



# Neurolinguistic Processing at the Interface of Syntax, Semantics and Prosody

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## THE TIME COURSE OF REFERENTIAL RESOLUTION

- Information Packaging
- Case 1: Contextual Marking of Information Status
- Neurocognitive Model: Expectation & Updating
- Case 2: Prosodic Marking of Information Status
- Case 3: Sentence Position & Topicality

# INFORMATION PACKAGING



- information can be „packaged“ in different ways
- correlation between form and function
  - \* syntactic form conveys information structural function („packaging“) (Chafe 1976)
  - \* form of anaphor depends on cognitive accessibility of its referent (Prince 1981; Ariel 1990; Gundel et al. 1993)
- speakers choose an optimal form X during information transfer
  - \* to guarantee coherence („backward orientation“)
    - reactivation & accessibility
  - \* to allow for information progression („forward orientation“)
    - activation & updating



# REFERENTIAL PROCESSING IN DISCOURSE

- ★ How does the language system optimize information transfer?
- ★ What are the neural correlates of information structure processing?
- ★ Which mechanisms support referential processing?
- ★ Which factors influences these processes?



Event-related brain potentials  
during referential processing

## Contextually-Determined Information Status

### REFERENTIAL DEPENDENCIES

(1) **Direct Anaphor (Coreference):**

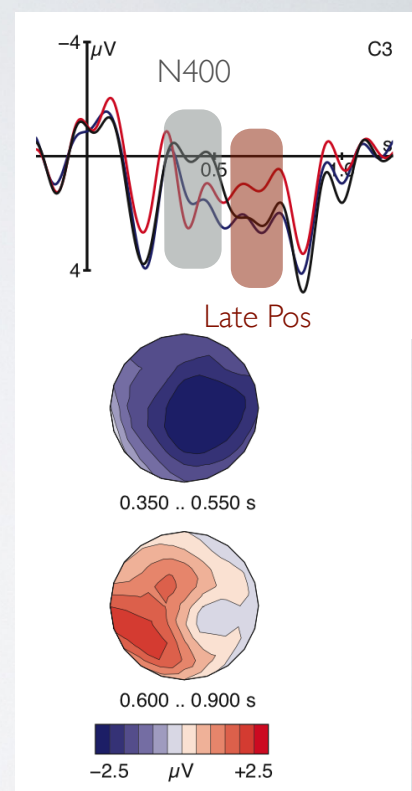
Peter has recently visited a conductor in Berlin. He said that *the conductor* was very inspiring.

(2) **Indirect Anaphor (Inference):**

Peter has recently attended a classical concert in Berlin. He said that *the conductor* was very inspiring.

(3) **No Antecedent/Anchor:**

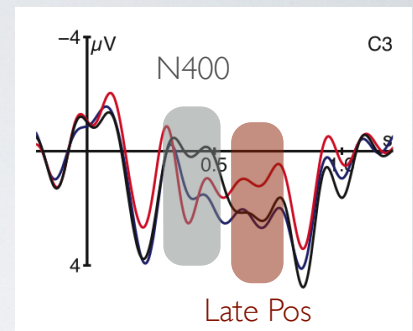
Peter has recently met Sarah in Berlin. He said that *the conductor* was very inspiring.



## REFERENTIAL DEPENDENCIES

Cost during integration with prior discourse /  
expectation-based parsing (here: semantic distance):  
**N400**

Updating of discourse structure (here: introduction of  
a new discourse referent): **Late Positivity**



