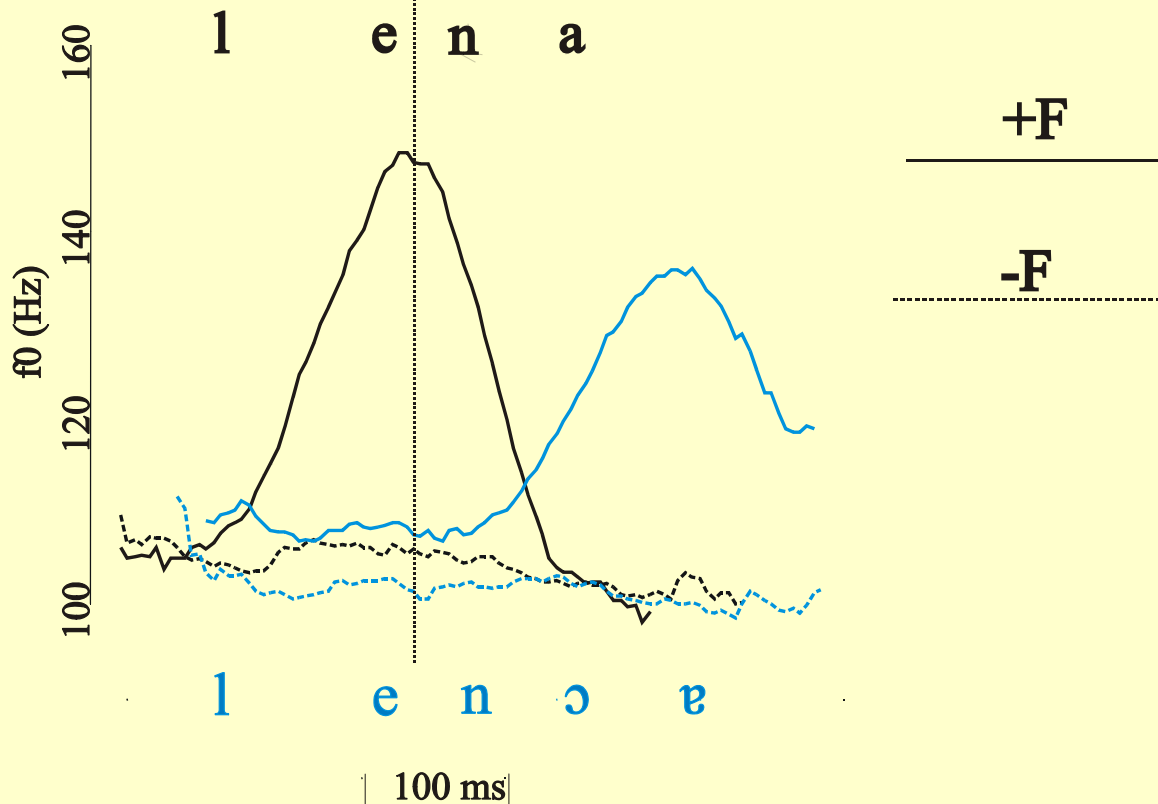
- comfortable
- loud: „speak loudly without shouting“
- soft: „speak softly without whispering“

All sentences were repeated 8 to 9 times

Recordings and analysis

- 5 speakers of Northern German,
1 speaker from Berlin (DP)
(20 to 30, non-smokers, male)
- Glottal waveforms by Laryngograph processor
- Acoustical labelling in Praat
- Computation of f0 contours, RMS and
formant tracks by EMU-tkassp from Kiel
- speaker normalization for formants: Lobanov
- Prosodic labelling by using EMU/R

1. F0 contours



- Clear peaks in accented position
 - Flat contour for deaccented words
- ➔ Similar f0 values for [-F] and [+F, -S]

Speaker-dependent variability:

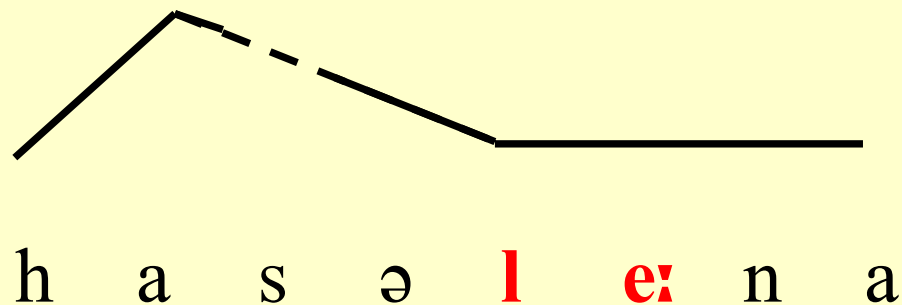
- Speaker DP (Berlin) never deaccented *Lena*, but all *Lenor*
- Speaker SB very variable patterns

1. Alignment of L-

- Grice et al. (2000): L- after H* is aligned to the next strong syllable in falling rising contours in German

