Actor identification in natural stories:

Qualitative distinctions in the neural bases of actor-related features

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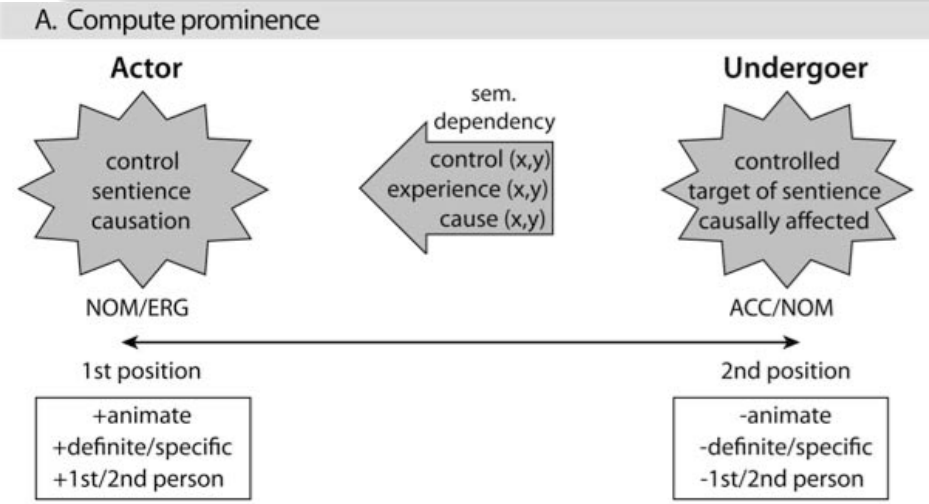
Theoretical Background

competition for the actor role

Actors

An actor is prototypically sentient, causes the event described and is also (consciously) in control of it. (cf. Primus 1999; Bornkessel-Schlesewsky and Schlesewsky 2009)



Bornkessel-Schlesewsky and Schlesewsky (2009)

Prominence scales:

- +animate > -anim.
- +definite > -definite
- +1. person > -1. pers.
- +nominative > -nom.
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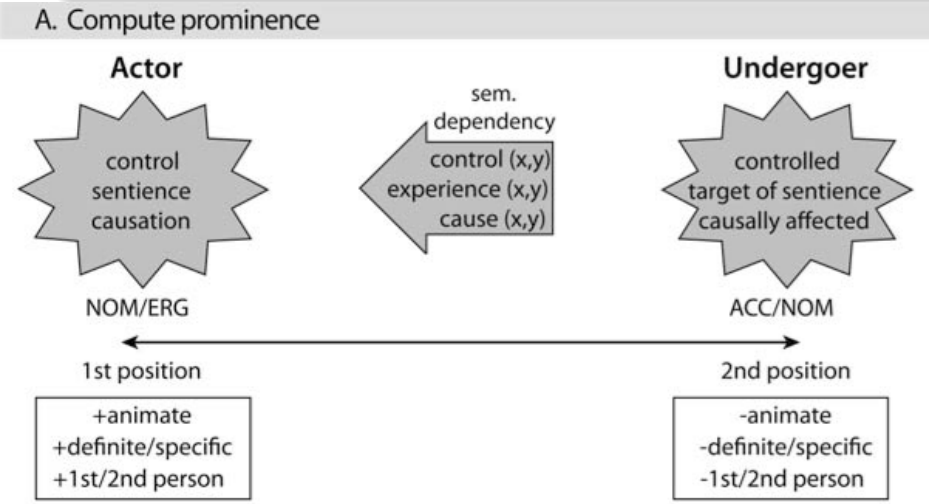

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a preference for actor prototypicality

Klaus fragte sich ...
Klaus wondered ...

- welchen Gärtner **der Abt** besuchte
  [which gardener]$_{\text{ACC}}$ the abbot visited
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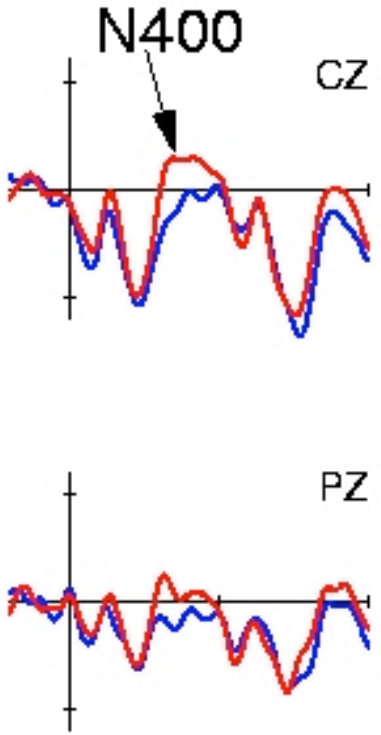

Frisch and Schlesewsky (2001)

- Negativity in the N400 time window for inanimate actor
- No comparable effect for first participant: not a lexical effect
- Crosslinguistic evidence for similar effects (cf. Weckerly and Kutas 1999; Bornkessel-Schlesewsky and Schlesewsky 2009): Actor-search as a potential universal strategy?

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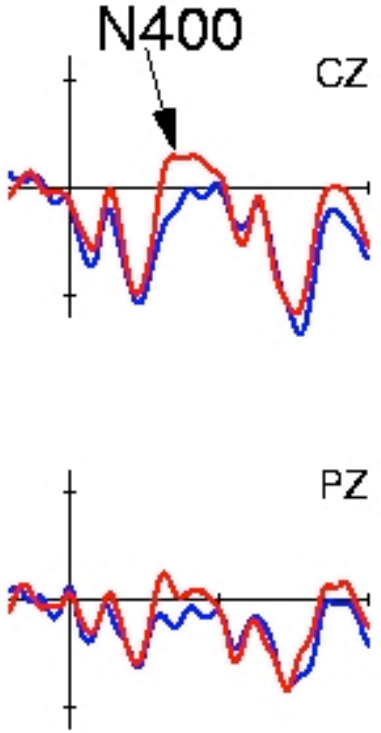

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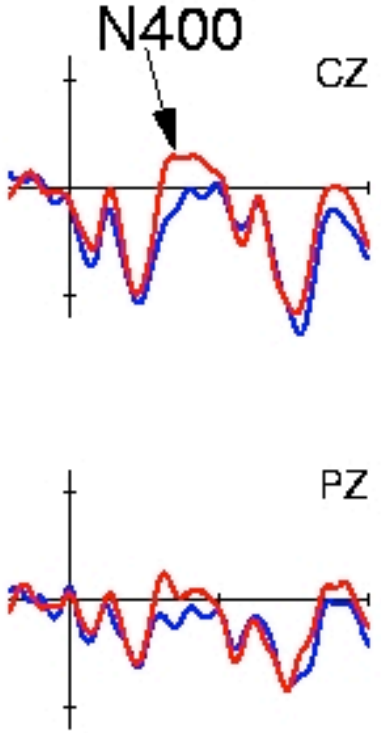

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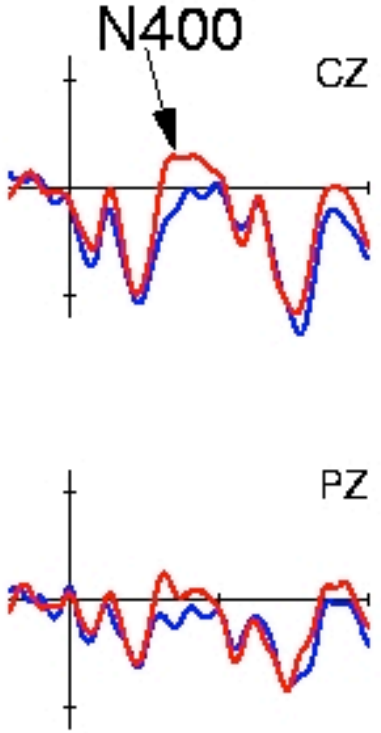

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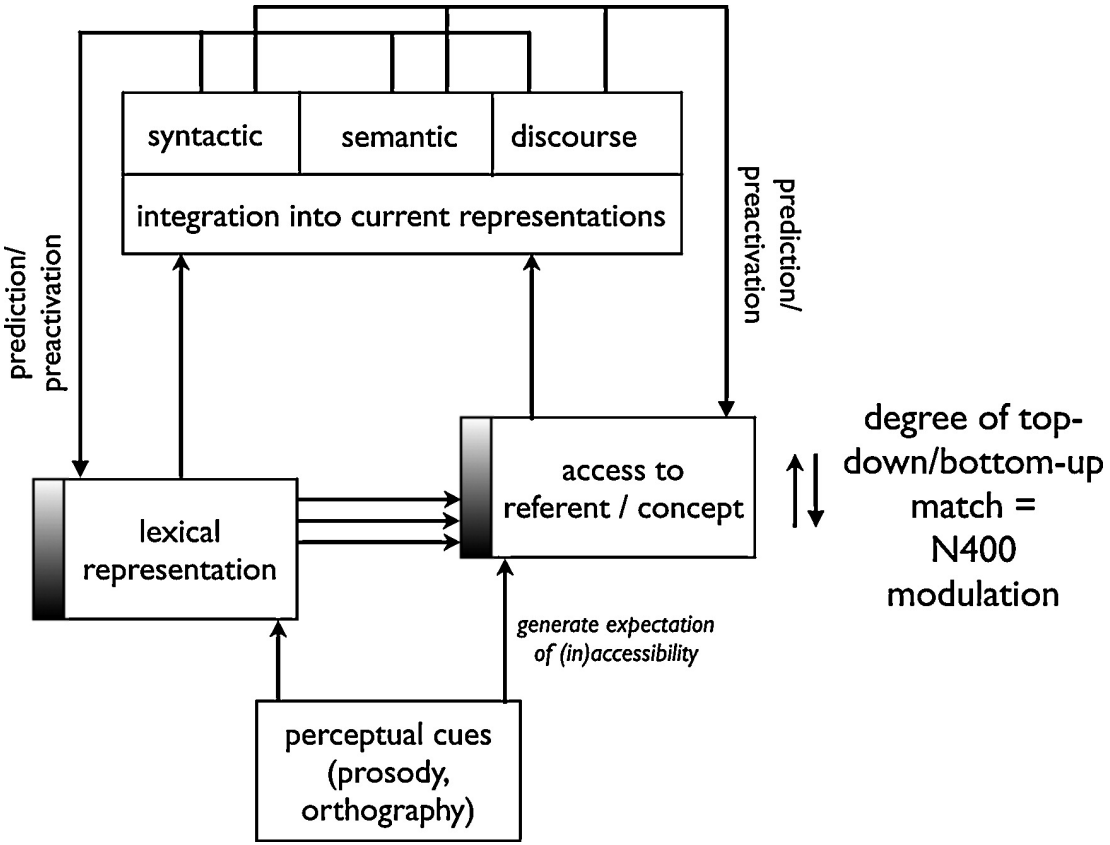
Theoretical Background

meeting expectations

The bidirectional account of the N400:



