

Electrophysiological studies of prosody

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BrainTalk
2 - 4 june, 2008
Lund, Sweden

Thanks to the Organizers!

Outline

- **Modality and semantics** (Astésano *et al*, 2004)
 - On-line processing of modality
 - Modality and Semantics : interactive processing
- **Prosodic focus and pragmatics** (Magne *et et al*, 2005)
 - on-line processing of focal accents
 - Processing of focal accents interacts with discourse context
- **Meter and semantics** (Magne *et al*, 2007)
 - on-line processing of syllabic lengthening
 - Meter and Semantics: interactive processing



Prosody

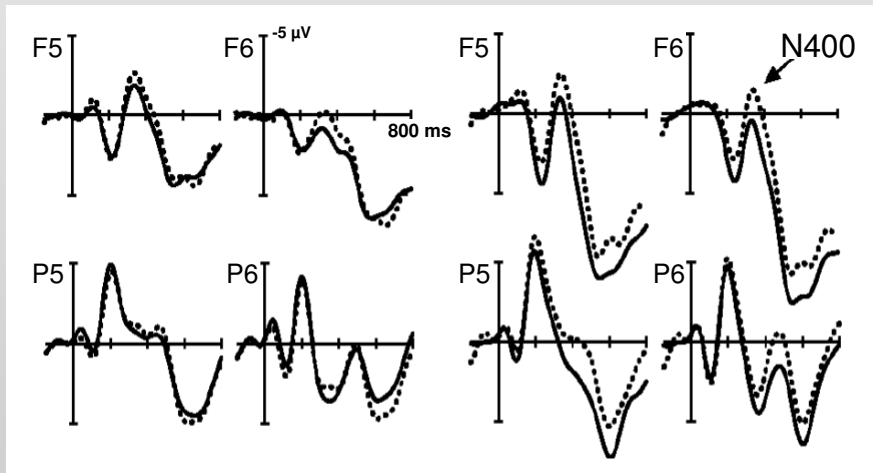
Emotional function: *express joy, sadness, anger ...*
(Schirmer et al, 2002; Kotz et al, 2003, ...)

Experiment 1

SOA 100 ms

Men

Women

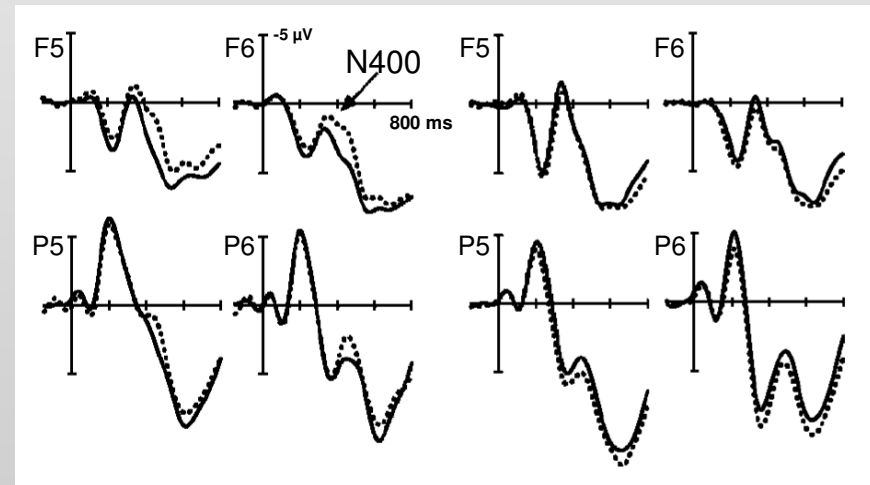


Experiment 2

SOA 300 ms

Men

Women

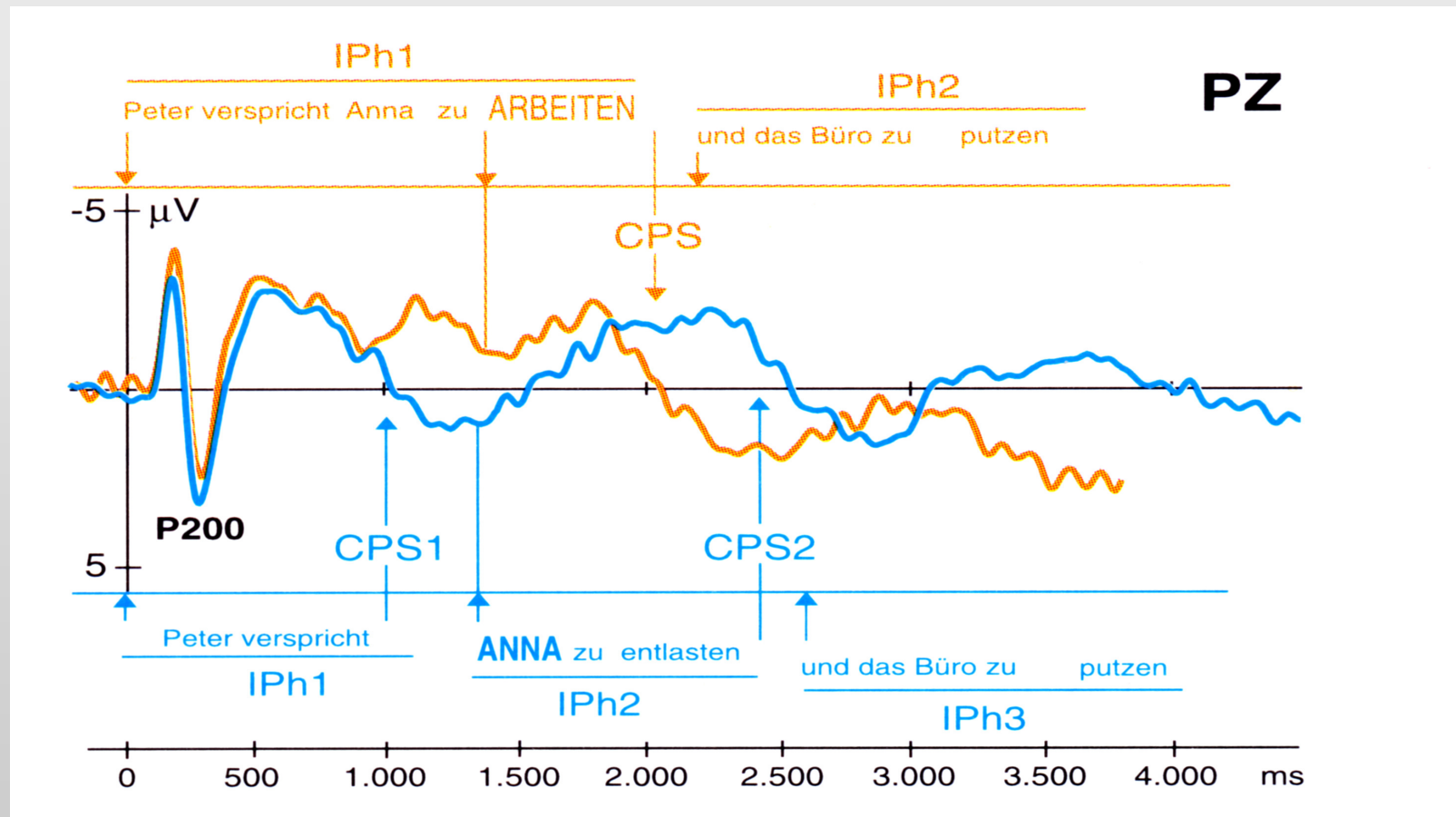


Prosody

Emotional function: *express joy, sadness, anger ...*

(Schirmer et al, 2001; Kotz et al, 2003, ...)