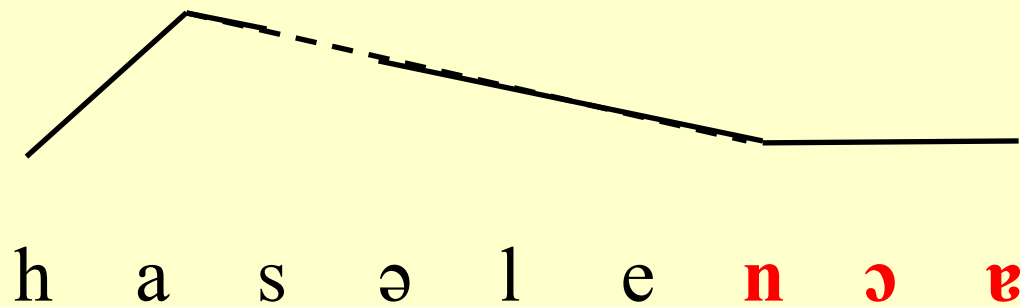
LENA:

→ steep slope during /ə/



LENOR:

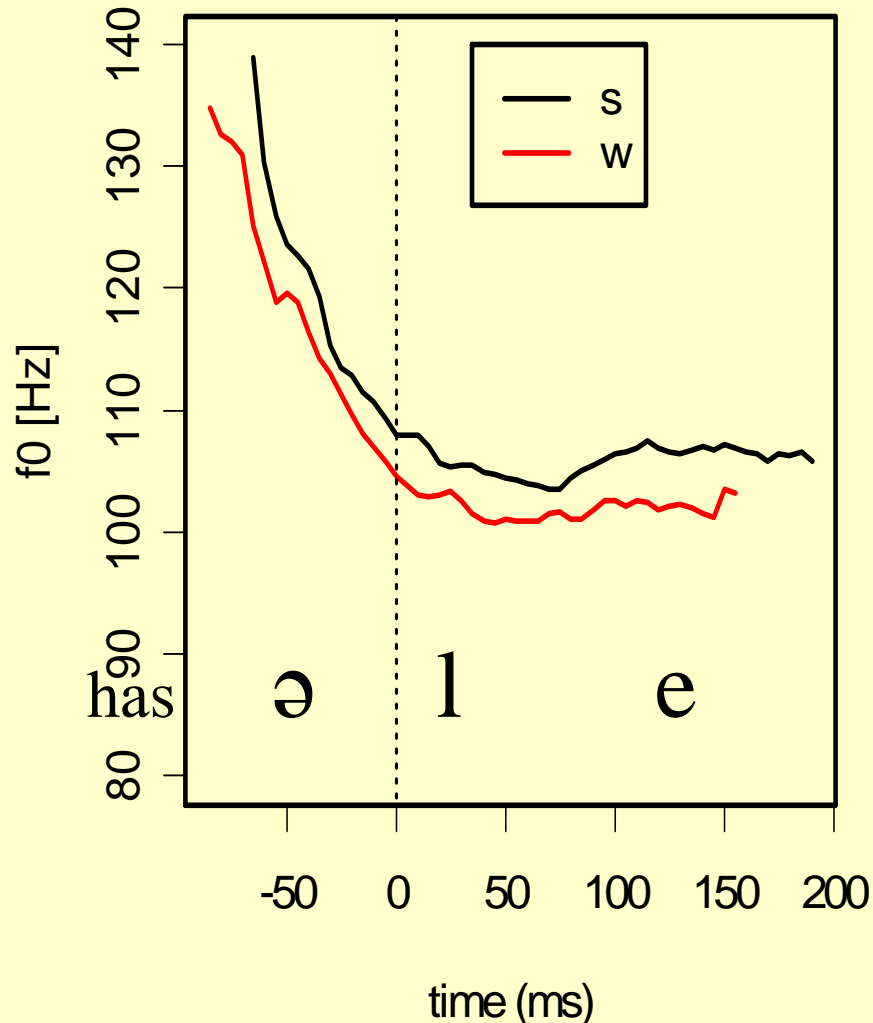
→ shallower slope during /ə/



1. Alignment: F0 contour

BD

Averaged contour for one speaker



Onset: begin of ə (*hase*)

Offset: end of first syllable
(*Lena or Lenor)*

Line-up point: end of ə
(*hase*)