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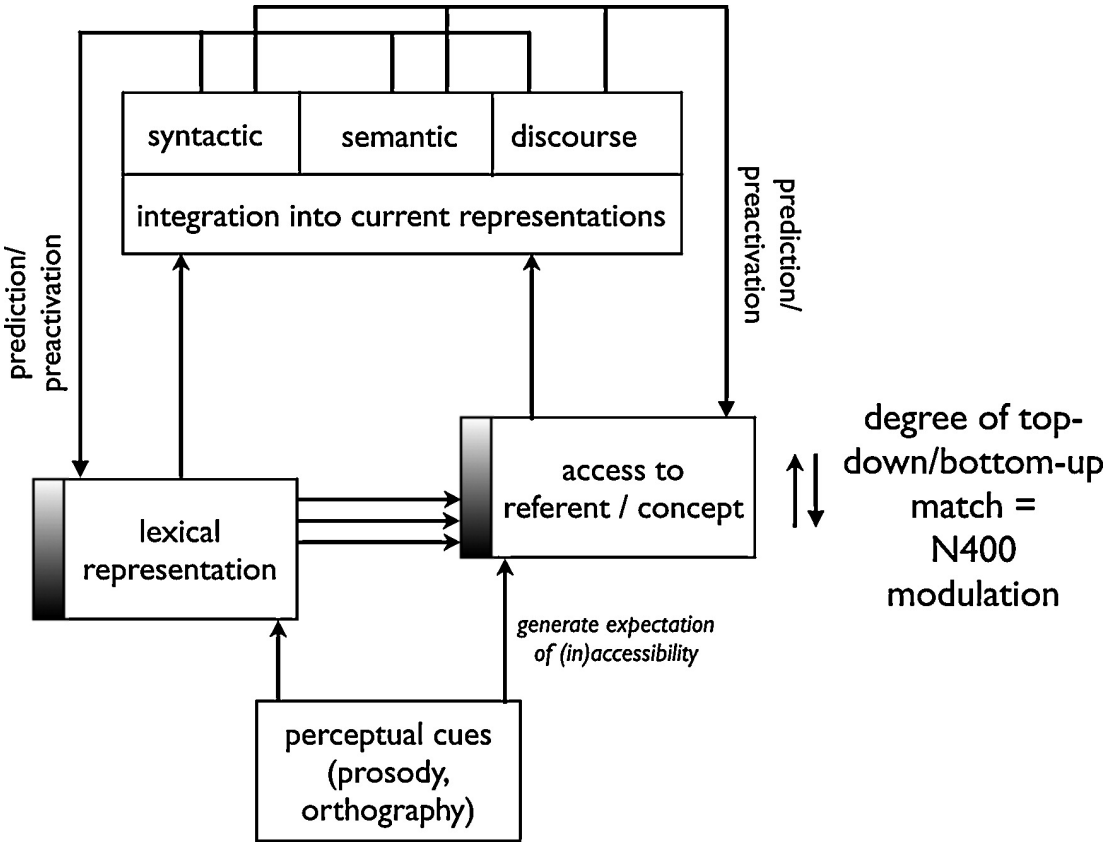

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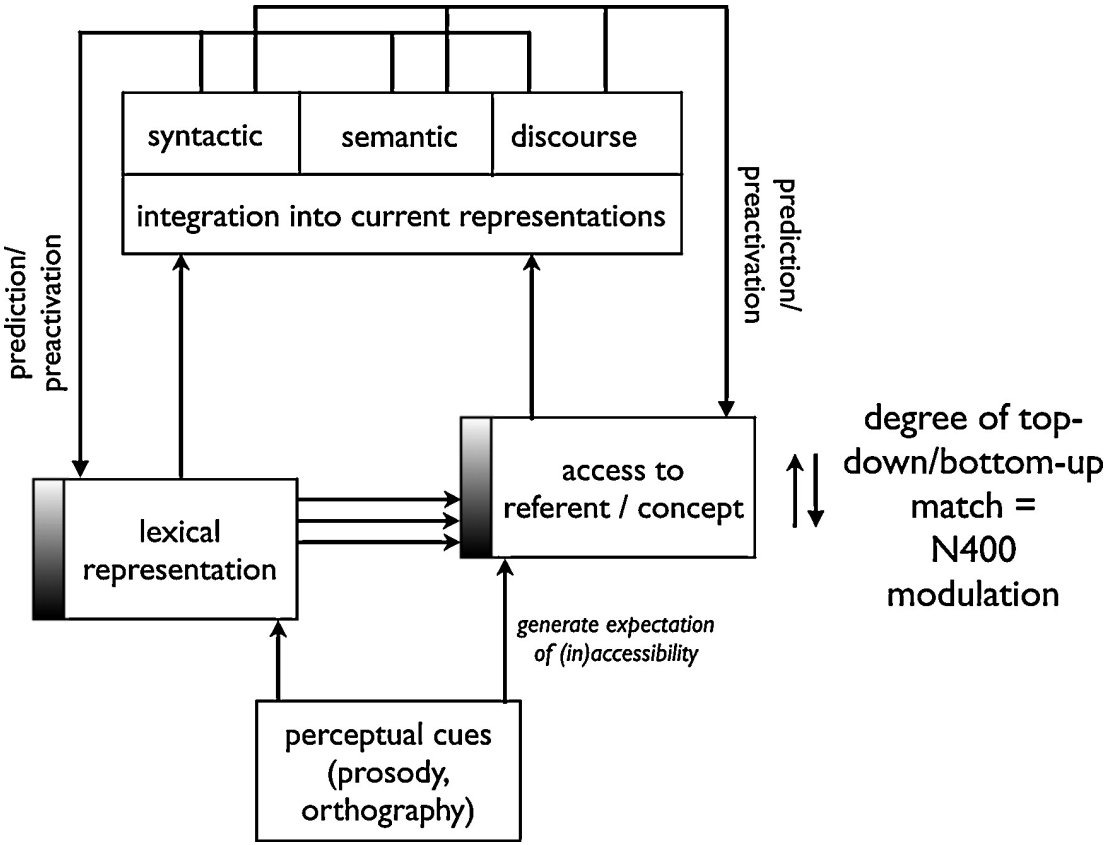

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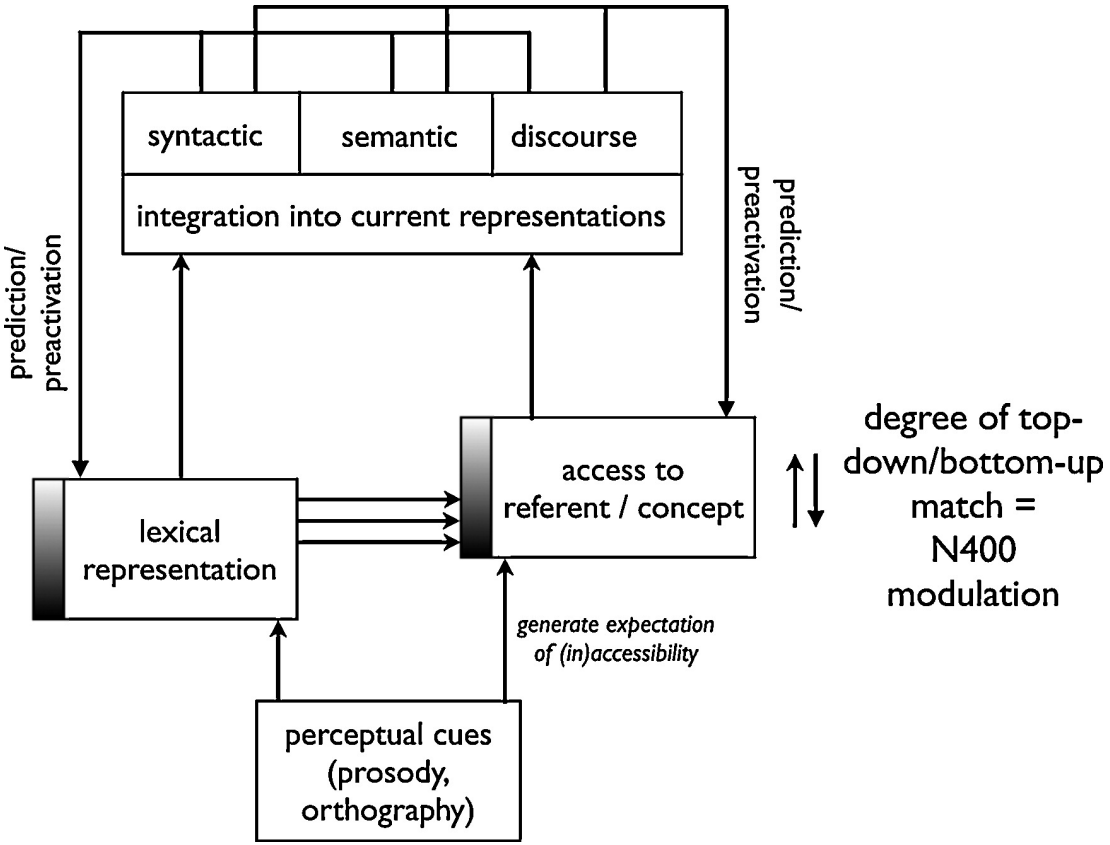