Linguistic function: *modality , focus, segmentation, ... through intonation, accents, meter, pauses (Alter et al, 2003; 2005; 2007; Astesano et al, 2003; Böcker et al, 1999; Eckstein & Friederici, 2005; Friedrich et al, 2004; Magne et al, 2005; Meyer et al, 2000; Steinhauer et al, 1999; ...)*



From Steinhauer, Alter & Friederici, 1999. Nature Neurosciences

Prosody

Emotional function: *express joy, sadness, anger ...*
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Acoustic parameters:

- Pitch/Frequency*
- Loudness/Intensity*
- Duration/Time*
- Timbre*

Modality and semantic processing

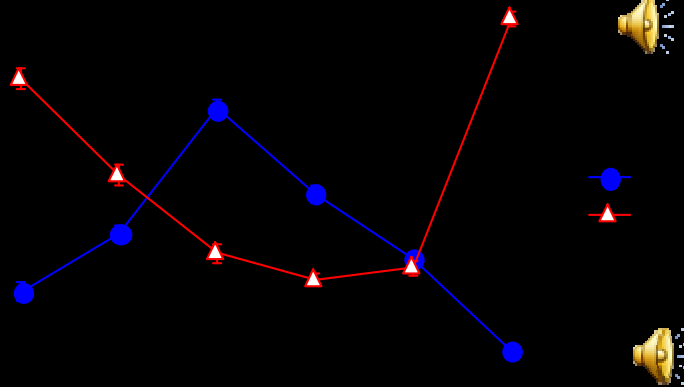
Astésano, Besson & Alter
(*Cognitive Brain Research, 2004*)

Prosody

- ➔ **ERP marker of an incongruous modality ?**
- ➔ **Time course of modality and semantic processing**
- ➔ **Independant vs interactive processes ?**

Materials

F0 contours of the Prosodically Congruous sentences



Le chauffeur conduisait?

The chauffeur was driving?

La lumière clignotait.

The light was flashing.

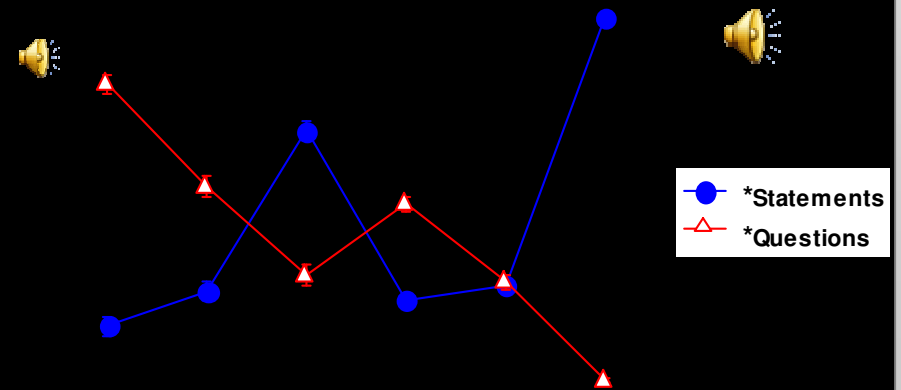
*Le piéton traversait.

**The pedestrian was crossing.*

*Le cycliste pédalait?

**The cyclist was pedaling?*

F0 contours of the Prosodically Incongruous sentences



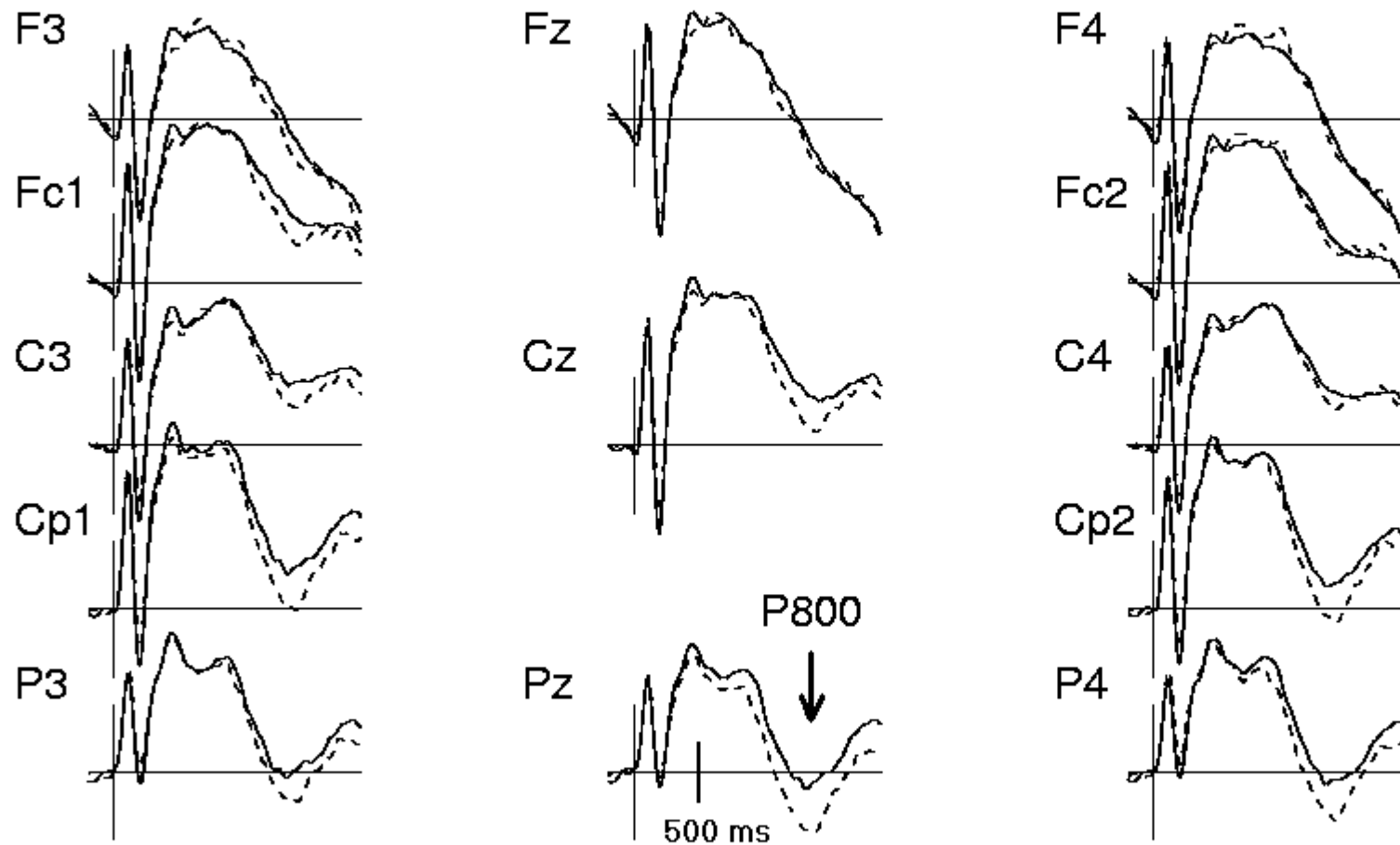
Procedure

- 16 French native speakers
- 2 judgment tasks
 - ✓ Attention to Semantic: congruous/incongruous
 - ✓ Attention Prosody: congruous/incongruous