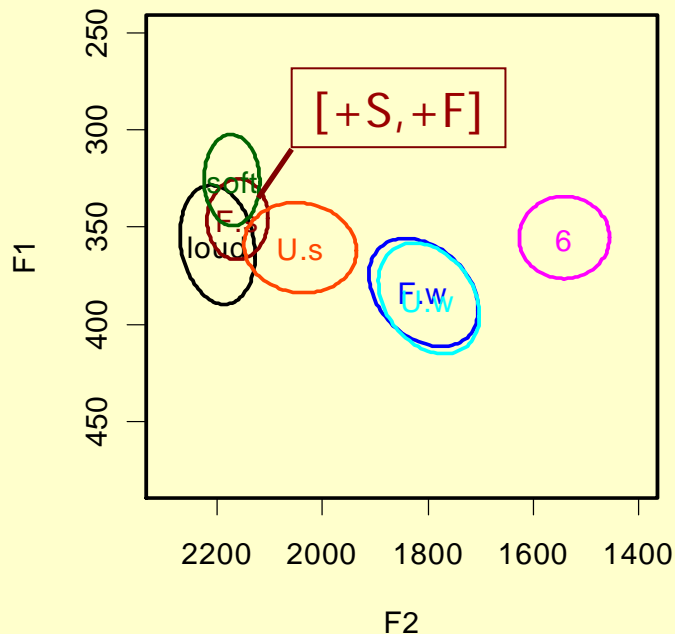
/*hasə 'le:na/*: strong condition

/*hasə le'nɔə/*: weak condition

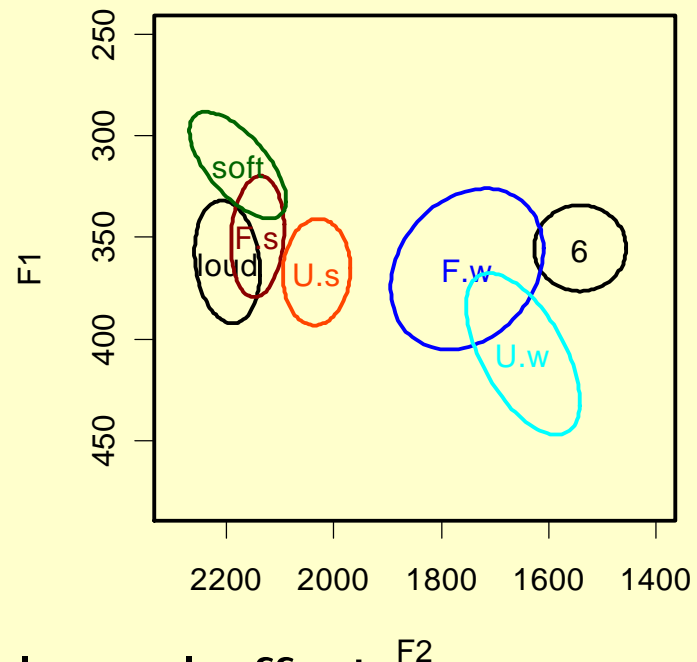
➔ No difference

2. Vowel quality: Formants

Lena - Lenor



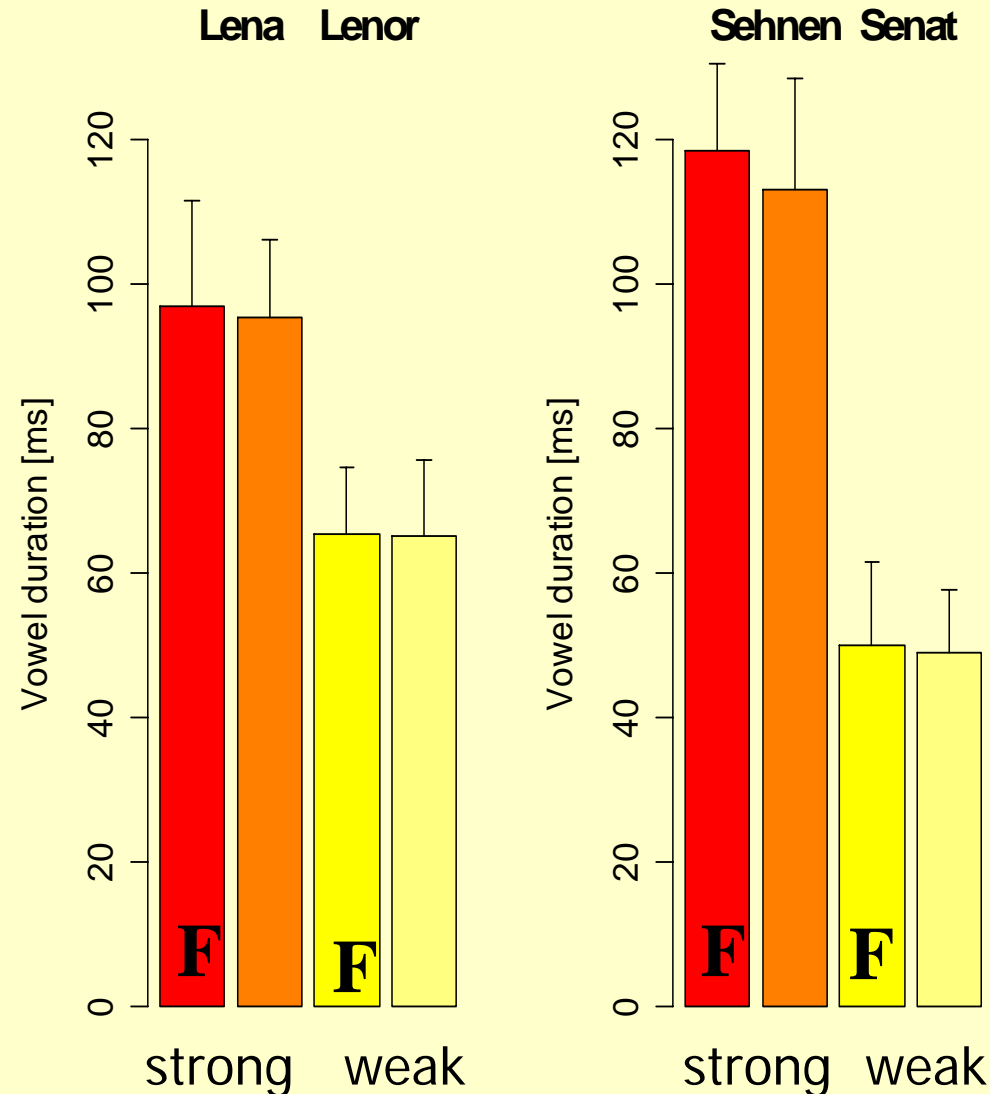
Sehnen - Senat



- F1 increases with *greater* global vocal effort and with *lower* degrees of prominence (\leftrightarrow sonority expansion)
- /e/ in unstressed syllables is centralized (= F2 lowering) but still distinct from /ə/ (6)