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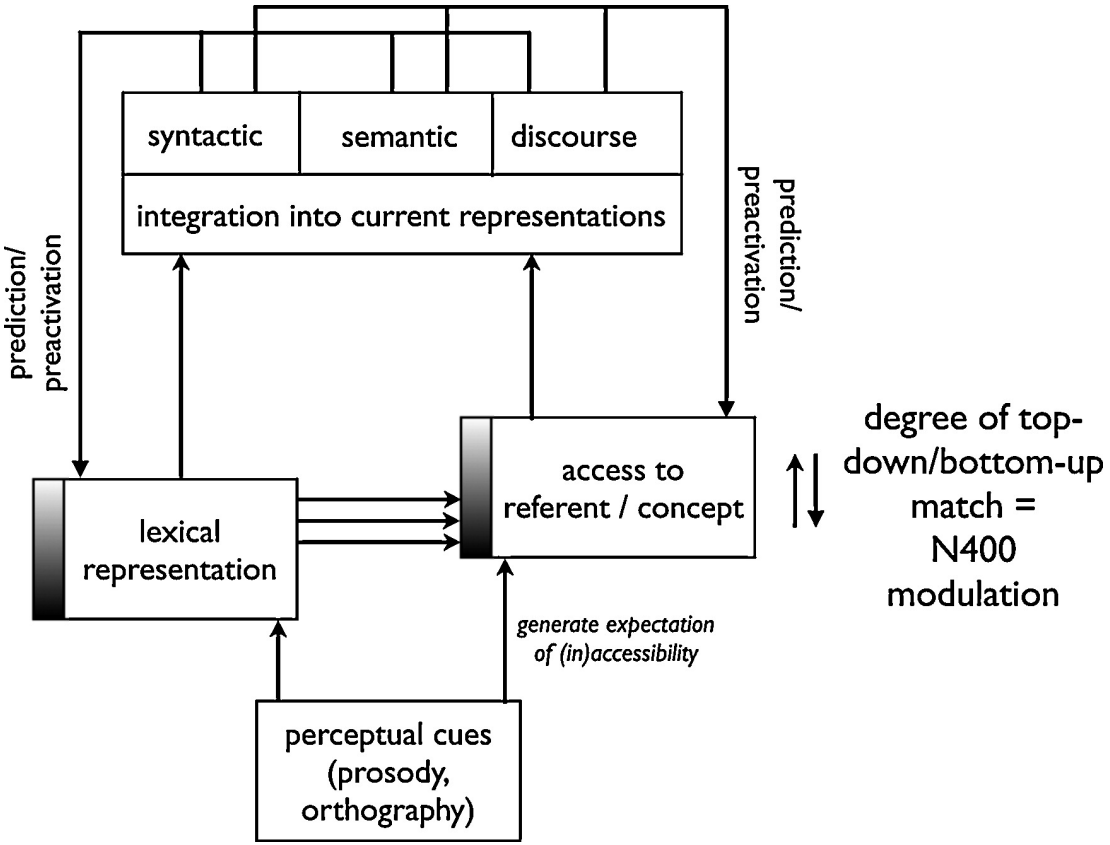

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N400 as an index of unmet expectations for an optimal actor?

The Present Study

motivation and aims

We sought to examine:

- universal status of "actor", avoiding task-related and language-specifc artifacts
- language processing in a comparatively natural context with less rigid structure
- neural bases and implementation of the prominence/actor heuristics
- the potential for qualitative differentiation of various prominence features based on their distribution and availability across languages

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Traditional Experimental Designs

constructed stimuli and online tasks

- Advantages
  - easy to control for potential confounds (frequency, phonology, etc.)
  - easy to collect good behavioral data as indicator for test-subject attention
  - data very cleanly elicited, relatively clear component structure
- Disadvantages
  - somewhat artificial – are sentences processed "normally" in such a context? (Skipper et al. 2009; Hasson et al. 2004)
  - pragmatic aspects and larger context almost completely out of the question
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Neurolinguistic Research with Natural Stimuli

in the current literature

Studies without an explicit task:

- EEG: Haupt et al. (2008)
- fMRI: Skipper et al. (2009)
- fMRI: Whitney et al. (2009)
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BUT: constructed stimuli and/or coarse-grained contrasts

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The Present Study

stimulus and task

- Stimulus from Whitney et al. (2009):
  - Story: lightly modified version of the novella *Der Kuli Kimgun* by Max Dauthendey (1909)
  - Length: approx. 23 Minutes (3581 Words)
  - Spoken by a male speaker (trained speech therapist)
- No online task — listening with open eyes, but comprehension questions afterwards
- Five actor-related cues contrasted (common nouns outside of PPs and GPs)

The Present Study

technical aspects

EEG

- 49 test subjects in the final analysis
- 25 Ag/AgCl electrodes
- 500 Hz sampling rate

fMRI

- 15 test subjects in the final analysis
- 1.5 T scanner (Gyroscan Intera, Philips Medical)
- TR: 2.0s

universally available

- animacy
- humanness
- position

language specific

- morphological case

optionally realized

- definiteness

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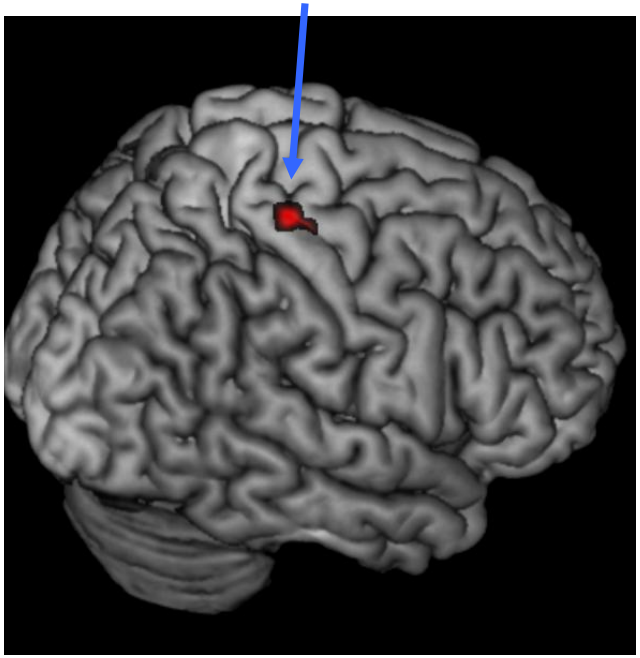
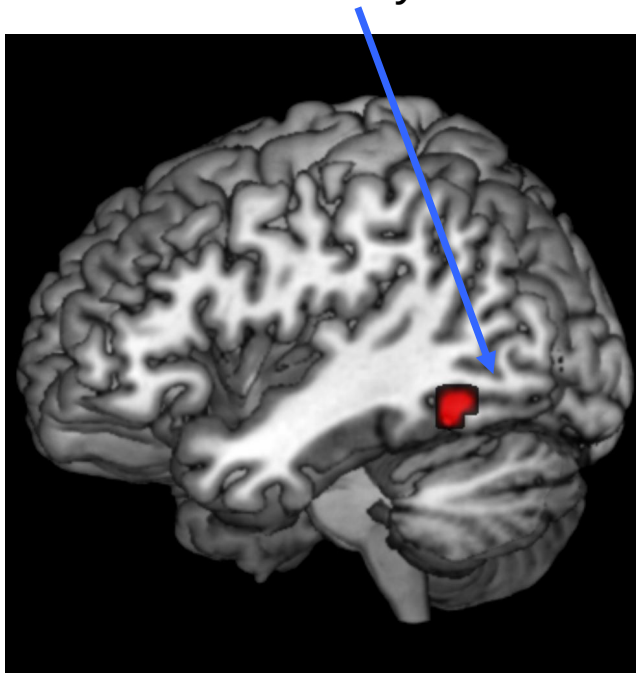
Animacy

