

# Is the length of a sentence planned? Evidence from breathing, pause and F0

Susanne Fuchs\*, Caterina Petrone\*, Jelena Krivokapić<sup>o</sup>

\*Centre for General Linguistics (ZAS Berlin)

<sup>o</sup>Yale University, New Haven



Summerschool „Planning and Dynamics“, Berlin, 29.09.10

# Speech Planning

---

- **Working definition:** Cognitive and physical processes to prepare speaking
- Affected by many factors, such as prosodic and syntactic constraints

Where can we find traces of planning?

# Phonetic indicators

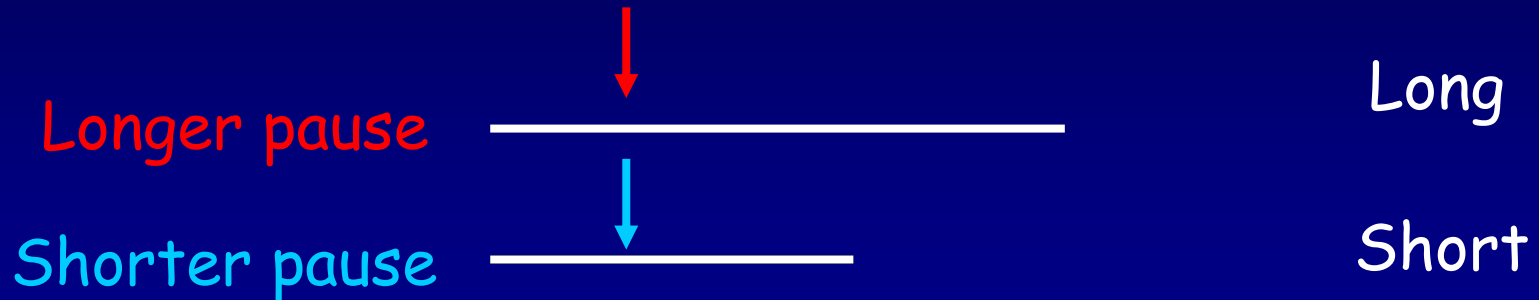
## 1. Pause



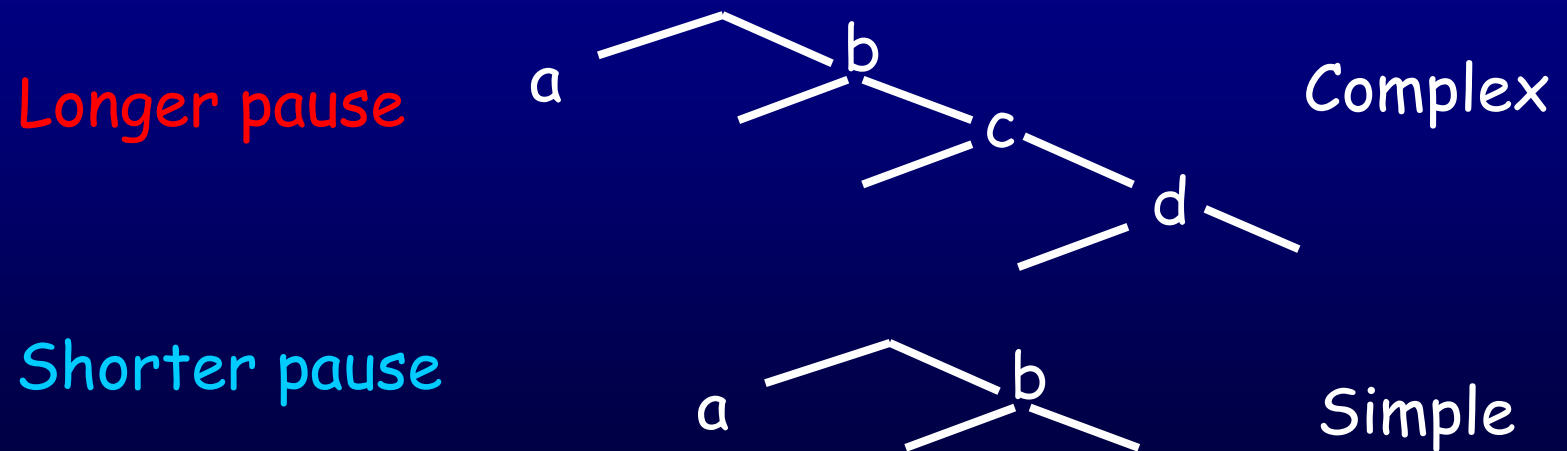
- **Factors affecting pause duration:**
  - **Discourse structure** (Bannert et al. 2003, Smith 2004, Swerts & Geluykens 1994)
  - **Speech rate** (Goldman-Eisler 1968, Trouvain & Grice 1999, Jun 2003)
  - **Individual speaker differences** (Goldman-Eisler 1968, Swets et al. 2007)
  - **Phrasal length** (Sternberg et al. 1978, Whalen & Kinsella-Shaw 1997, Zvonik & Cummins 2003, Krivokapic 2007, 2010)
  - **Linguistic structure** (Grosjean et al. 1979, Gee & Grosjean 1983, Ferreira 1991, 1993, Horne et al. 1995, Strangert 1997, Watson & Gibson 2004)