No Antecedent  
Indirect Anaphor  
Direct Anaphor

Burkhardt 2006, *Brain Lang*

A Neurocognitive Model  
of Discourse Processing

# REFERENTIAL PROCESSING IN DISCOURSE

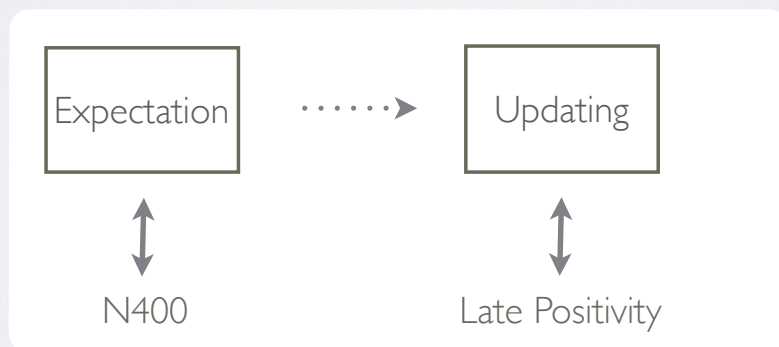
- takes place in (at least) 2 core steps

- \* Expectation-based parsing

- ▶ Anticipation of referent
- ▶ Expectation determined by multiple prominence criteria

- \* Discourse updating

- ▶ Consequences for discourse representation
- ▶ Attentional orientation



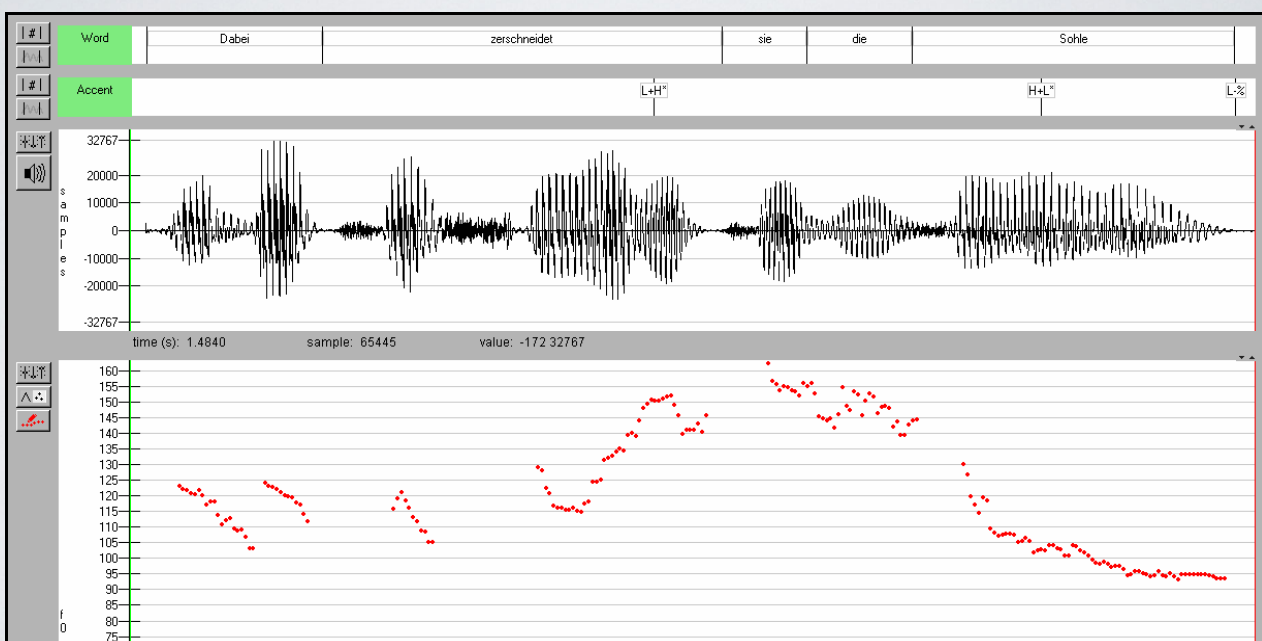
Prosodic Realisation of  
Information Status

## PROSODIC ACCESSIBILITY

- Information status of referential expressions can be cued prosodically (cf. Baumann & Grice 2006)
  - \* given information: deaccented
  - \* new information: accented (H\*)
  