inanimate > animate

Postcentral Gyrus



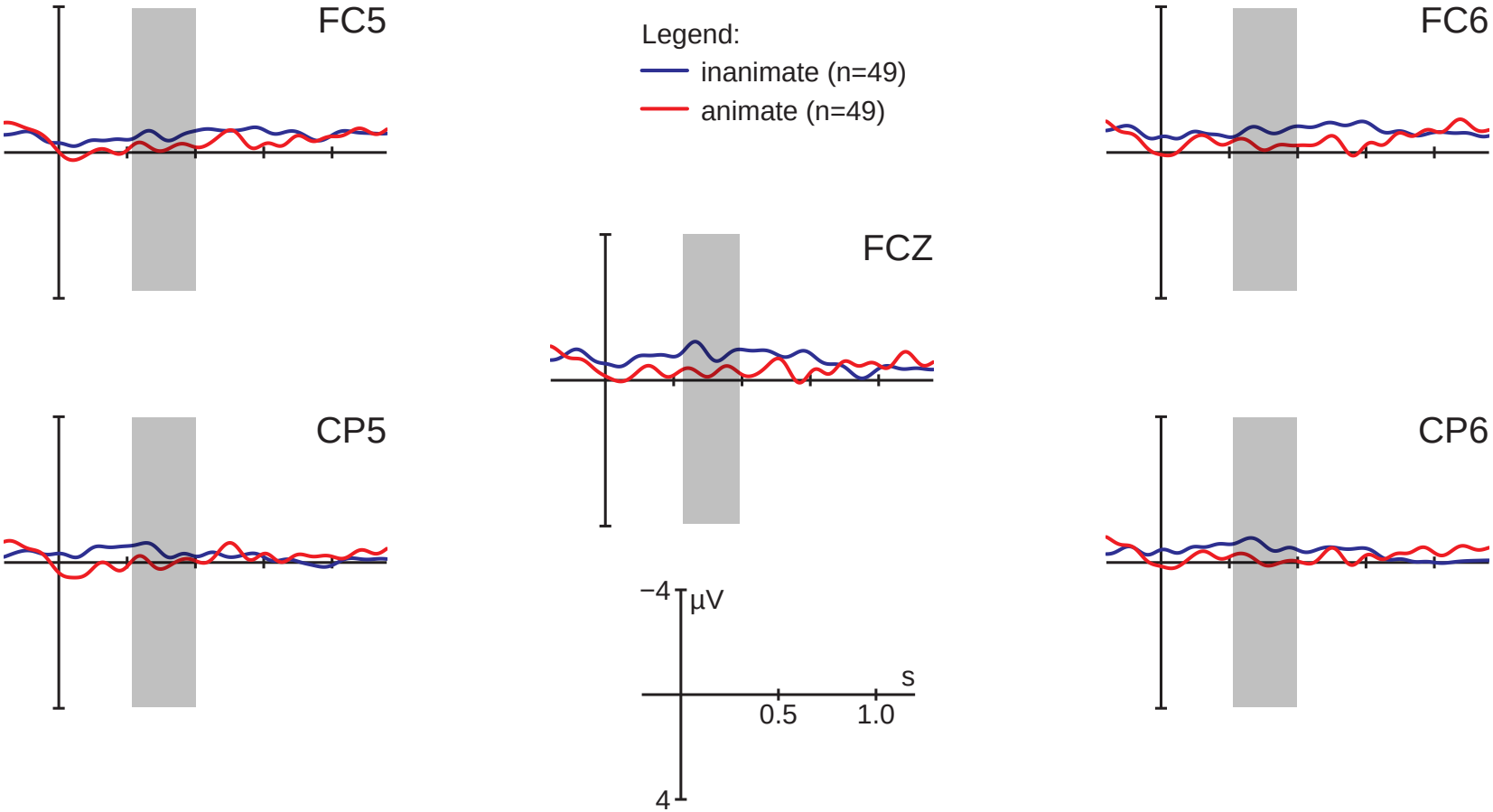
Fusiform Gyrus



$p < 0.001$

Animacy

from availability

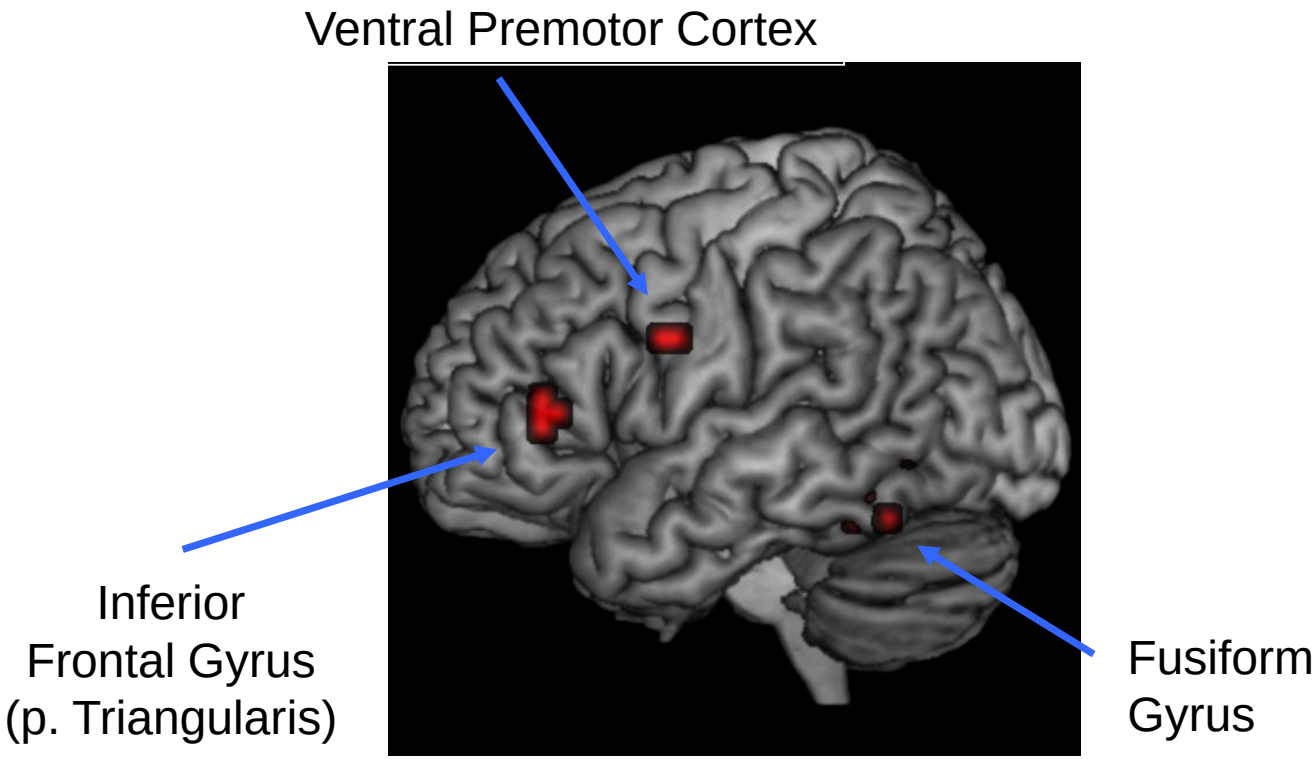


ANOVA window: 000-300ms: $F(1, 48) = 9.22,\ p < 0.00386$

ANOVA window: 300-500ms: $F(1, 48) = 9.22,\ p < 0.00386$

Humanness

not-human > human



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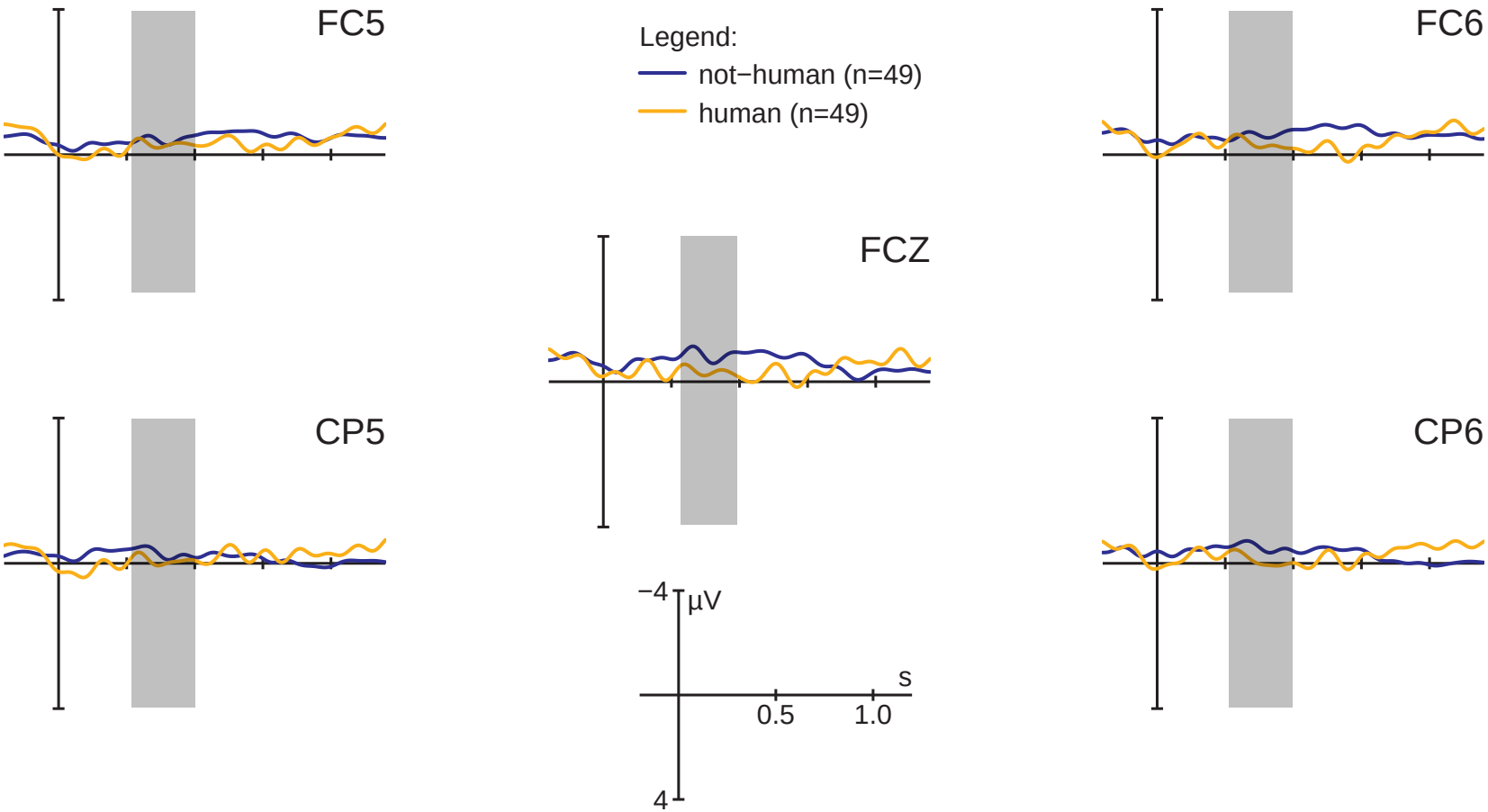
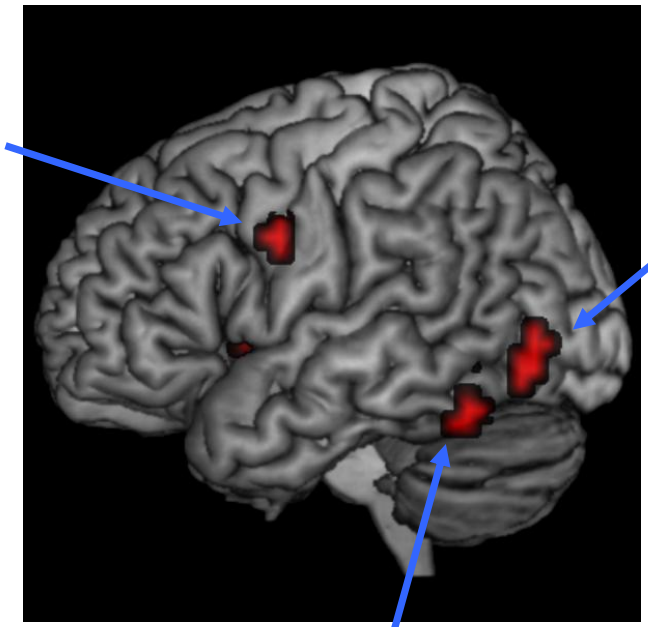