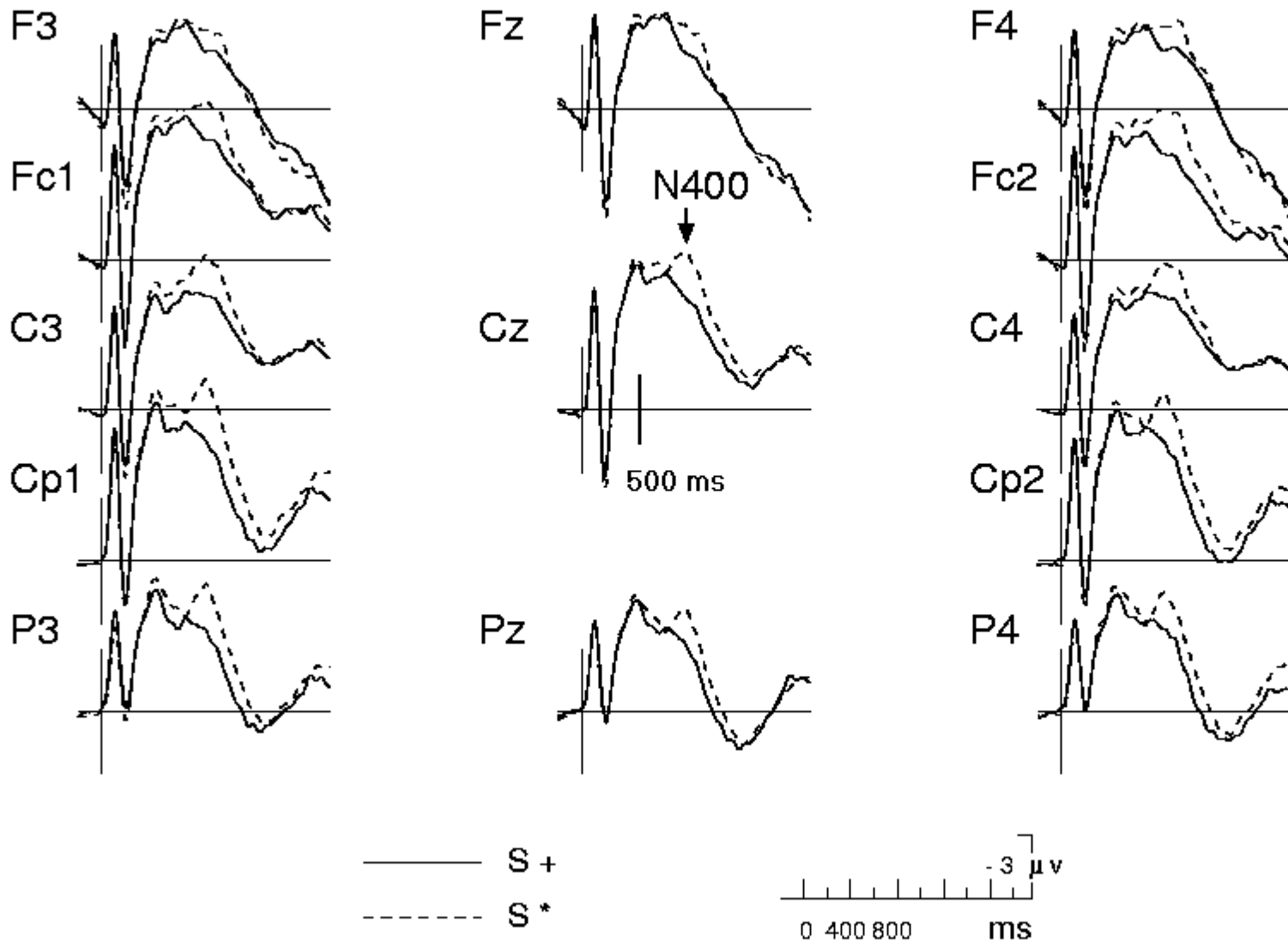
Base Line	Auditory Stimuli	Yes/No Answer
200 ms	'Le garçon coloriait' (<i>The boy was drawing</i>)	XXX
	2000 ms	2000 ms

- 28 scalp electrodes (International 10/20 system)

ATTENTION PROSODY



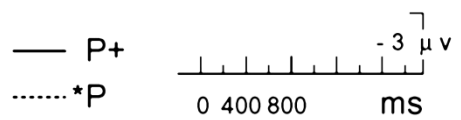
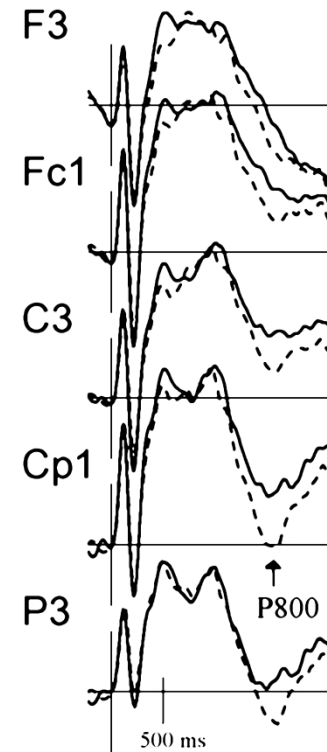
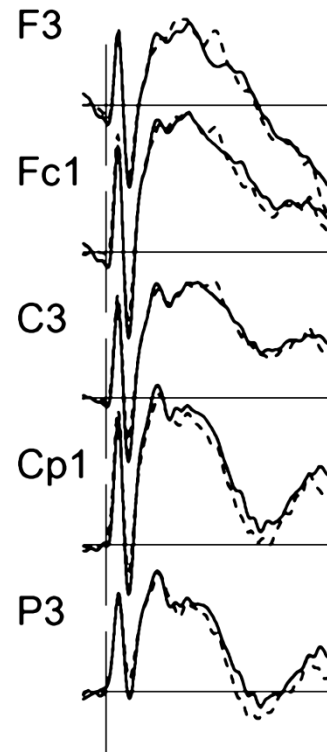
ATTENTION PROSODY