- \* yet, no binary distinction: intermediary accent types for indirect anaphors: e.g. inferentially accessible whole-part relations: (H+)L\*

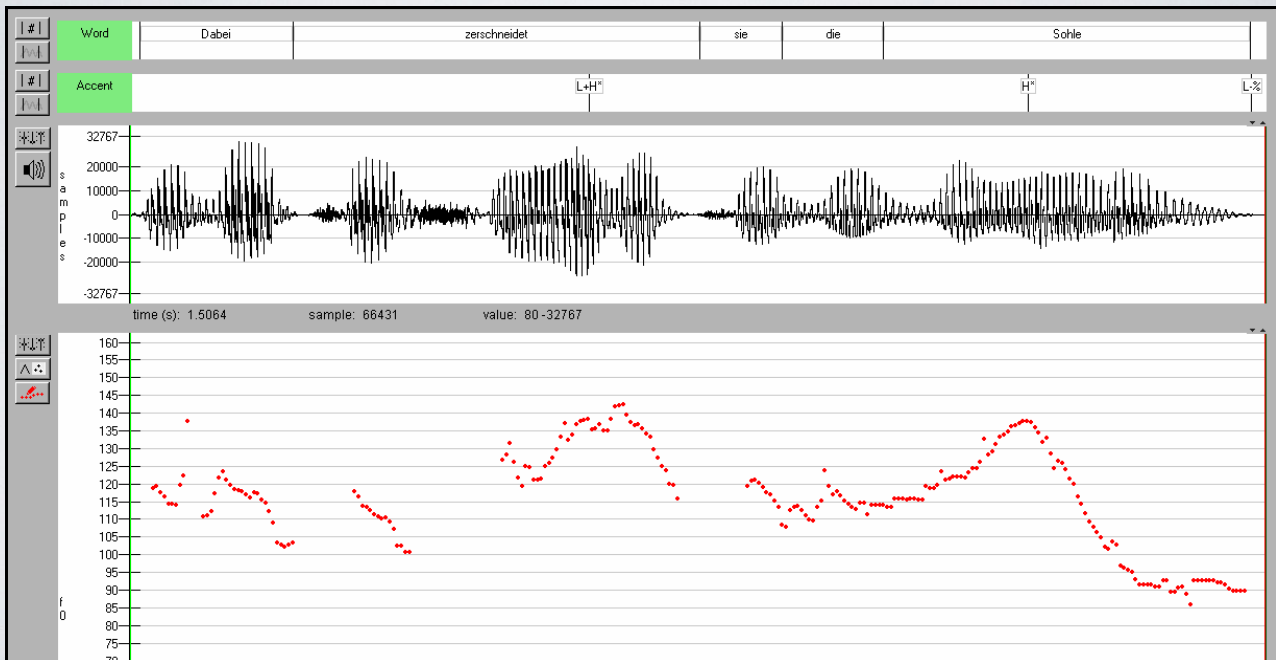
## PROSODIC ACCESSIBILITY

- Indirect Anaphor (Whole-Part Relation): (H+)L\*



# PROSODIC ACCESSIBILITY

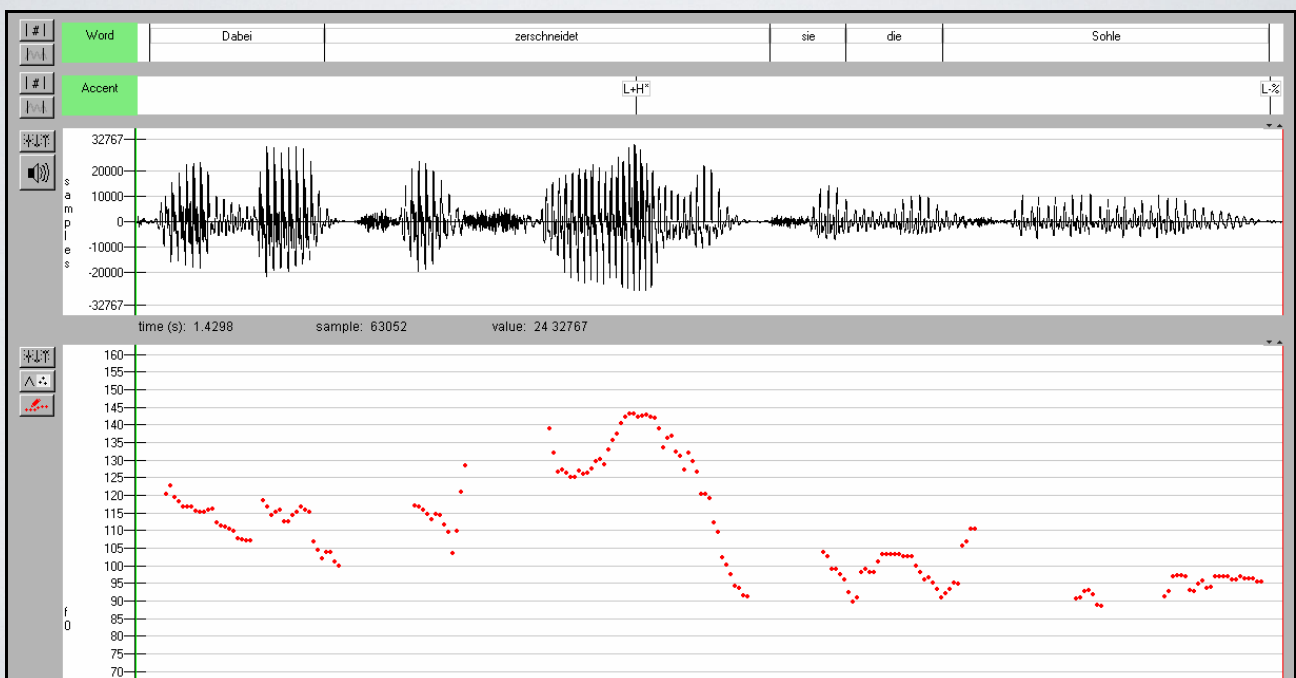
- New Information: H\*



Schumacher & Baumann, 2010. *Neuroreport*

# PROSODIC ACCESSIBILITY

- Given Information: Deaccentuation



Schumacher & Baumann, 2010. *Neuroreport*

## PROSODIC ACCESSIBILITY

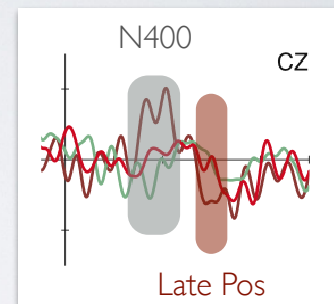
(4) Sabine repariert einen alten Schuh.  
Dabei zerschneidet sie **die Sohle**.

*Sabine repairs an old shoe.  
In doing so, she cuts **the sole**.*

a) ✓ indirect accent: (H+)L\*

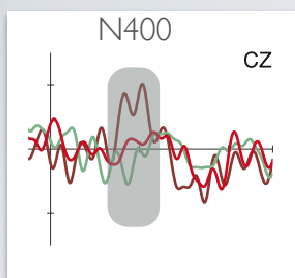
b) \* new accent: H\*

c) \* given: deaccented



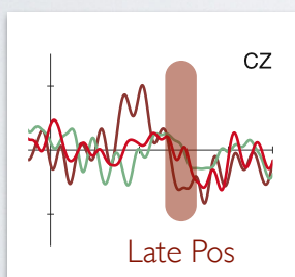
Schumacher & Baumann 2010, *NeuroReport*

## PROSODIC ACCESSIBILITY



\* three-way N400-modulation: deaccentuation > H\* > (H+)L\*

- ➔ prosodic information influences prediction-based processes (independent of lexical-semantic activation)
- ➔ accent type is expected for information status