# Phonetic indicators

- **Phrasal length** (Sternberg et al. 1978, Whalen & Kinsella-Shaw 1997, Zvonik & Cummins 2003, Krivokapic 2007, 2010)



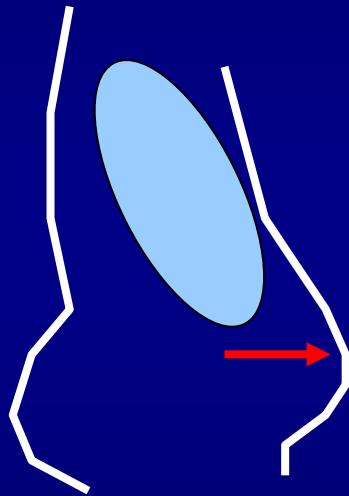
- **Linguistic structure** (Grosjean et al. 1979, Gee & Grosjean 1983, Ferreira 1991, 1993, Horne et al. 1995, Strangert 1997, Watson & Gibson 2004)



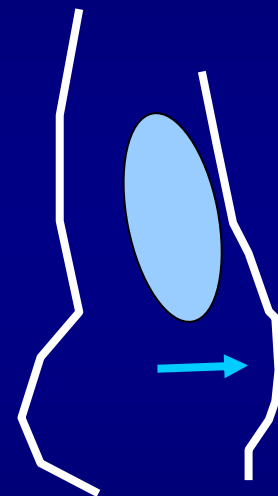
# Phonetic indicators

## 2. Breathing

- Even with similar pause duration, inhalation is deeper *before* long sentences (Whalen & Kinsella-Shaw, 1997):



Long sentence:  
Preplanning of  
large air consumption



Short sentence:  
Preplanning of  
small air consumption

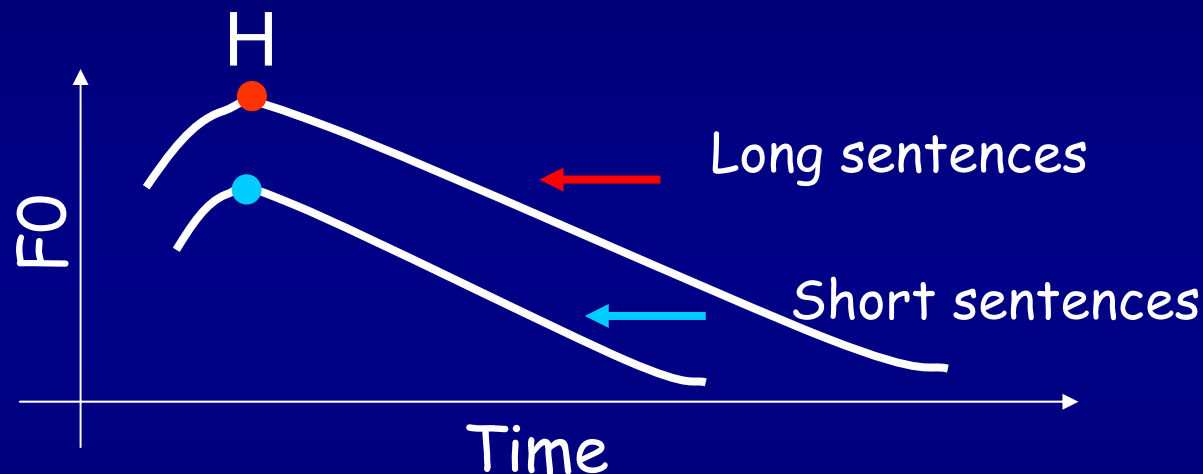
Phrases with  
5-82 syllables

**BUT:** Task-dependent results?

# Phonetic indicators

## 3. Fundamental Frequency (F0)

- Raising the initial F0 peak to get more tonal space in long sentences (t' Hart, 1979; Cooper & Sorensen, 1981; Rialland, 2001)