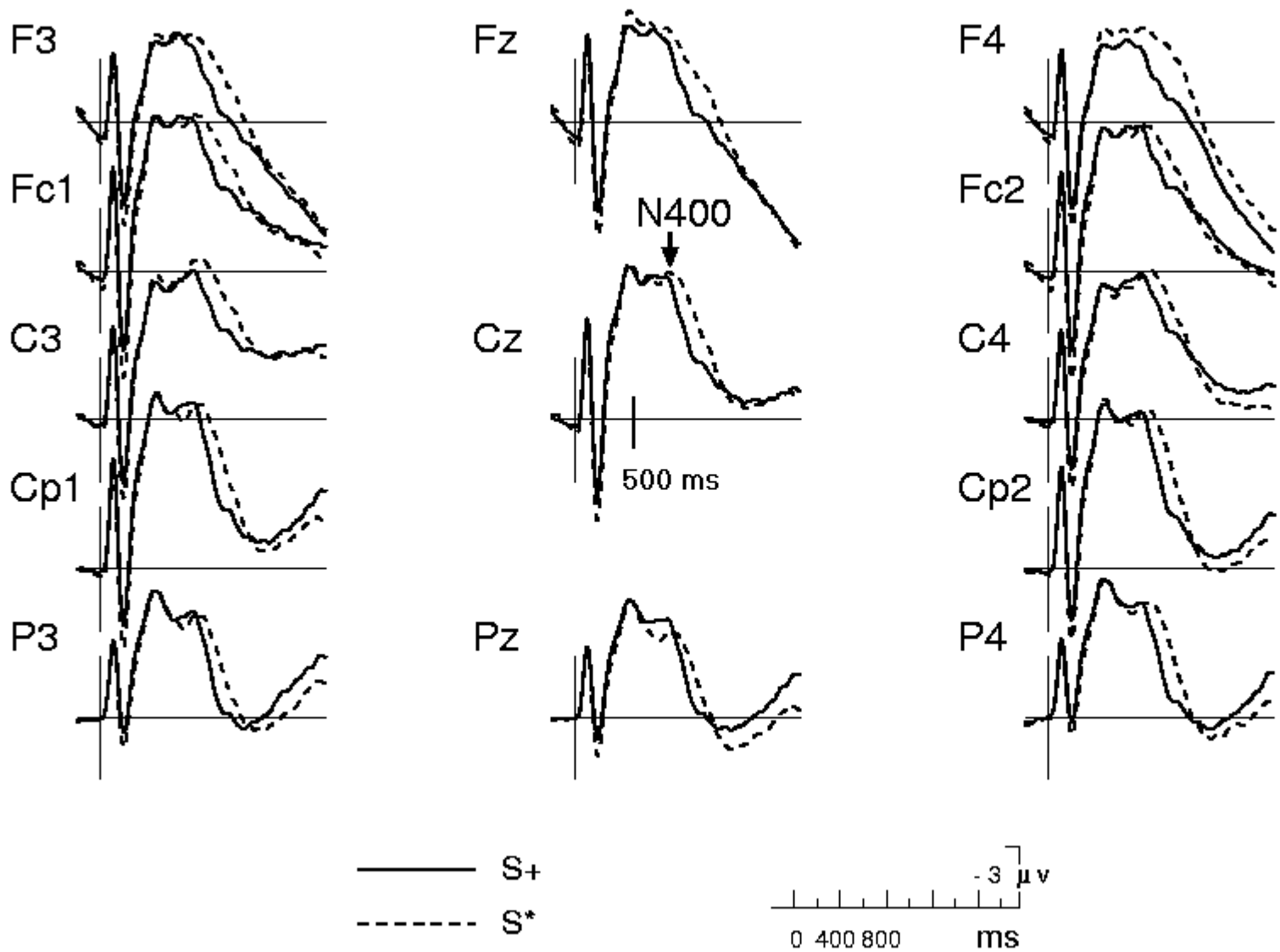
ATTENTION PROSODY

Semantically Congruous

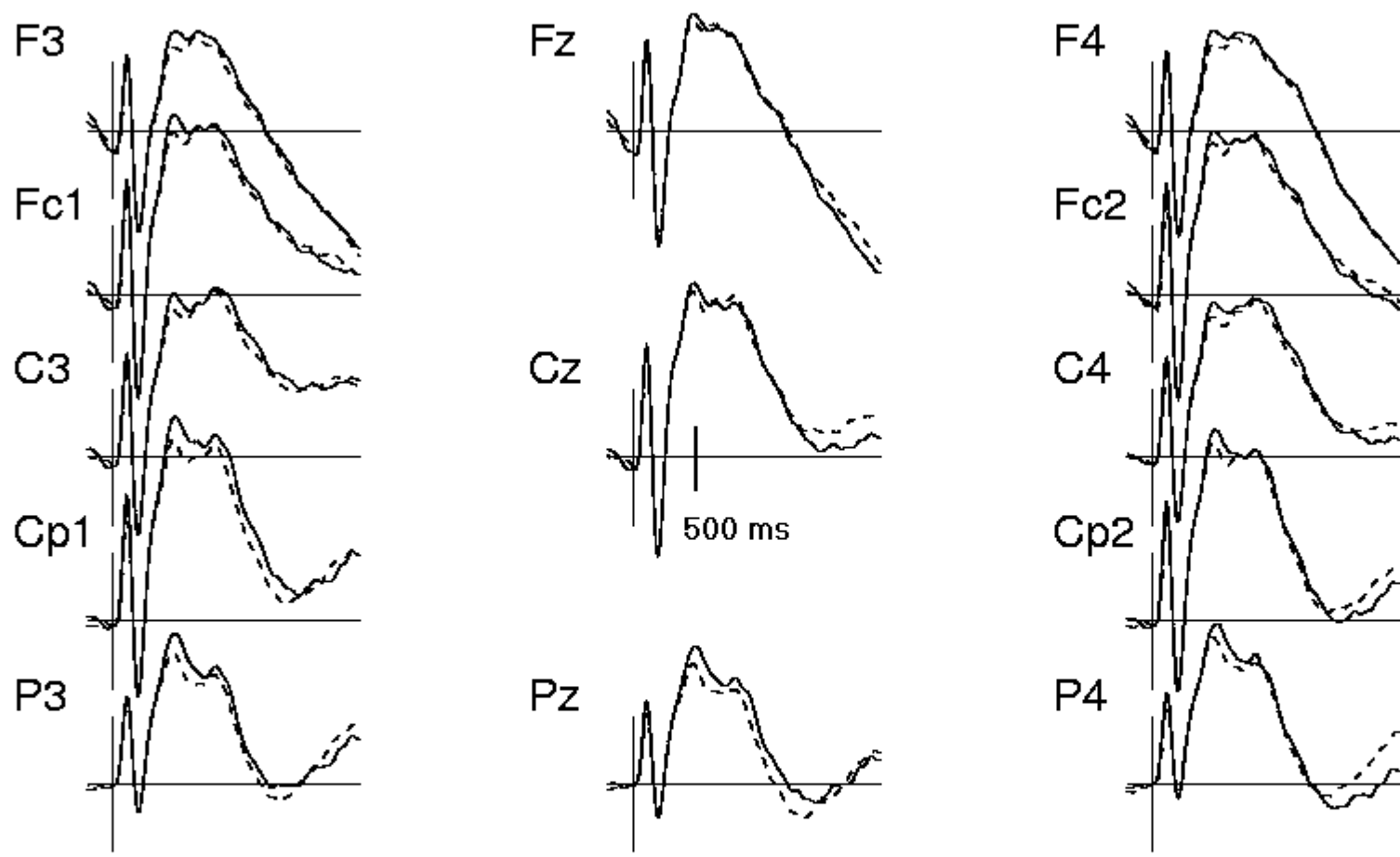
Semantically Incongruous



ATTENTION SEMANTIC



ATTENTION SEMANTIC



Modality and Semantics

Prosody

- ➔ **P800 : ERP marker of modality processing**
- ➔ **Semantic processing precedes modality processing
(but differences in task difficulty)**
- ➔ **Interaction between semantic and prosodic processing**

Prosodic focus

Prosody

Magne, Lacheret, Morel, Alter & Besson
(*Jal of Cognitive Neuroscience, 2005*)

Discourse : pragmatic structure organized around 2 main concepts:

➔ **topic** : known information (*le thème = what we are speaking about*)

➔ **focus** : new information /relevant (*le rhème = what we are saying about it*)

Focus is marked :



➔ **prosodically** : focal accent ➔ ↗ F0, duration and intensity

Objectives

- ➔ **Are focal accents processed in real time?**
- ➔ **Time course of focal accent processing as a function of pragmatic constraints**

Stimuli

➔ Questions :

-  **Q1** *Tu as eu une bonne ou une mauvaise note à ton contrôle d'histoire ?*
-  **Q2** *Où as tu eu une mauvaise note, à ton contrôle d'histoire ou d'anglais ?*

➔ Answers :

Focus on sentence middle word (M)

-  **R1** *En fait, j'ai eu une **mauvaise note** à mon contrôle d'histoire*

Focus on sentence terminal word (T).