ANOVA window: 000-300ms: $F(1, 48) = 2.37$, $p < 0.131$

ANOVA window: 300-500ms: $F(1, 48) = 4.80$, $p < 0.00334$

Position

second > first



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Position

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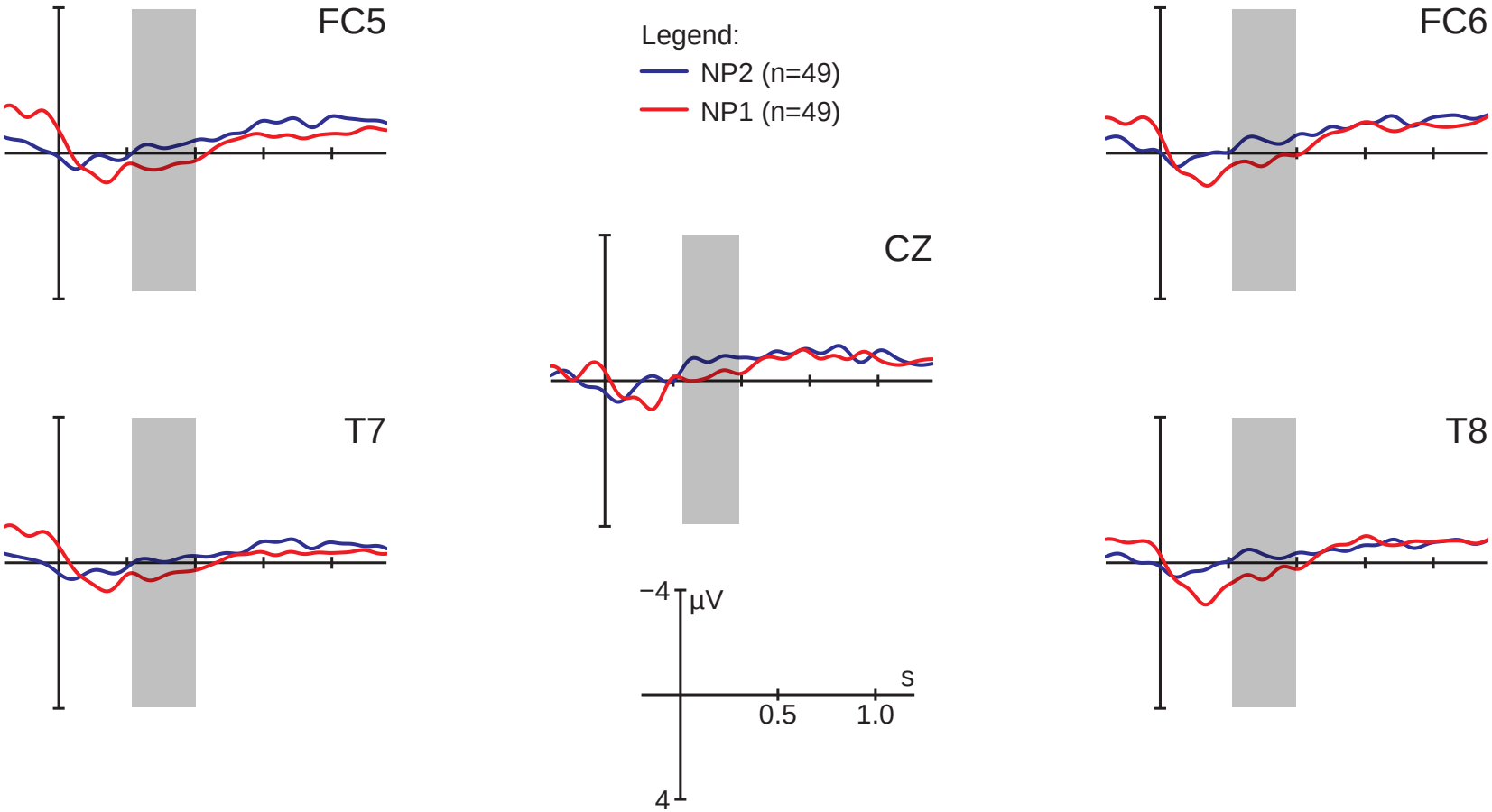


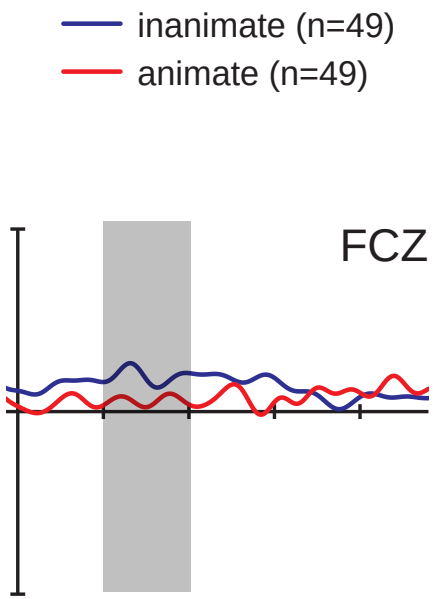
ANOVA window: 000-300ms: $F(1, 48) = 3.67$, $p < 0.0615$

ANOVA window: 300-500ms: $F(1, 48) = 16.06$, $p < 0.000213$

Universal Availability

summary

Animacy



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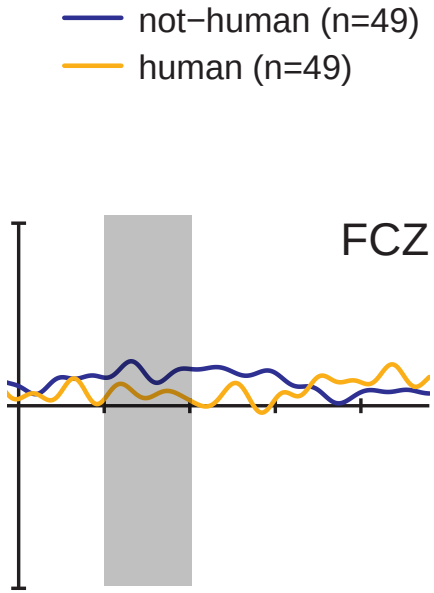

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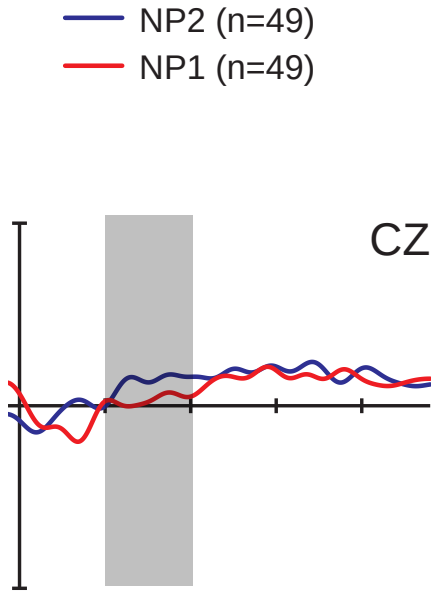

For less prominence:

negativity between 300–500ms

overlapping left-lateralised networks involving the fusiform gyrus and ventral premotor cortex