**BUT:**

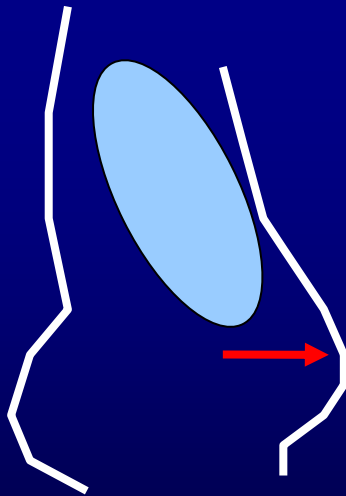
- Controversial issue (Thorsen, 1980; Lieberman & Pierrehumbert, 1984; Van Heuven, 2004, Prieto et al. 2006, *inter alia*)
- Speaker-specific tendency (“soft pre-planning”) (Lieberman & Pierrehumbert, 1984; Prieto *et al.* 2006)
- Maybe consequence of inhalation depth (Chih, 2000; van Heuven, 2004): + breath > + high F0

# Our Experiment

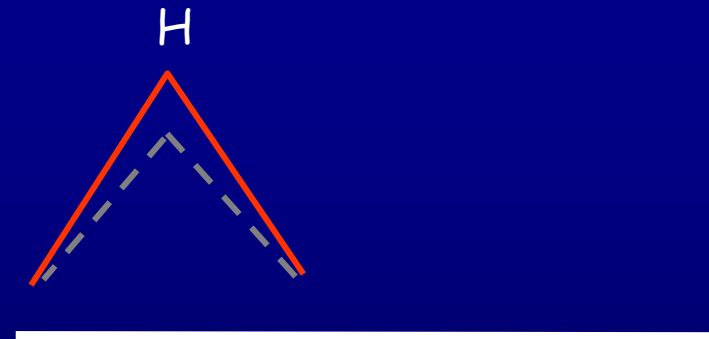
# Hypothesis

In German, syntactic complexity and phrasal length will affect inhalation depth, pause duration and F0 of utterance initial peaks

+ Long, + Complex sentences:



Longer pause



# Corpus

- 2 Target Word (Sonja/Tonja) x 2 Prosodic Length (Short/Long) x 2 Syntactic Complexity (Simple/Complex)

Short/ Simple	<i>Sonja Wunderlich besuchte die Komische Oper</i> ("S.W. visited the Komische Oper")	Major prosodic boundary (IP)
Short/ Complex	<i>Sonja Wunderlich, die Tanz liebt, besuchte die Oper</i> ("S.W., who loves dance, visited the opera")	
Long/ Simple	<i>Sonja Wunderlich bestaunte in einer warmen Sommernacht im August die Oper</i> ("S.W. marveled at the opera during a warm summer night in August")	Major prosodic boundary (IP)
Long/ Complex	<i>Sonja Wunderlich sagte einem Freund, der uns morgens anrief, sie begeistert sich für Oper</i> ("S.W. told a friend who phoned us in the morning that she is crazy about opera")	

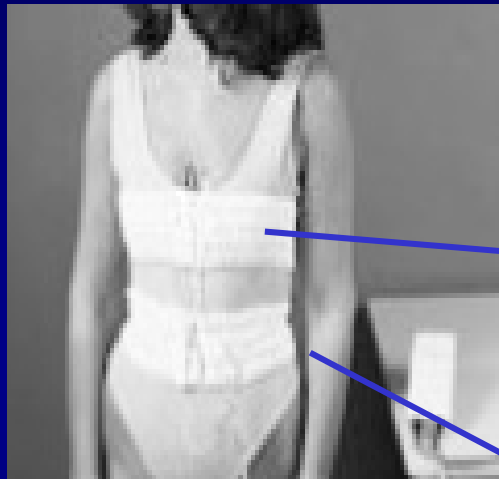
- Test sentences preceded by a filler sentence:



- 10 repetitions X 12 speakers: 1080 obs.