-  **R2** *En fait, j'ai eu une mauvaise note à mon contrôle **d'histoire***

4 experimental conditions

- ➔ Focus on sentence middle or terminal words (M vs T)
- ➔ Focus at good or bad positions (+ vs -)

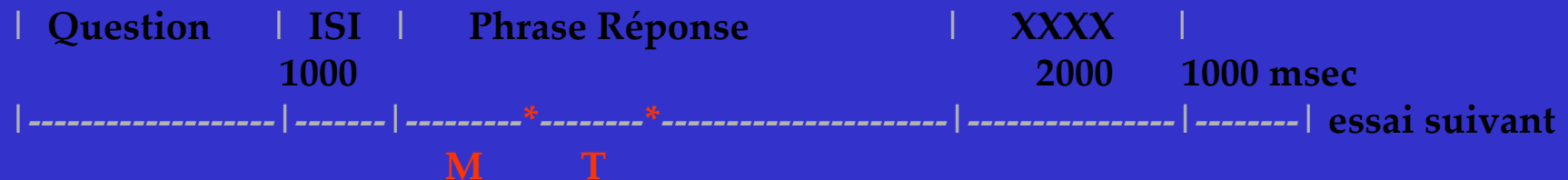
M+(T0)	Focus good on middle word (none on terminal word)
M-(T0)	Focus bad on middle word (none on terminal word)
T+(M0)	Focus good on terminal word (none on middle word)
T-(M0)	Focus bad on terminal word (none on middle word)

PROCEDURE

Participants: 16 native French speakers; right handed

Task: is the intonation of the answer correct in the context?

EEG acquisition

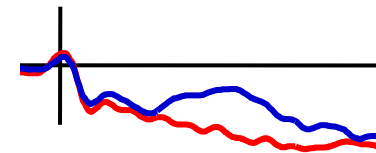
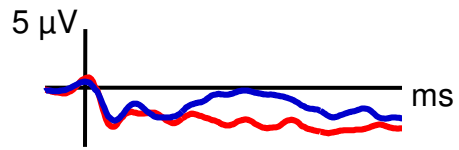


Behavioural data

Conditions	M+	M-	T+	T-
% Erreurs (Sd)	5 (5)	9 (6)	5 (6)	6 (5)

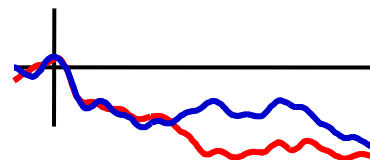
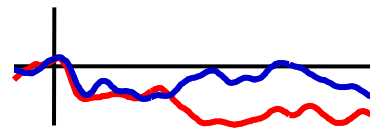
Middle word

With focal accent



— Congruous
— Incongruous

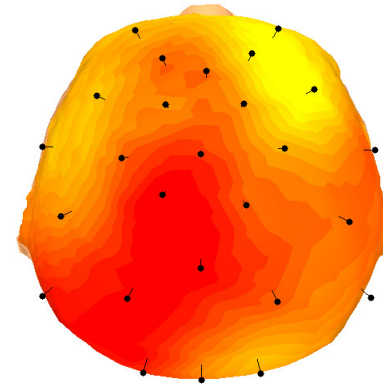
Without focal accent



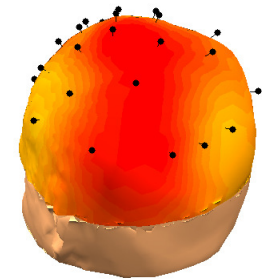
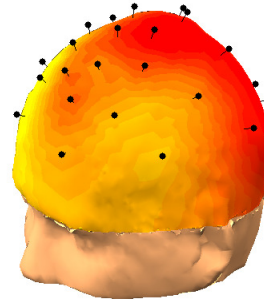
Cz

300-1000 ms

Pz

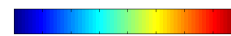


Cz



Pz

- 2 μ V

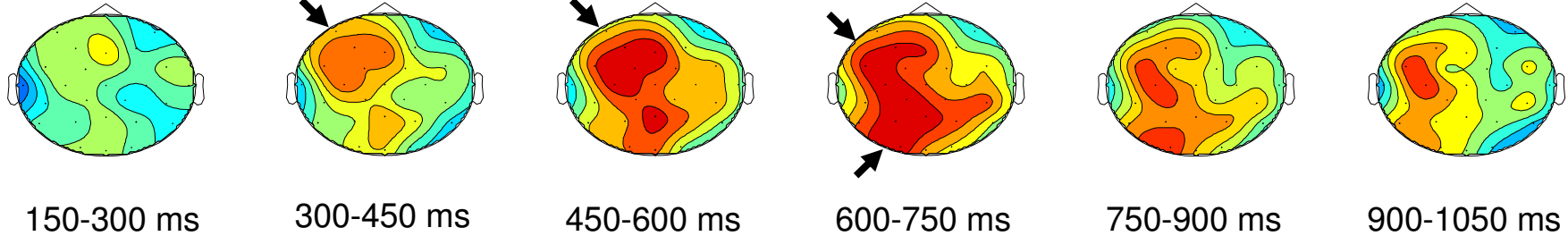


+ 2 μ V

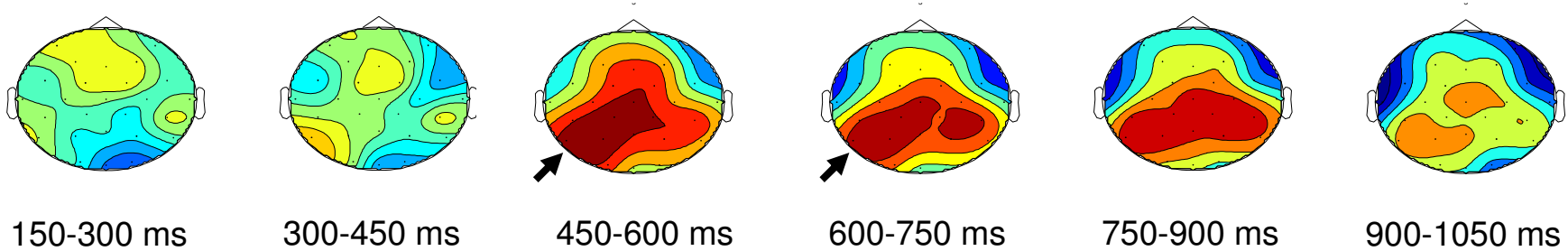
Pragmatic congruence

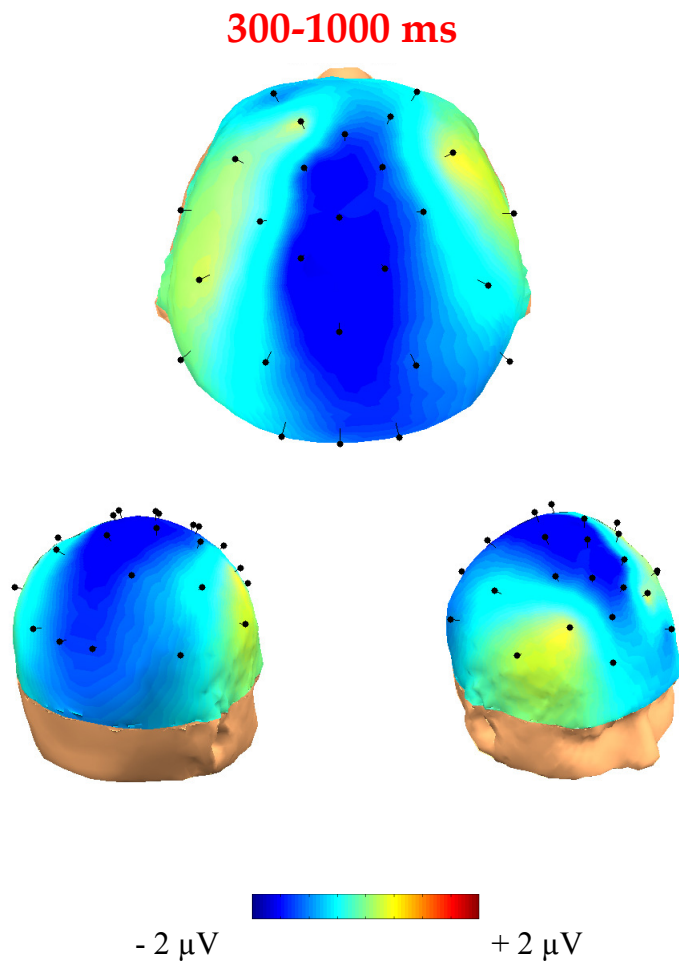
(difference waves)

a. Focal accent (M⁻ - M⁺)