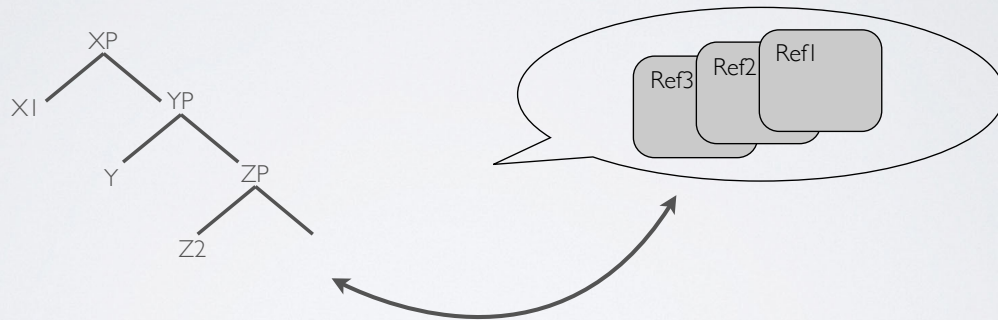


\* Late Positivity for indirect anaphors with deaccentuation (signaling givenness): deaccentuation > H\* / (H+)L\*

- ➔ conflict between prosodic realization of information status and actual information status of the referent
- ➔ newness accent does not evoke a conflict



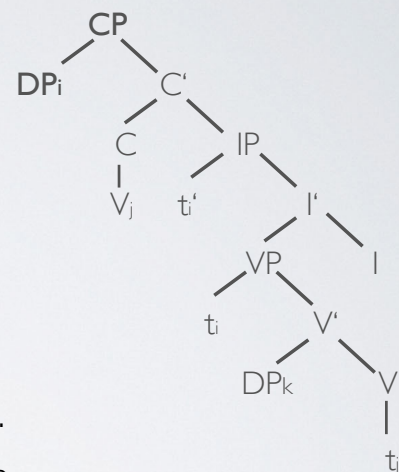
## Sentence Position & Aboutness-Topicality



## SENTENCE POSITION & ABOUTNESS-TOPICALITY

- what an utterance is about (Reinhart 1981)
- German: argument placement in topological prefield (Spec CP) can mark topicality (i.e. the starting point for utterance organization)

- (5) Ein Student besuchte neulich einen Vortrag in Berlin.
- Er verwickelte **den Redner** in eine hitzige Diskussion.
  - Den Redner** verwickelte er in eine hitzige Diskussion.



*A student has recently attended a lecture in Berlin.*

*He engaged **the speaker** in a heated debate.*

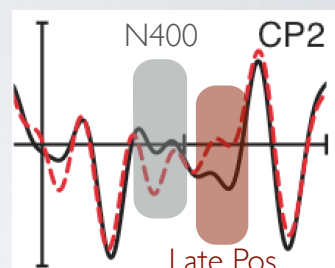
## ABOUTNESS-TOPICALITY

### (5) a. Direct Anaphor, SVO:

A student has recently visited a speaker in Berlin.  
He engaged **the speaker** in a heated debate.

### (5) b. Indirect Anaphor, SVO:

A student has recently attended a lecture in Berlin.  
He engaged **the speaker** in a heated debate.

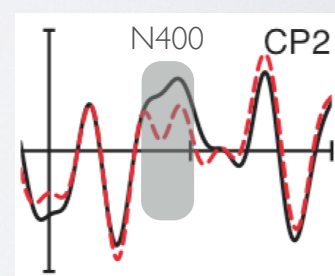


### (6) a. Direct Anaphor, OVS:

A student has recently visited a speaker in Berlin.  
**The speaker**, he engaged [him] in a heated debate.

### (6) b. Indirect Anaphor, OVS:

A student has recently attended a lecture in Berlin.  
**The speaker**, he engaged [him] in a heated debate.