# Methods

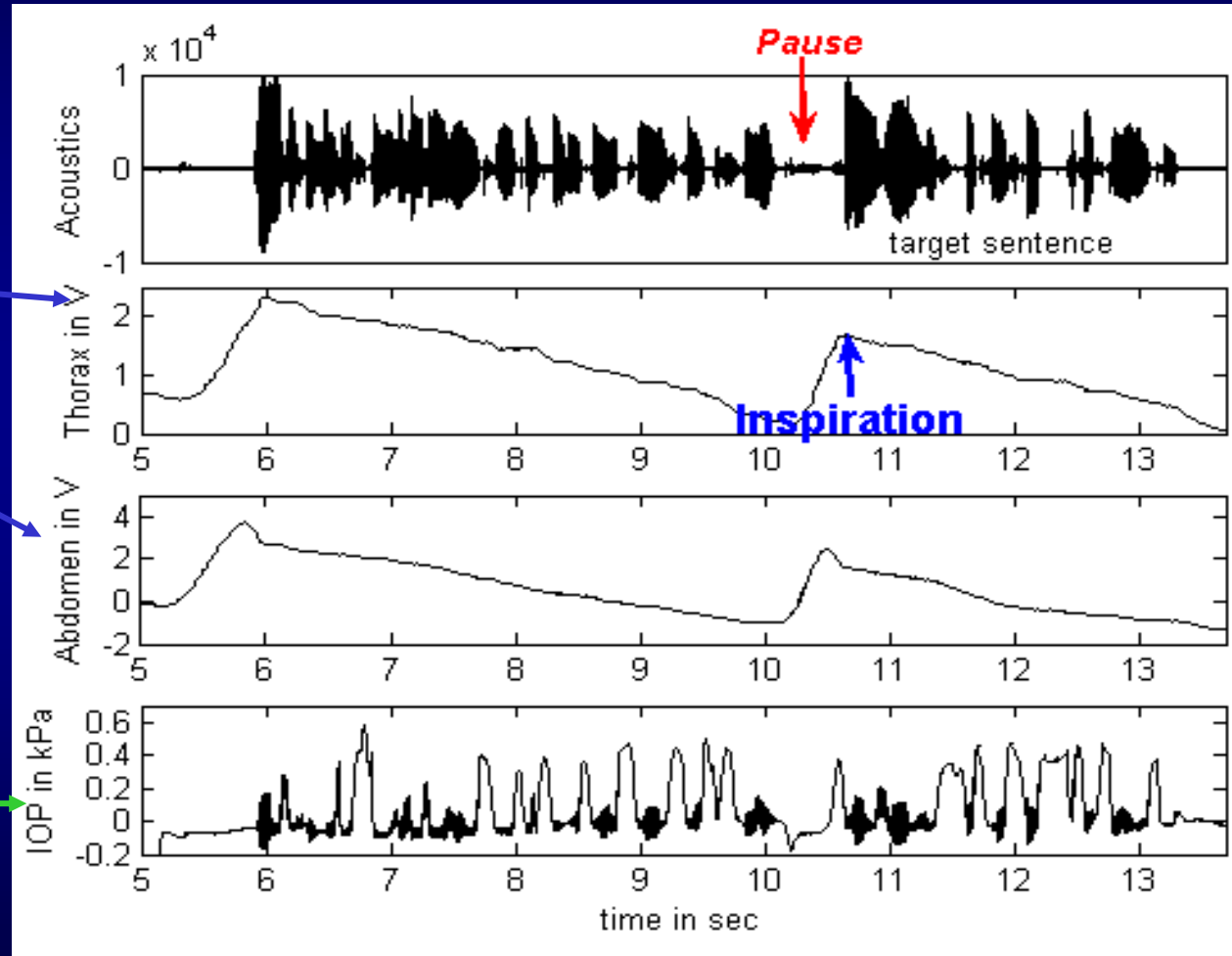
- Breathing & Pause



Resptrace



Intraoral Pressure