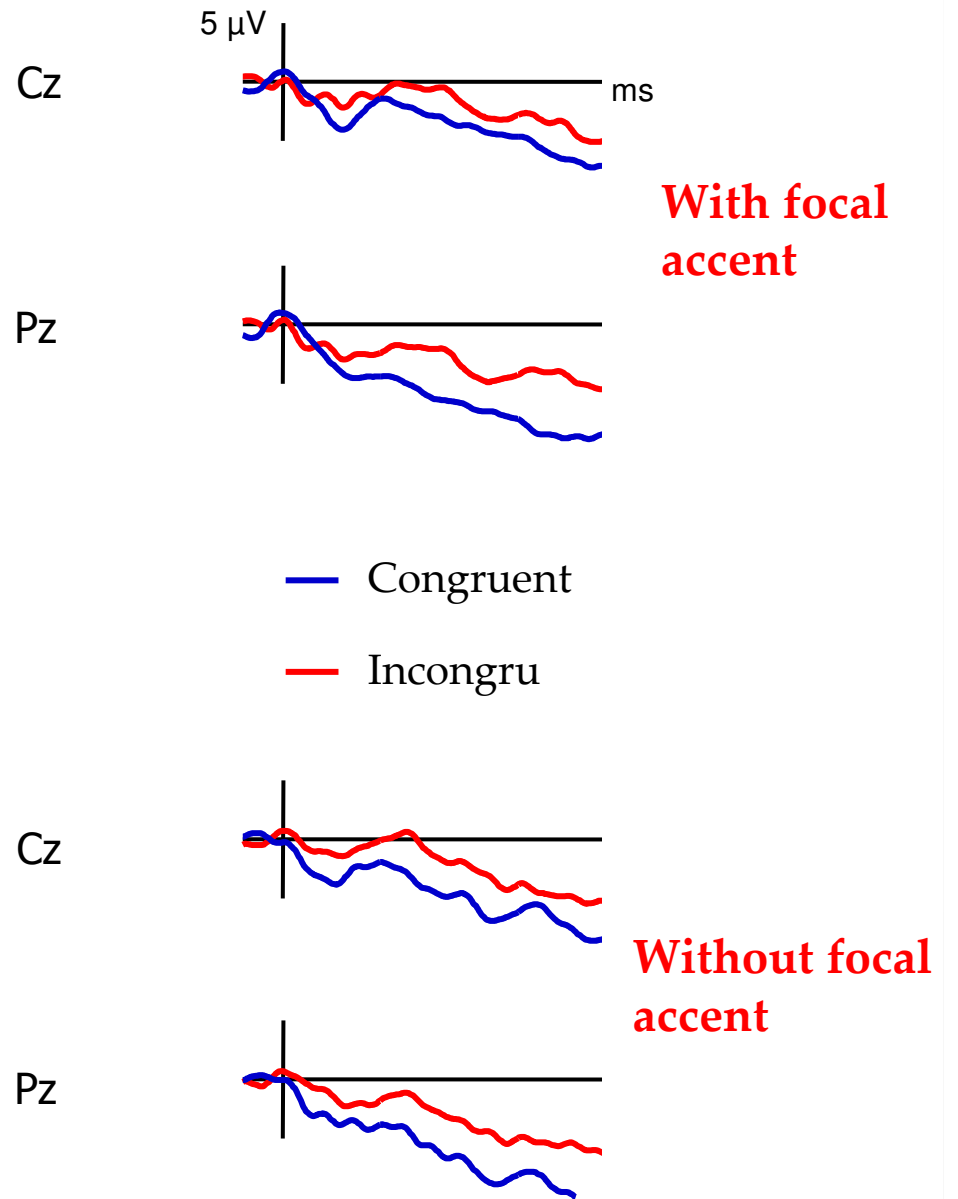


b. No focal accent (M⁰T⁻ - M⁰T⁺)





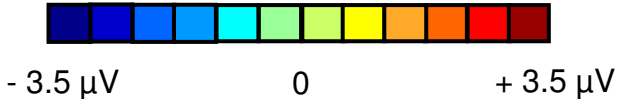
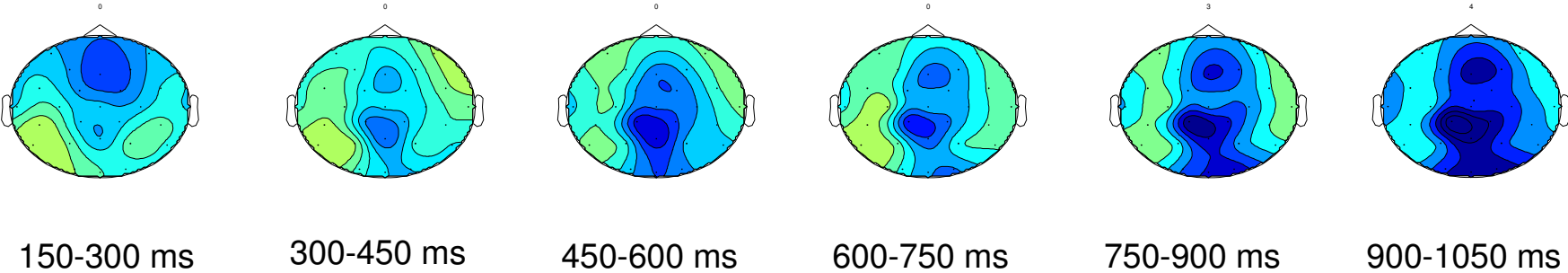
Terminal word



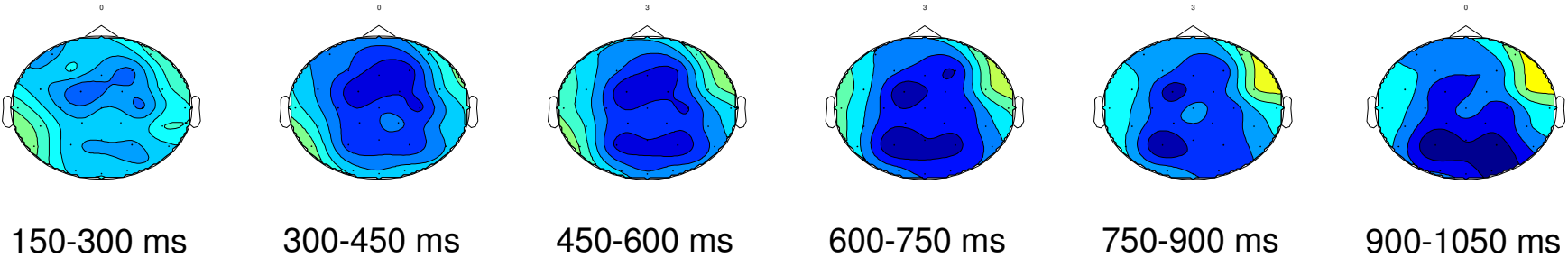
Pragmatic congruence

(difference waves)

a. Focal accent ($T^- - T^+$)



b. No focal accent ($M^-T^0 - M^+T^0$)