(except for /e/ in Senat of speaker DP from Berlin)

2. Duration: vowels

Red: stressed
Yellow: unstressed
F: focussed
without: unfocussed



- Shortening of unstressed vowels
- Differences are greater for /e/ in Sehnen vs. Senat
- No significant effects of accent

2. Duration: initial consonants

- Shortening of consonants in weak syllables

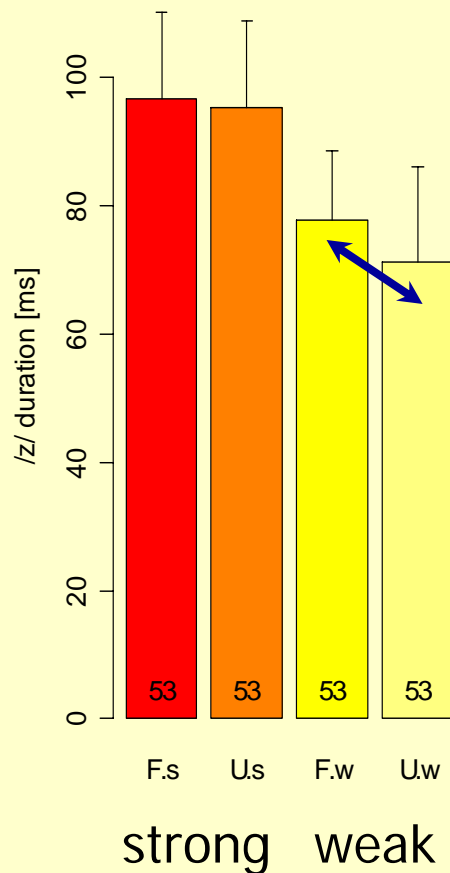
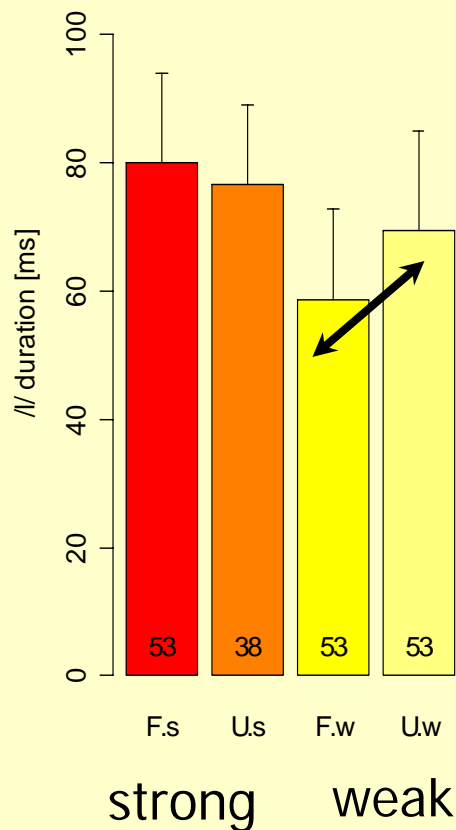
ACCENT:

- shorter /l/ in weak syllables for [+F]