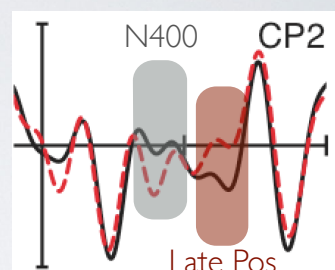


Schumacher & Hung 2012, JML

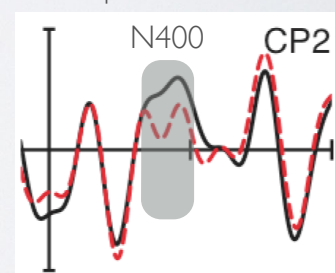
## ABOUTNESS-TOPICALITY

- **N400** modulated by semantic relation (indirect anaphor > direct anaphor)
- **Late Positivity**: Position-specific assessment of information status
  - \* sentence-medial position: given vs. new
  - \* sentence-initial position: topic

canonical - SVO



topicalized - OVS



Schumacher & Hung 2012, JML

## WHY NO LATE POS SENTENCE-INITIALLY?

Function of position?

Syntactic function?

Dislocation effect?

\* in isolated sentences: LAN for unambiguous object- vs. subject-initial sentences (Matzke et al., 2002 - *time-locked to determiner*)

\* But: no case effect on unambiguous initial subject/object by Frisch et al., 2002



## ANAPHOR X CASE

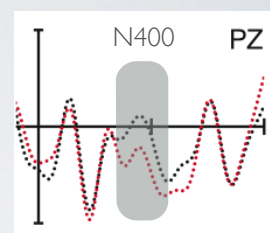
### ANAPHOR X CASE - REFERENTIAL CONTRAST

#### (7) a. Direct Anaphor, Subj-VO:

Ein Student besuchte neulich einen Redner in Berlin.  
*Der Redner* verwickelte ihn in eine hitzige Diskussion.

#### (7) b. Indirect Anaphor, Subj-VO:

Ein Student besuchte neulich einen Vortrag in Berlin.  
*Der Redner* verwickelte ihn in eine hitzige Diskussion.

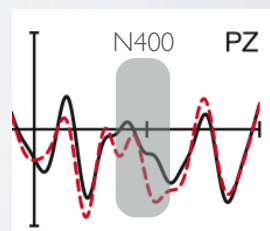


#### (5) a. Direct Anaphor, Obj-VS:

Ein Student besuchte neulich einen Redner in Berlin.  
*Den Redner* verwickelte er in eine hitzige Diskussion.

#### (5) b. Indirect Anaphor, Obj-VS:

Ein Student besuchte neulich einen Vortrag in Berlin.  
*Den Redner* verwickelte er in eine hitzige Diskussion.



## ANAPHOR X CASE - SYN. FUNCTION CONTRAST

(7) **Subj-VO:**

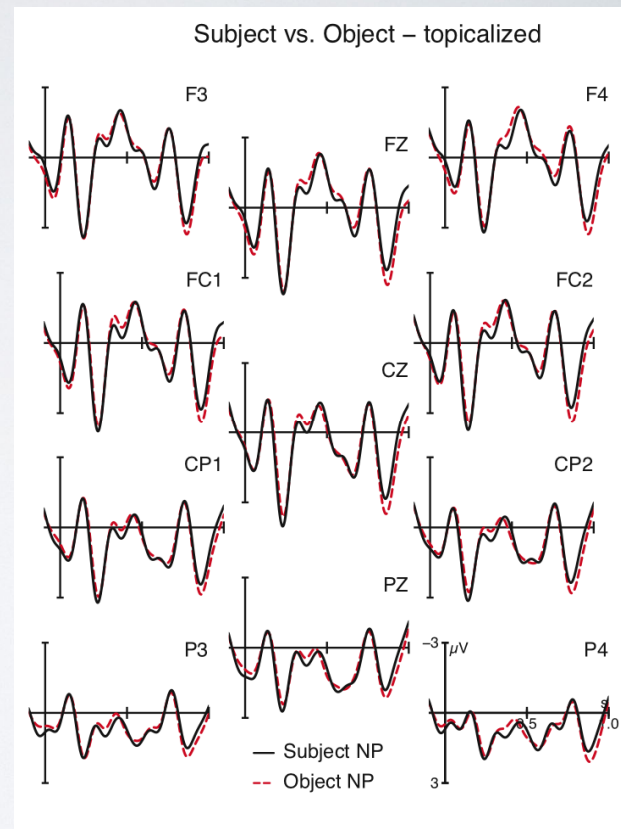
Ein Student besuchte neulich einen Redner / einen Vortrag in Berlin.