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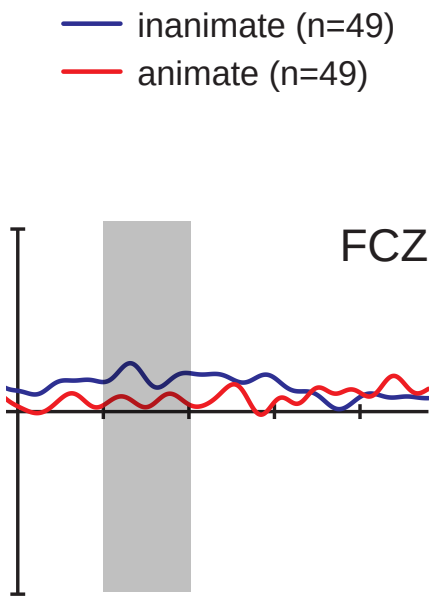

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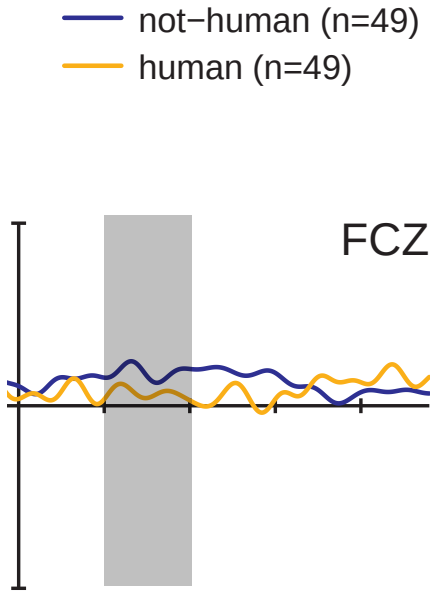

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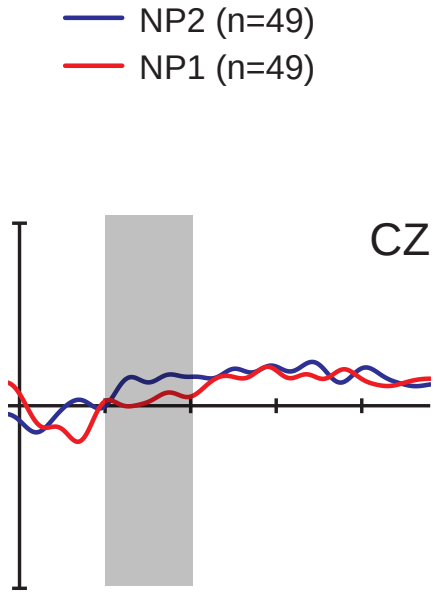

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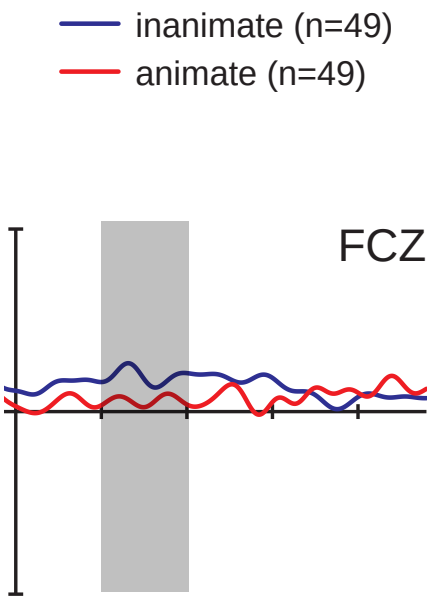

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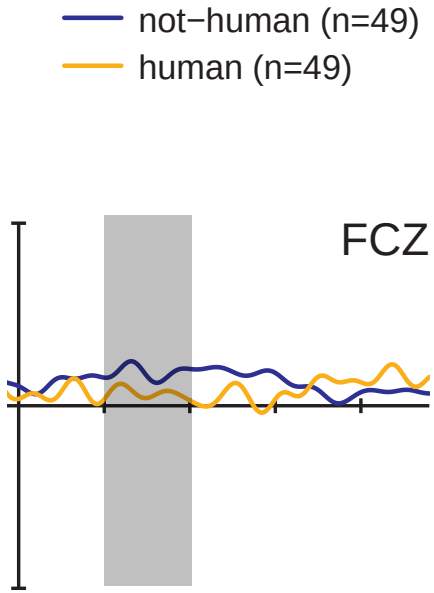

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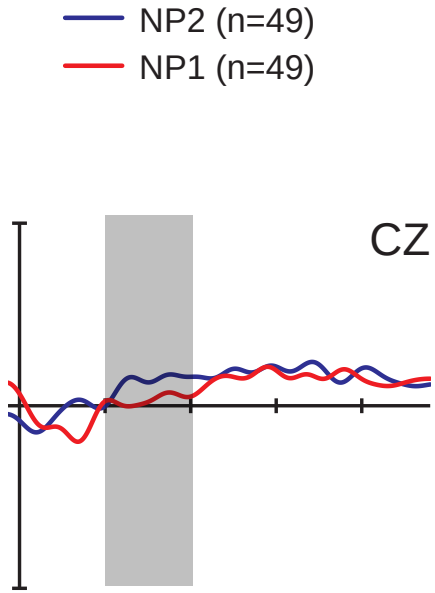

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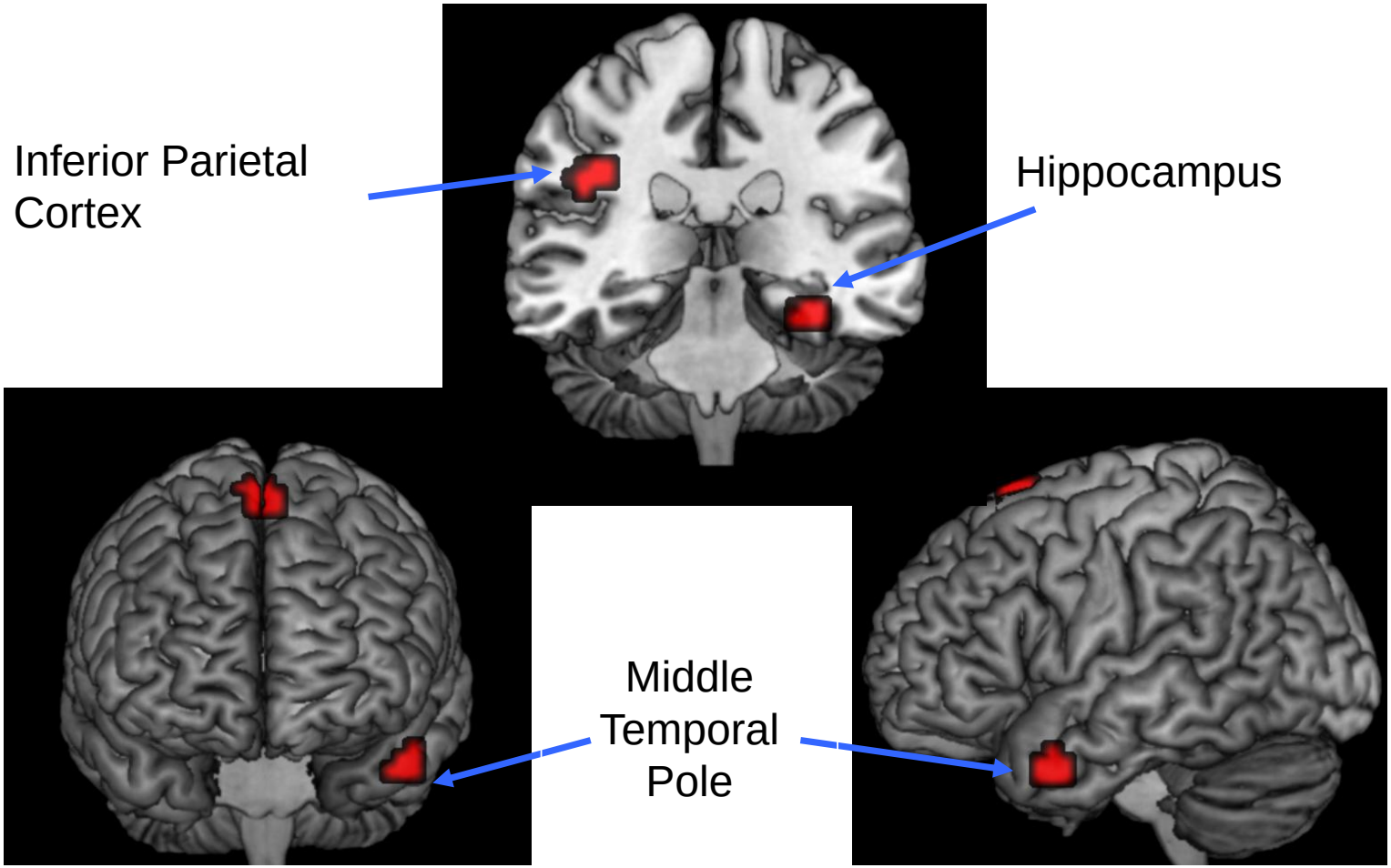
Morphology