Conclusions

- **Focal accents are processed in real time**
 - Psychobiological relevance of prosodic focus
- **Interaction between prosodic focus and pragmatic context**
 - Pragmatic relevance of focal accent determines the observed effects (more than its presence - absence)
- **Observed effects depend upon the position of focal accents in the sentence**
 - Middle word : positivity → Surprise
 - Terminal word : negativity → Integration





Meter and semantic processing

Magne, Astésano, Ystad, Kronland-Martinet & Besson
(*Cerebral Cortex*, 2007)

Prosody

- ➔ **ERP marker of incongruous syllabic lengthening ?**
- ➔ **Independent vs interactive processes ?**
- ➔ **Influence of attention**

Experimental conditions

Meter	Congruous (M+)	Incongruous (M-)
Semantic		
Congruous (S+)	 M+S+ Le concours a regroupé mille candidats	 M-S+ Le concours a regroupé mille candidats
Incongruous (S-)	 M+S- Le concours a regroupé mille bigoudis	 M-S- Le concours a regroupé mille bigoudis

➡ 32 sentences / experimental condition (= 128 sentences)

Protocole

Task Meter : Is the final word well-pronounced ?

Semantic : Is the final word meaningful in the context?

Participants: 14 native French speakers, right-handed

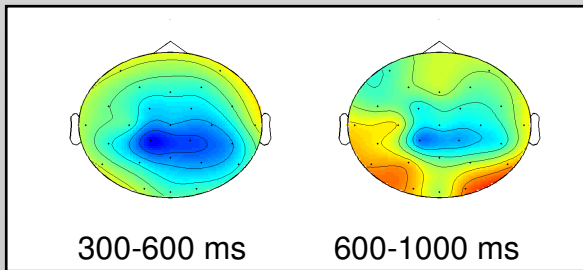
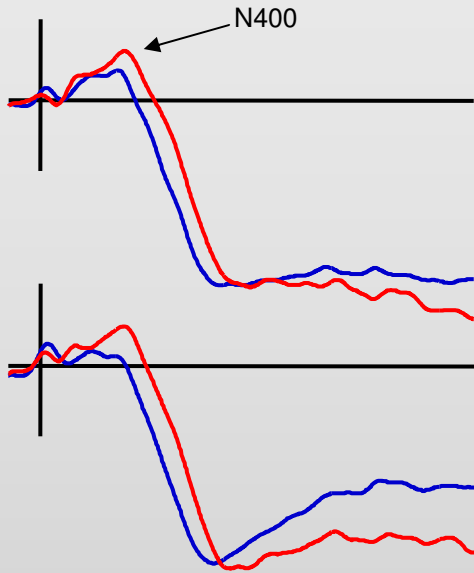
Acquisition EEG + % errors + RTs Time course



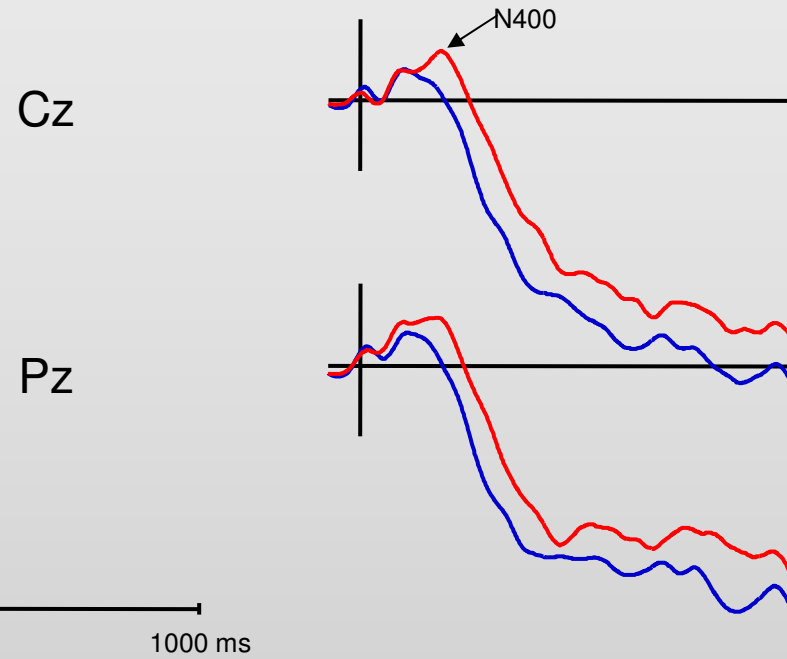
Behavioural data

	Mètre				Sémantique			
	S+M+	S-M+	S+M-	S-M-	S+M+	S-M+	S+M-	S-M-
%Err	13 (16)	19 (16)	15 (14)	17 (16)	11 (6)	15 (17)	24 (18)	15 (11)
TRs	932 (152)	1055 (179)	966 (102)	997 (135)	975 (139)	1127 (184)	1011 (164)	1138 (146)

Meter

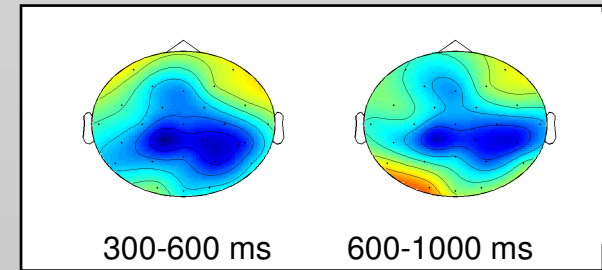


Semantic

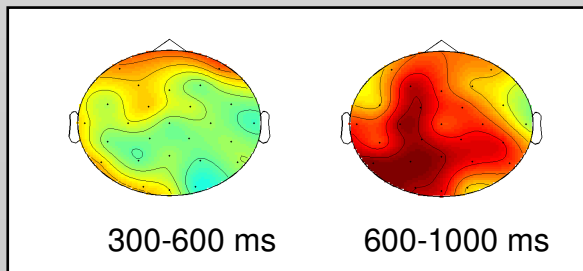
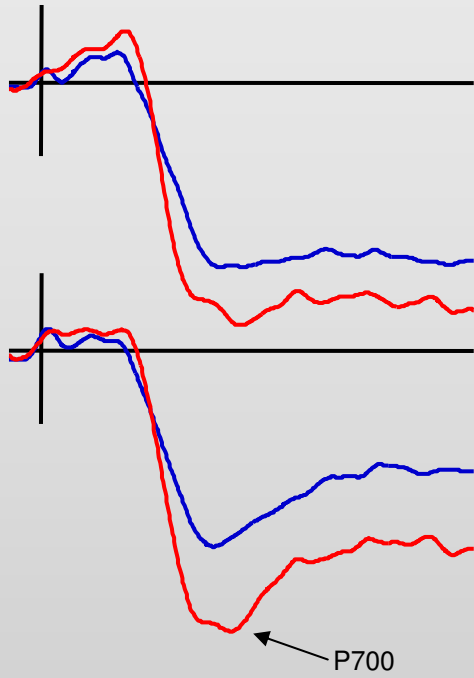