- longer /z/ in weak syllables for [+F] → effect of devoicing

Lena Lenor

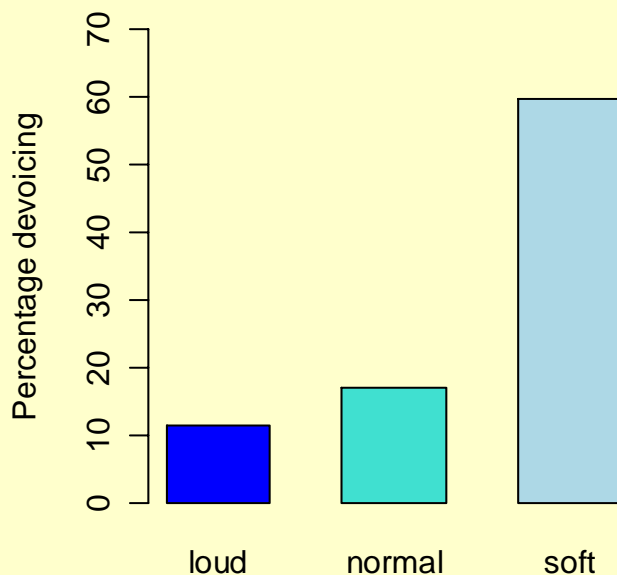
Sehnen Senat



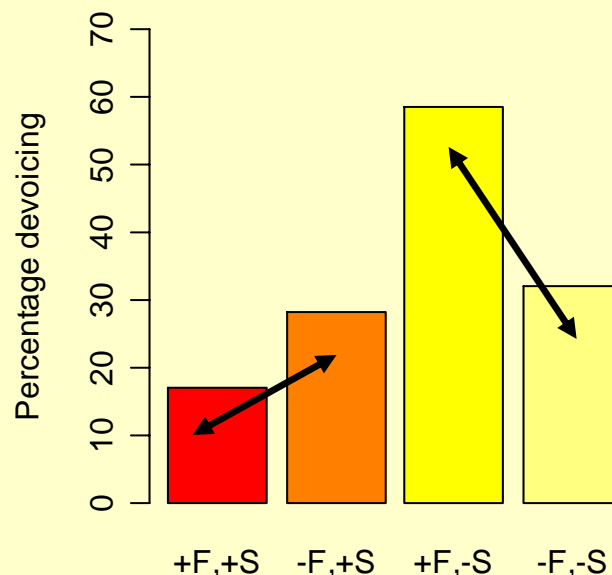
2. Devoicing of /z/

(voicing of /z/ is not distinctive in this position)

Vocal effort



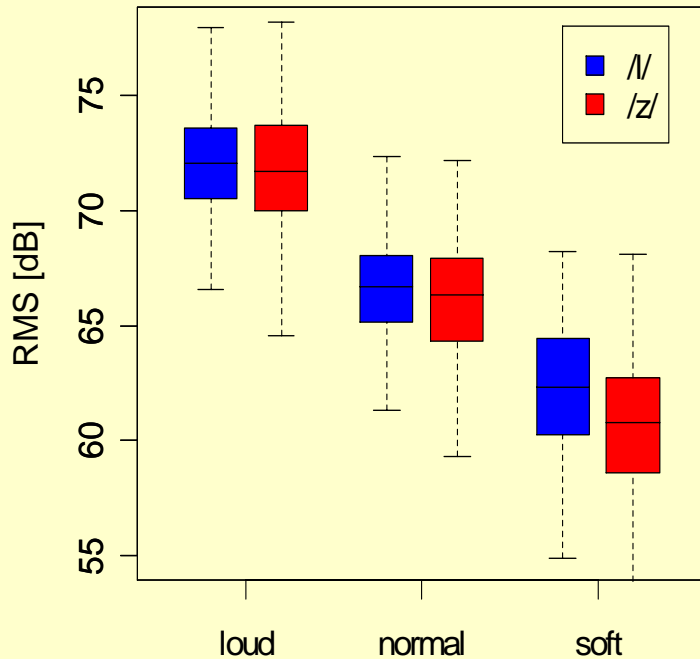
Ling. prominence



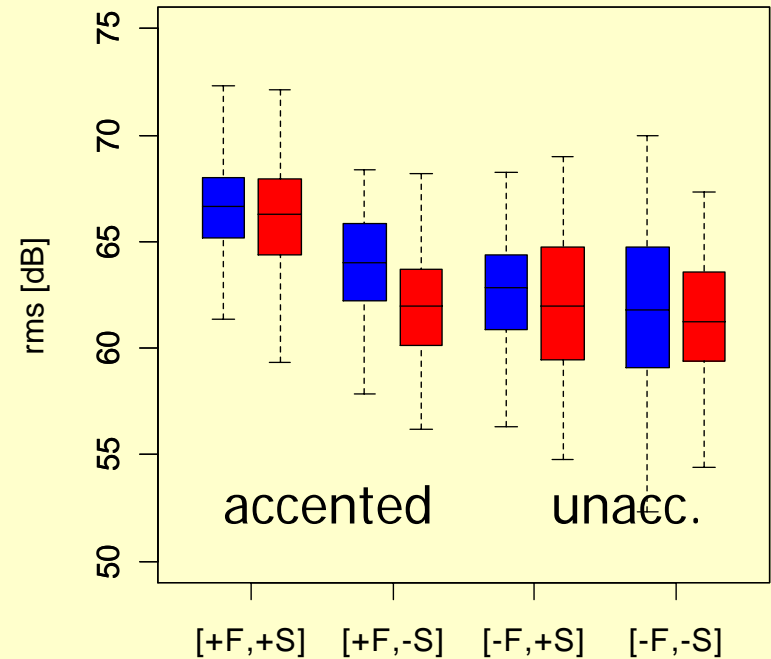
- Frequency of devoicing increases with decreasing vocal effort
- ➔ decreasing subglottal pressure (passive devoicing)
- More frequent devoicing of /z/ in *Sehnen* when unaccented
- Opposite pattern for *Senat*: more often devoicing in accented position