*Der Redner ...*

(5) **Obj-VS:**

Ein Student besuchte neulich einen Redner / einen Vortrag in Berlin.

*Den Redner ...*



## WHY NO LATE POS SENTENCE-INITIALLY?

Function of position?

~~Syntactic function?~~

Dislocation effect?

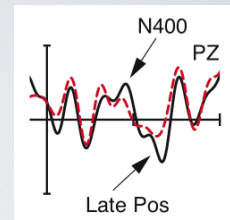


ANAPHOR X POSITION II

## POSITION II

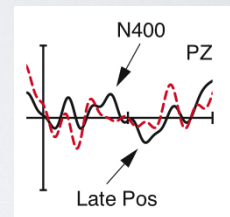
### (8) In/Direct Anaphor, Canonical:

Ein Student besuchte neulich einen Redner/Vortrag in Berlin.  
Ein Kritiker verwickelte **den Redner** in eine hitzige Diskussion.  
*A student has recently visited a speaker/ a lecture in Berlin.  
He engaged **the speaker** in a heated debate.*



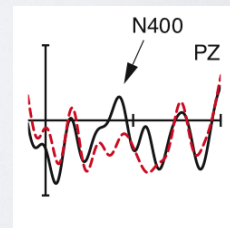
### (9) In/Direct Anaphor, Scrambled:

Ein Student besuchte neulich einen Redner/Vortrag in Berlin.  
Laut BILD verwickelte **den Redner** ein Kritiker in eine hitzige Diskussion.  
*... According to BILD engaged **the speaker** a critic in a heated debate.*



### (10) In/Direct Anaphor, Topicalized:

Ein Student besuchte neulich einen Redner/Vortrag in Berlin.  
**Den Redner** verwickelte ein Kritiker in eine hitzige Diskussion.  
*... **The speaker**, he engaged [him] in a heated debate.*



Schumacher & Hung 2012, JML

## WHY NO LATE POS SENTENCE-INITIALLY?

Explanations that can be excluded:

- ◆ No dislocation effect (Scrambling vs. Topicalization)
- ◆ No syntactic function effect (Subject vs. Object)



Function of position



Sentence-initial argument does not exert differential discourse updating costs, because it serves as address for what the rest of the utterance is about.

# INFORMATION PACKAGING & PROCESSING

- ➔ Referential processing subserved by two basic principles of brain function
- ➔ Expectation-based parsing
  - IS guides prediction of upcoming input
  - prediction error results in N400
  - N400 affected by different cues
- ➔ Discourse updating
  - IS impacts orienting of attention & updating of mental models
  - Late Positivity reflects language-specific requirements on information packaging
- ➔ Information packaging manifests itself in meaningful ways in information processing



## MORE INFO:

Burkhardt, Petra. (2006). Inferential Bridging Relations Reveal Distinct Neural Mechanisms: Evidence from Event-Related Brain Potentials. *Brain and Language*, 98, 2, 159-168.

Schumacher, Petra B. & Stefan Baumann. (2010). Pitch Accent Type Affects the N400 during Referential Processing. *Neuroreport*, 21, 9, 618-622.

Schumacher, Petra B. & Yu-Chen Hung. (2012). Positional Influences on Information Packaging: Insights from Topological Fields in German. *Journal of Memory and Language*, 67, 2, 295-310.