nominative > not-nominative



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Morphology

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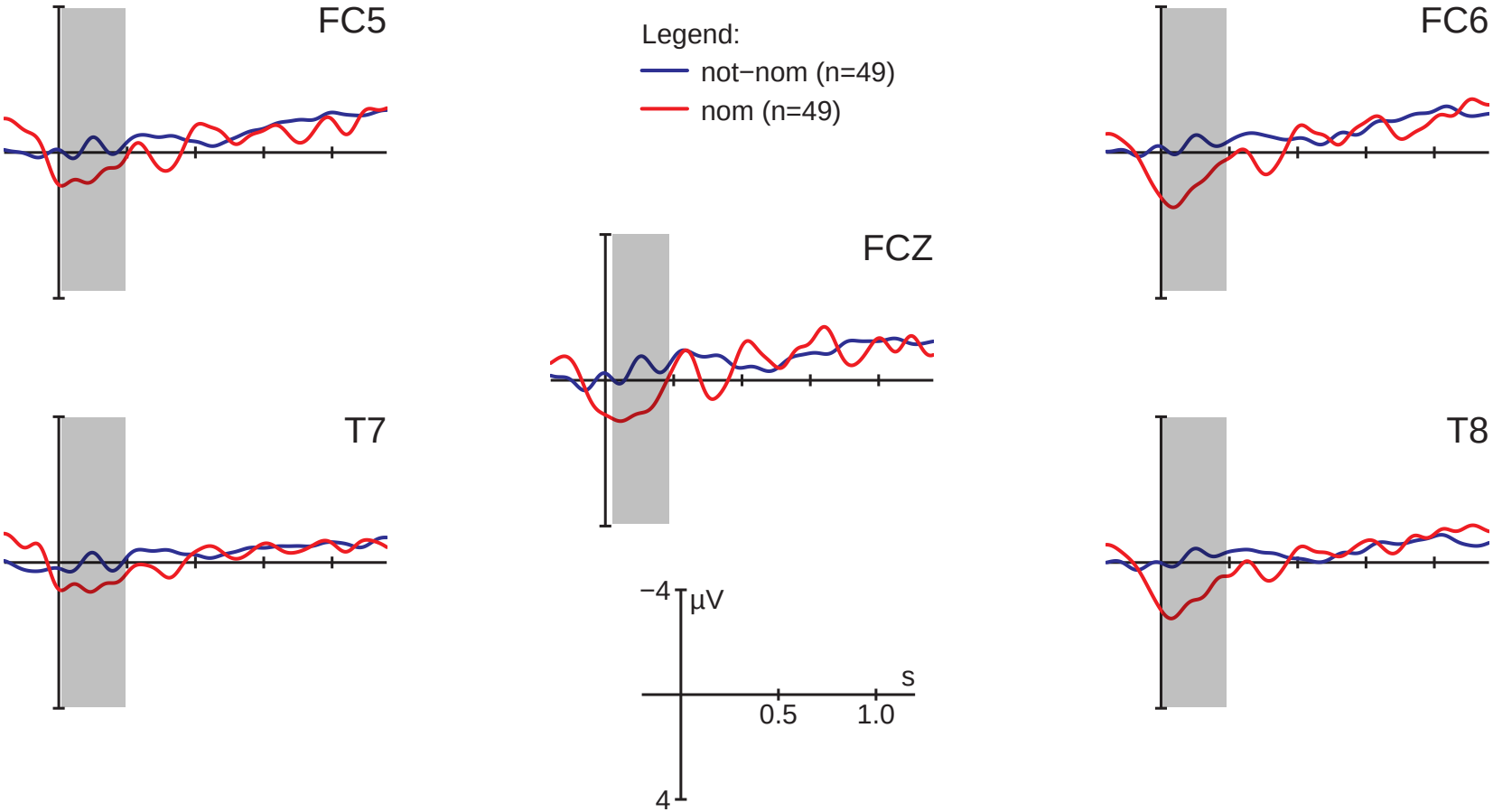

ANOVA window: 000-300ms: $F(1, 48) = 11.69$, $p < 0.00129$

ANOVA window: 300-500ms: $F(1, 48) = 2.31$, $p < 0.135$

Language Specific Availability

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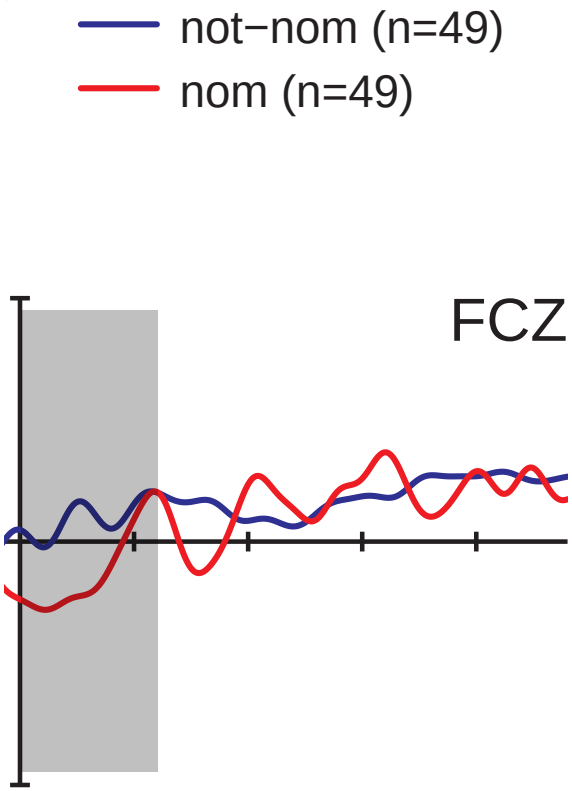

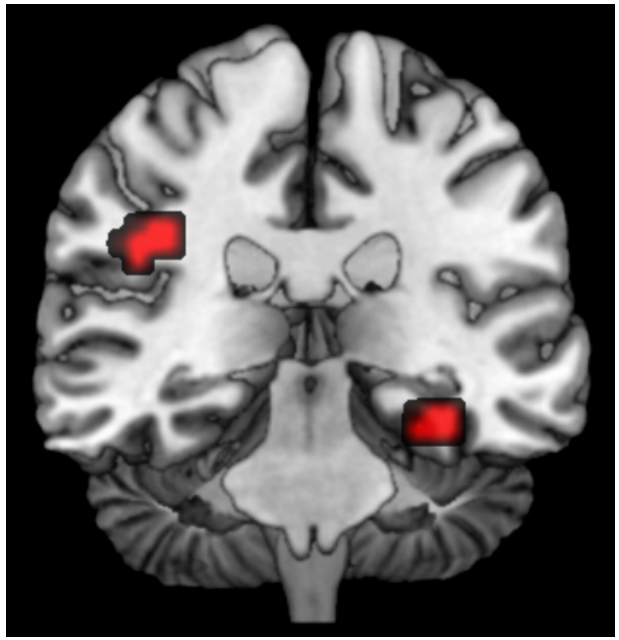

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early positivity

activation in temporal (temporal pole, hippocampus) and parietal regions

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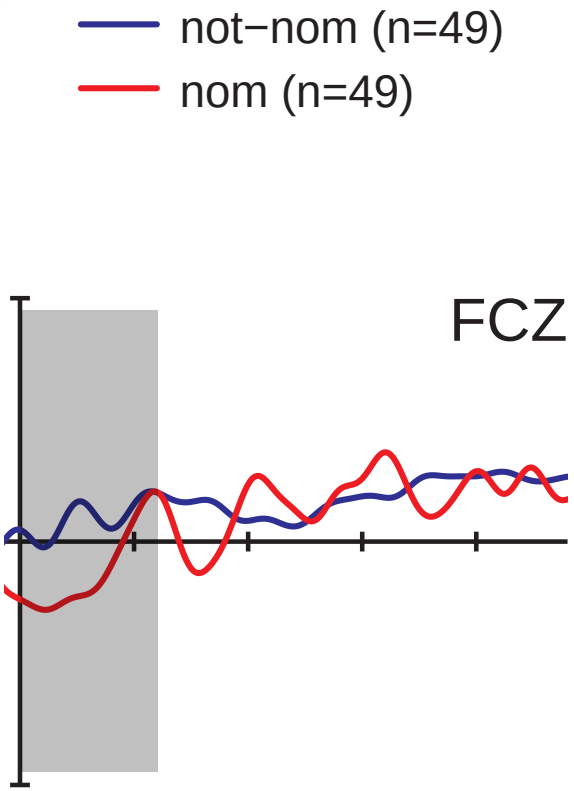

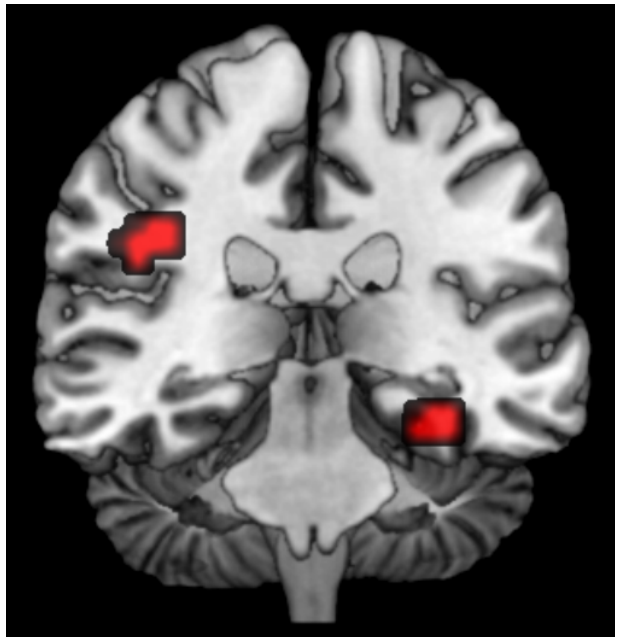

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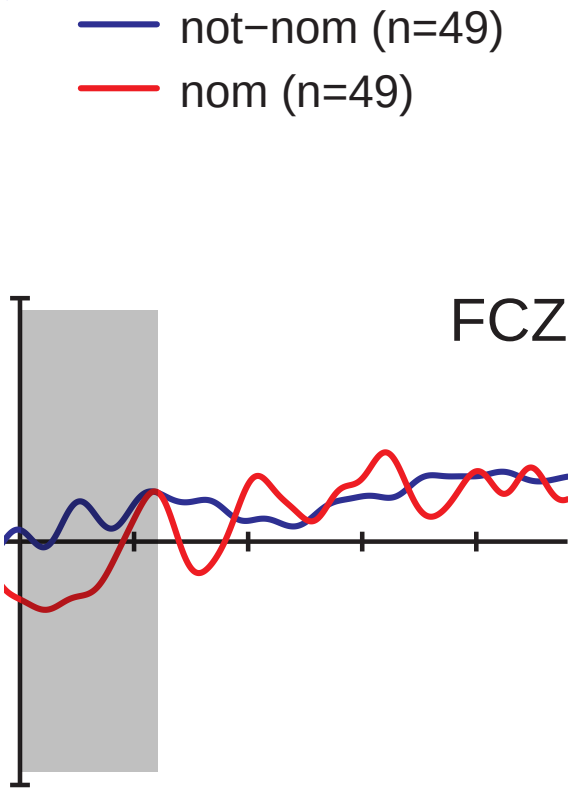