3. Intensity and glottal pulse

Vocal effort



Ling. prominence



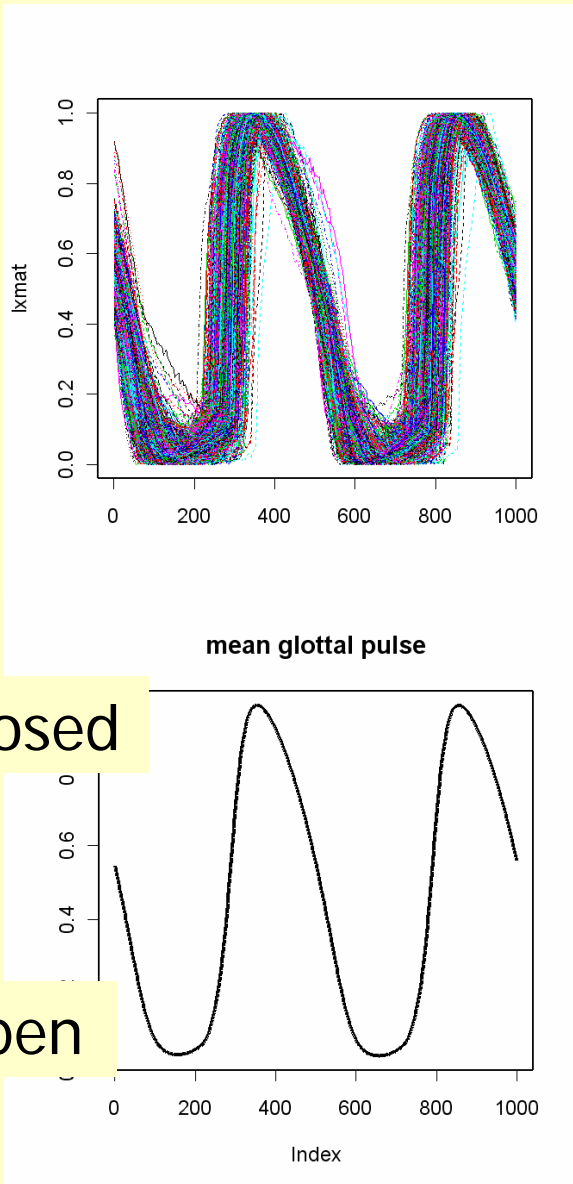
Intensity during vowel

- Clear decrease of intensity for global vocal effort changes

Unaccented condition

- /l/: little but significantly higher intensity for stressed than unstressed
- /z/: no difference

3. Glottal pulses: EGG



- Two periods taken from mid-vowel
 - time and amplitude normalized glottal periods
 - Quicker closing of the folds than opening
 - EGG: difficulty in determining the instance of glottal opening
- ➔ Not OQ and SQ was analysed but the shape of the glottal pulse

3. Glottal pulses: FDA

- Holistic analysis of the glottal pulse shape by using **F**unctional **D**ata **A**nalysis
= functional versions of time-variant digital data by computing splines
(here: Fourier splines)

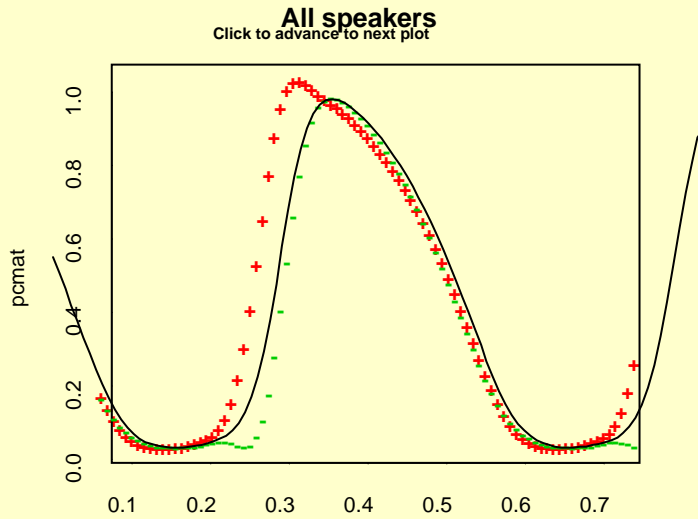
Advantage:

- continuity
- Tools: functional version of PCA

Principal Component Analysis: extraction of relevant factors for explaining the sources of the variance in the data

Transformation of the raw data to a new coordination system → factor scores

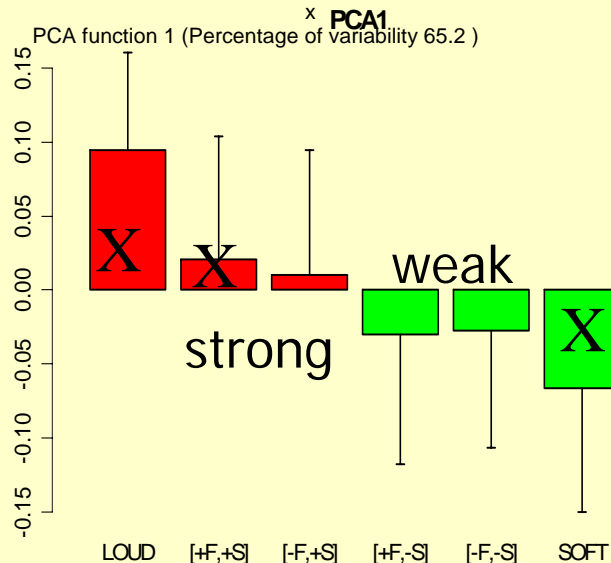
3. Glottal pulses: shape



Positive: longer closed phase,
steeper rising
(\approx loud speech)