— S+M+

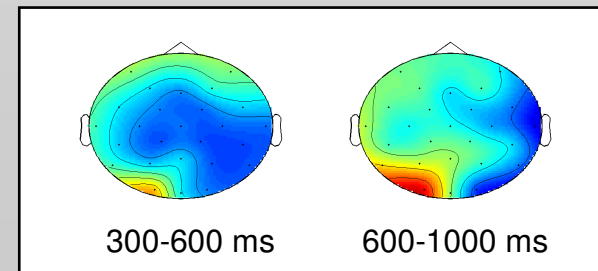
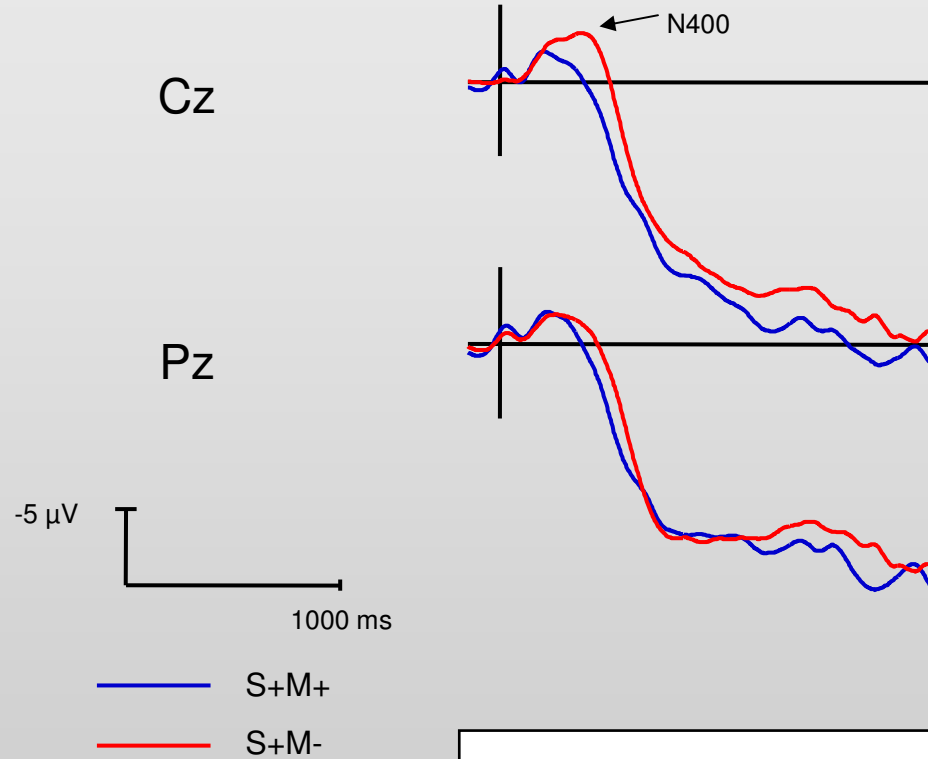
— S-M+



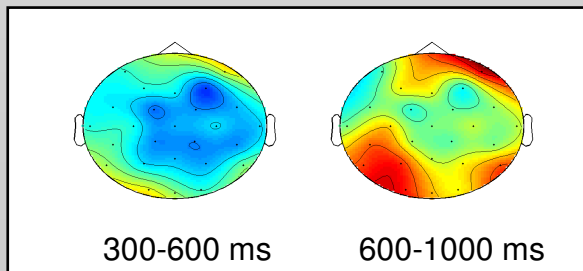
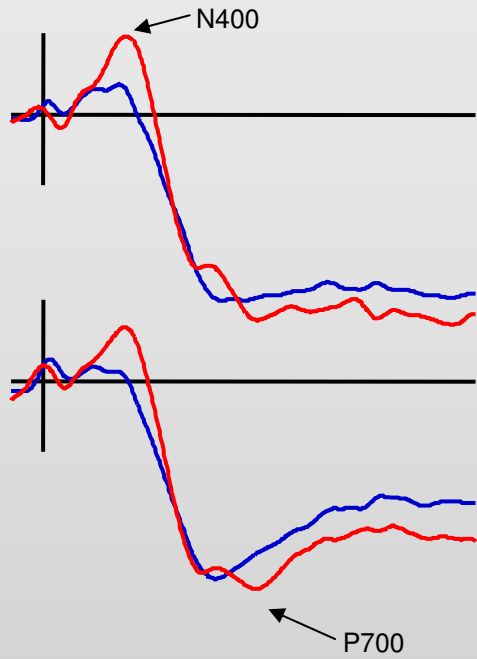
Meter



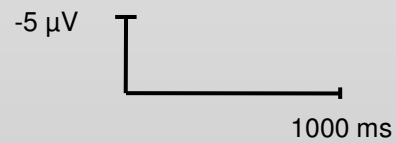
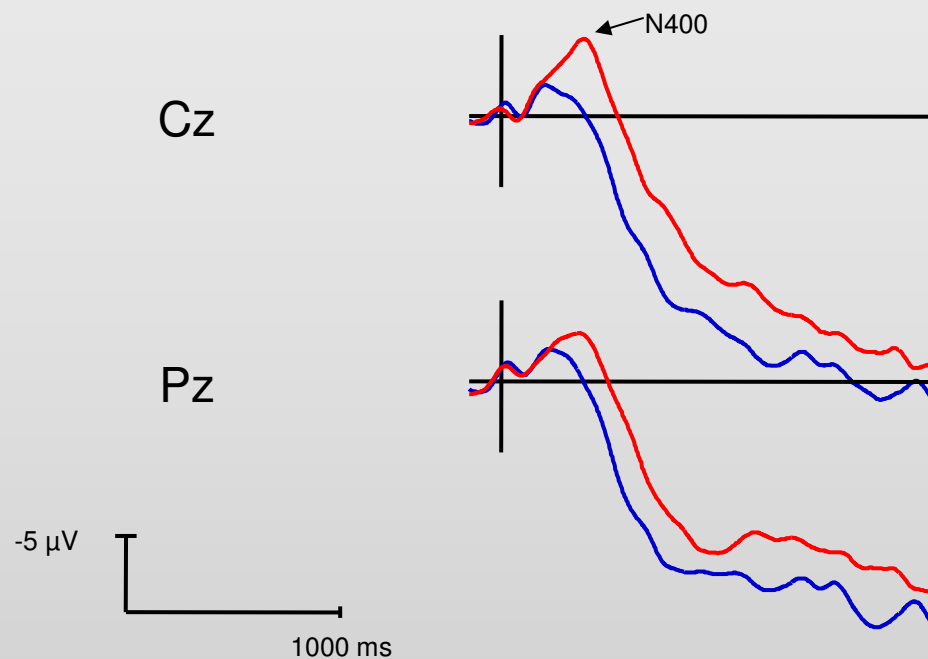
Semantic



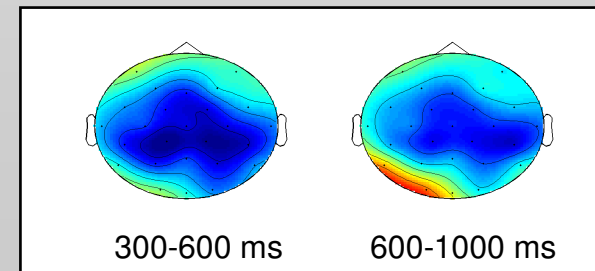
Meter



Semantic



— S+M+
— S-M-



Conclusions

- P700 to metric incongruity when attention is focused on meter
 - participants are sensitive to the metric structure of words
- N400 to metric incongruity when attention is focused on semantics
 - Interaction between metric and semantic processing
- N400 to semantic incongruity independently of attention.
 - N400 also reflects automatic semantic processing

Thank you!

General Conclusion

○ **Psychobiological validity of several aspects of prosodic processing :**

- ➔ Modality
- ➔ Focal accent
- ➔ Meter

○ **Interactions between levels of processing :**



○ **Linguistic specificity ?**