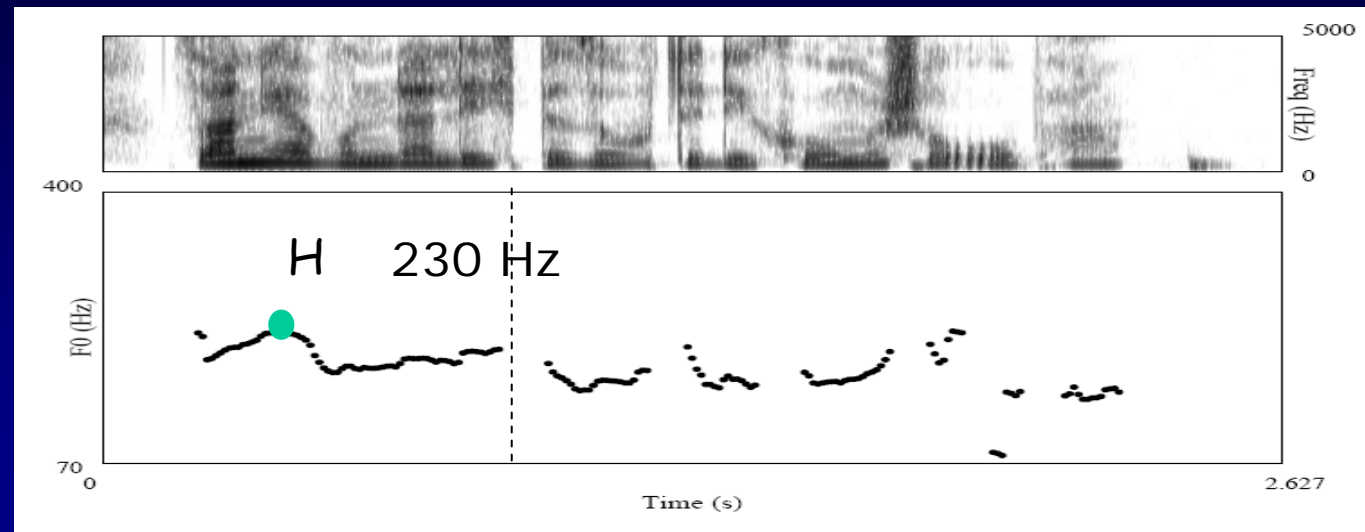


- Inhalation depth and duration

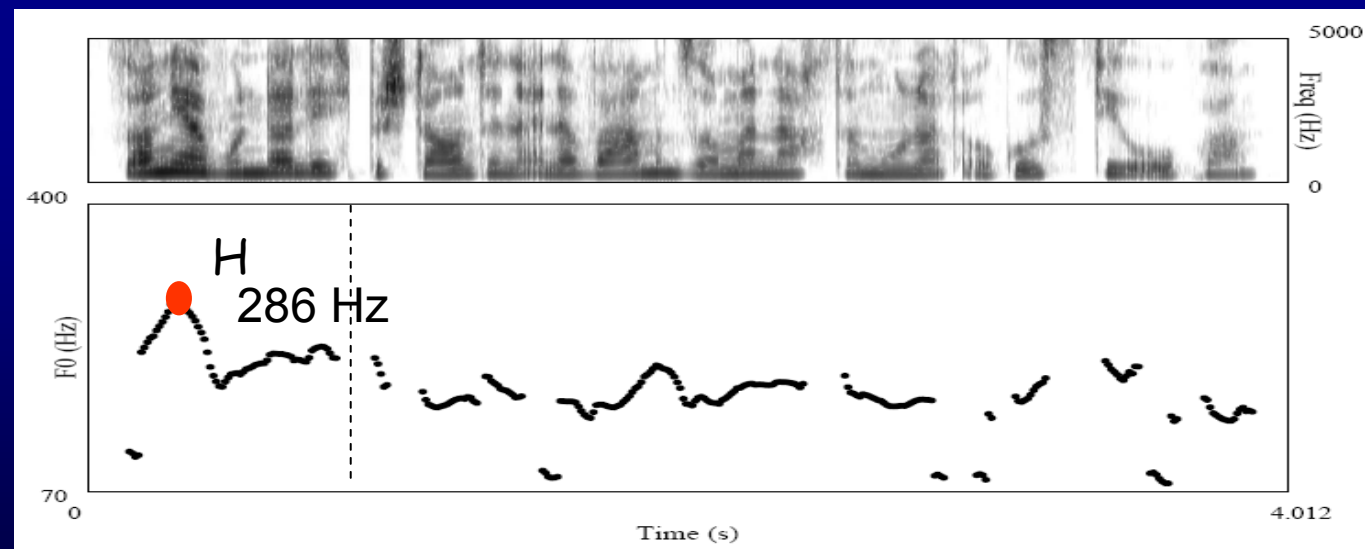
# Methods

- F0

Short/simple