Negative: longer open phase, later
peak
(\approx soft/breathy)

Analysis of resulting factor scores:
what items (e.g. loud) are similar
to the extreme values?



- ➔ Significant differences between loud, normal and soft
- ➔ Significant differences between stressed and unstressed, independent of accent

3. Glottal pulse: individual speakers

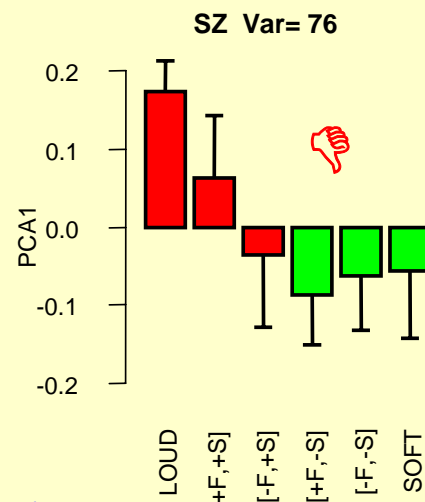
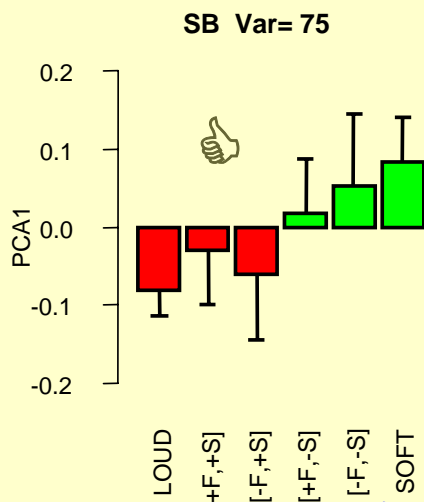
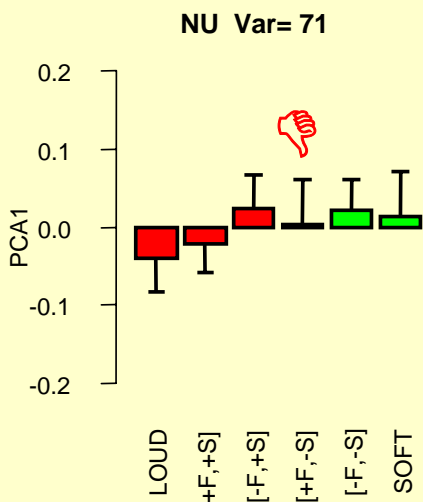
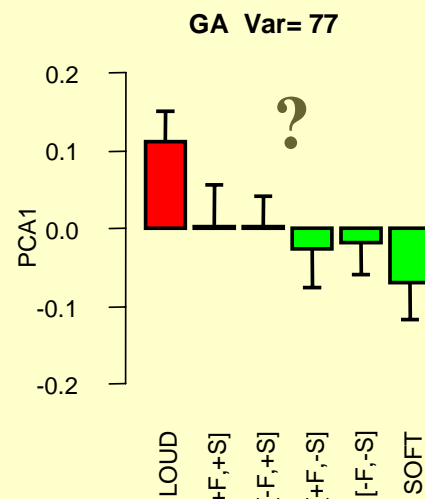
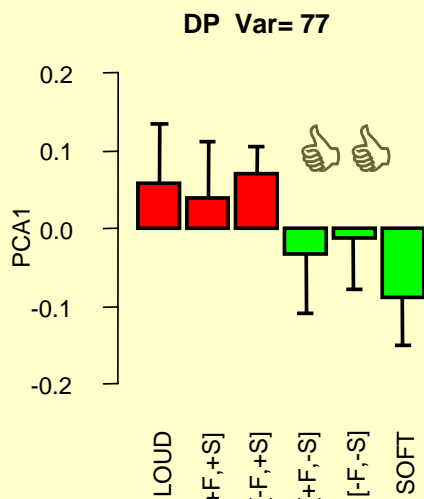
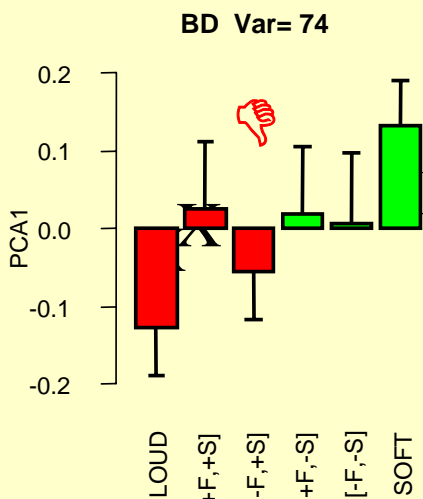
Vocal effort:
sign. for all
speakers