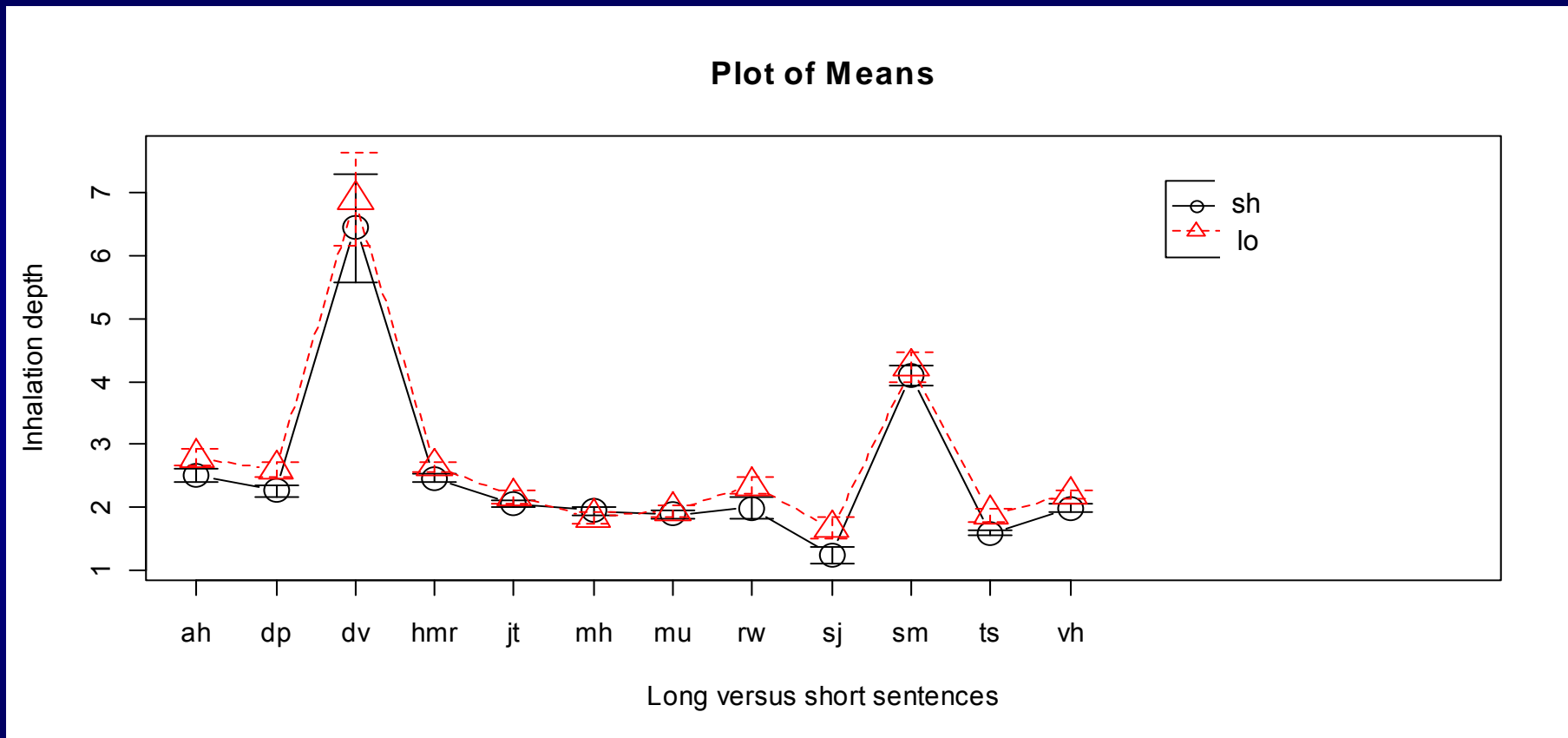
Long/simple



- Auditory annotation:** Prosodic breaks (2 German annotators)