Prominence:

DP:
s > w and F = U

SB and GA:
only tendencies

BD, NU, GA:
wrong direction



Summary (1)

Independent of accent

- unstressed /e/ is
 - shorter
 - more centralized (lower F2 frequencies)
- unstressed consonants are
 - shorter (/l/ and /z/)
 - and more often devoiced (/z/)

Summary (2)

- Unstressed /e/ is not generally produced with a more symmetrical glottal pulse shape
 - indicating breathy or soft voice
 - contrary to
 - Sluijter et al. (1996): greater spectral tilt → slower glottal closure
 - Ladefoged (1967, 2005): lower subglottal pressure in (accented) unstressed syllables
 - in agreement with
 - Campbell and Beckman (1997), Fant et al. (2000)
- No L- alignment effects
 - contrary to Grice et al. (2000)
 - different dialect?
 - not a falling-rising contour?

Discussion

- stress affects segmental features also in deaccented position
 - e.g. vowel and consonant durations, F2 in vowels, voicing for fricatives
- voicing of /z/:
 - unstressed /z/ was more often devoiced in accented (60 %) than in deaccented position (30%)
 - ↔ lower subglottal pressure (Ladefoged)
 - ↔ glottal configuration (Sluijter et al.)

Discussion

→ more reduction/weakening in **accented** unstressed consonants (vs. **deaccented**)

WHY?

→ in order to enhance the syntagmatic contrast between initial unstressed and following stressed syllable (not important in deaccented position)

IMPLIES

→ active control of hypoarticulation

→ contrary to the assumption that reduction also means less effort

Conclusion

Initial question: Is there lexical stress without accent?

YES!!!

Stress is not just an abstract landing place for accents but segments differ phonetically in deaccented position

In German stress in deaccented position affects only segmental features

BUT NOT more global and *longer-lasting* properties such as subglottal pressure, voice quality, f₀ contours or intensity

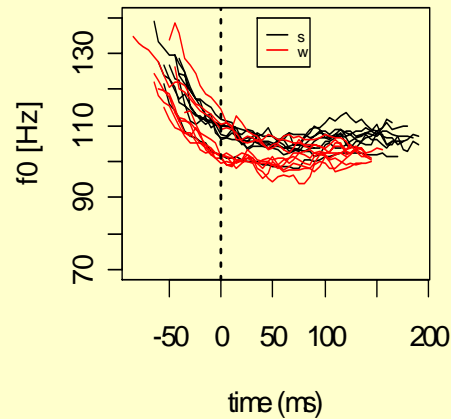
Acknowledgements

Thanks to:

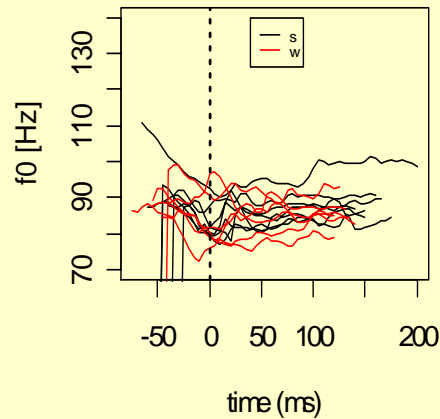
- Jennifer Schneeberg for help with labelling
- our technician Herbert Fuchs
- and to some of our speakers for deaccenting

2. Alignment: F0 contour (individual speakers)

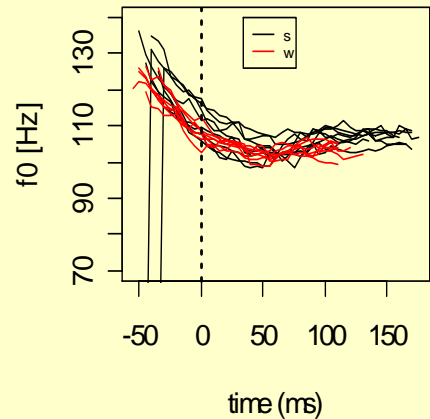
BD



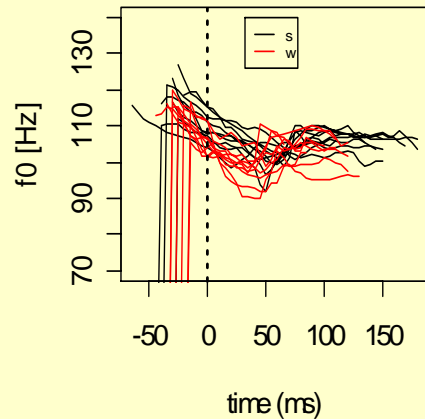
NU



GA



SZ



All speakers:

Speakers BD, GA and SZ show no evidence for a steeper slope when followed by a strong syllable (black lines)

(speaker NU very variable)

➔ L- is not foot-sensitive