# Results

- Breathing



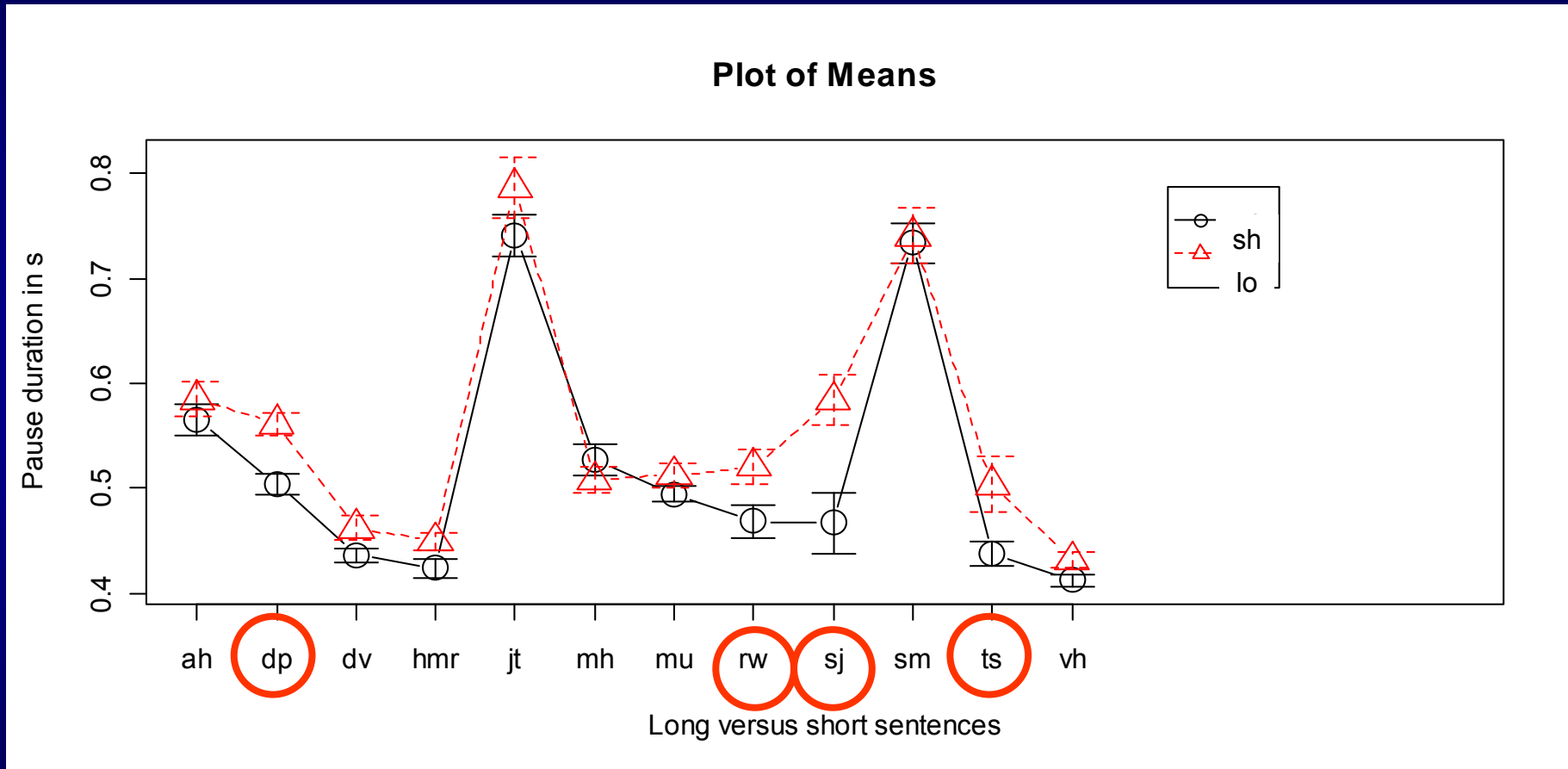
Length = NO

Syntax = NO

(Similar results for inhalation duration)

# Results

- Pause duration

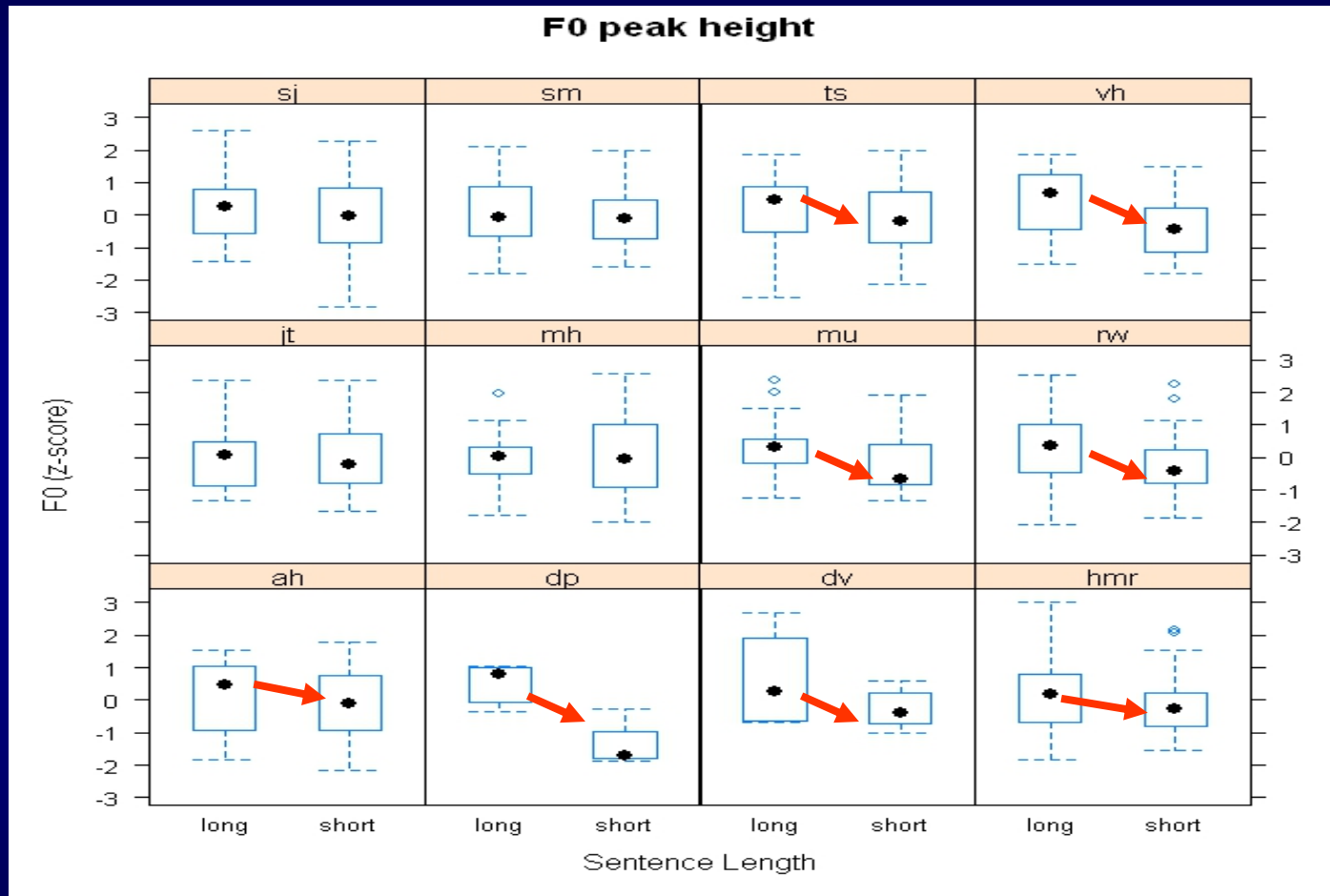


Length = YES ( $p < .01$ )  
BUT: Speaker-dependent

Syntax = NO

# Results

- F0



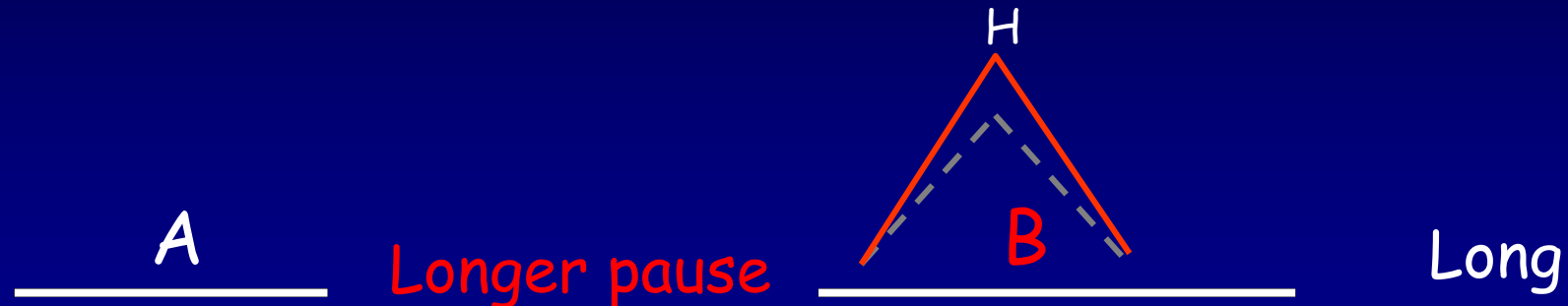
Length = YES ( $p < .01$ )  
BUT: Speaker-dependent

Syntax = NO

# Results

- F0

Correlation F0 ~ Pause ( $p < .01$ ): + LONG pause  $\rightarrow$  + High F0



Correlation F0 ~ Inhalation depth ( $p = .01$ )

- Auditory Annotation

Prosodic break after the subject constituent, independently of syntactic and length manipulations

Sonja Wunderlich | ...

80% transcribed by 2 annotators  
(99% at least by 1 annotator)

# Discussion & Conclusion

- **Phrase length** effects (in line with Ferreira, 1991; Zvonik & Cummins 2003, Krivokapic 2007, 2010). Planning of the upcoming sentence is reflected in both pause duration and F0 of initial peaks:
  - + LONG sentences -> + Long Pause, + High F0
- **Syntactic complexity**: No effects
- **Inhalation** works more independently, thus suggesting that F0 trends are partly under the speaker's control (Lieberman & Pierrehumbert, 1984)

# Discussion & Conclusion

Speaker-dependent effects: *Why?*

Prosodic structure affects planning (Krivokapić, 2007; this summerschool ):

- Speakers might adapt the scope of planning differently even in presence of similar prosodic structure:

1) Some plan the first prosodic constituent ->  
**NO** length effects on pause & F0

2) Others plan over the first prosodic constituent ->  
**YES** length effects on pause & F0




*Sonja Wunderlich, die Tanz liebt, besuchte die Oper*

# Discussion & Conclusion

- Speaker-specific tendency in speech planning might reflect differences in Working Memory (WM) capacities (Swets et al., 2007; Wagner et al., 2010)

High Working Memory spans -> + Planning?

Low Working Memory spans -> - Planning?

 Understanding effects of linguistic and cognitive constraints as well as their interactions on phonetic variability

**Thanks/Danke!**

# Acknowledgments

- This work was supported by a grant from the DFH to the PILIOS project and a grant from the BMBF.



## Thanks to:

- our subjects,
- Jörg Dreyer for technical support,
- Phil Hoole for experimental set-up,
- Anne Gwinner, Dominique Vornwald, Hristo Velkov and Matthias Ziervogel for acoustic analyses.