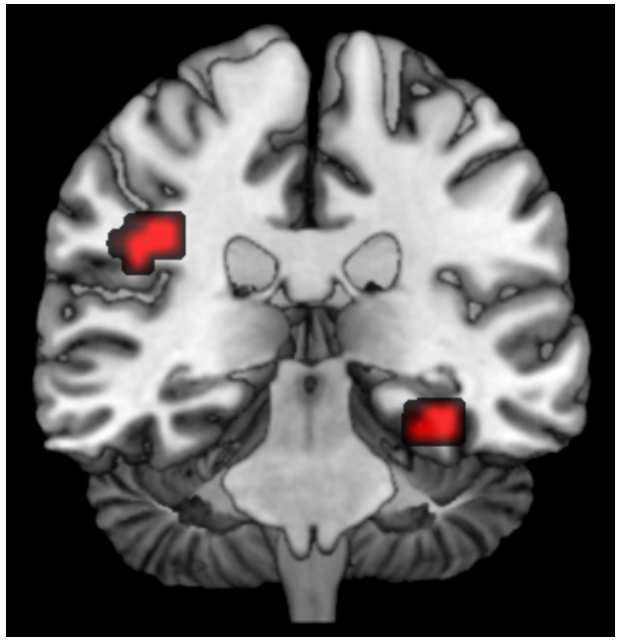

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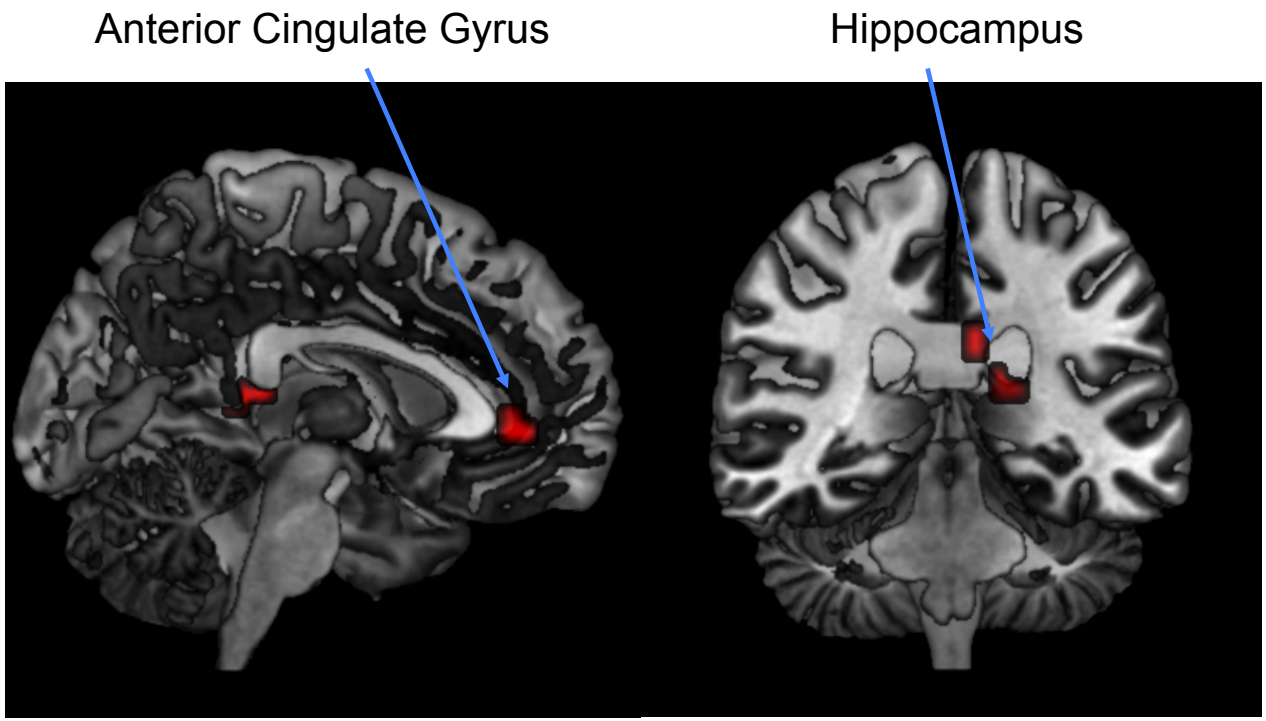
Definiteness

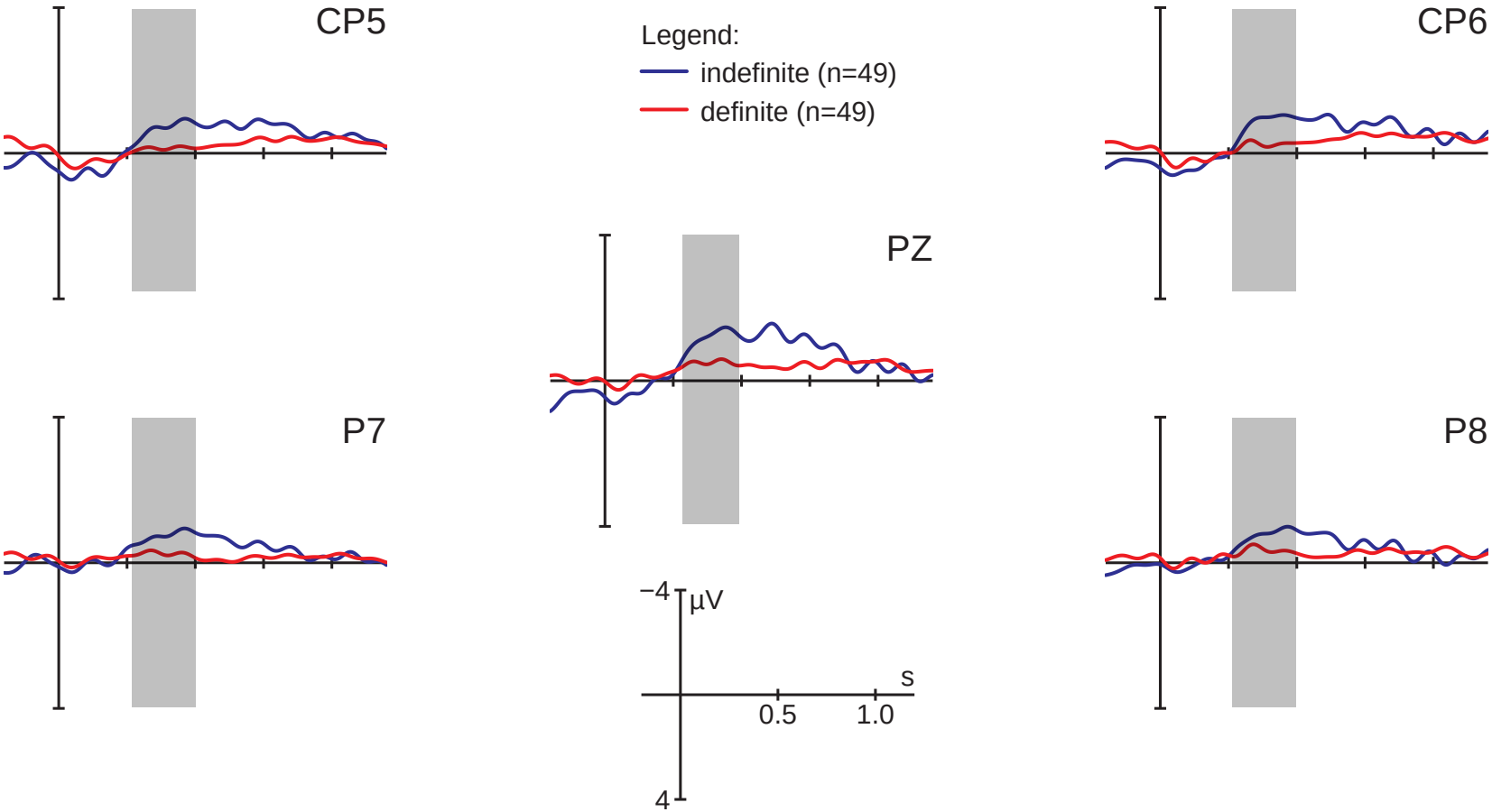
not-definite > definite



$p < 0.001$

Definiteness

from availability

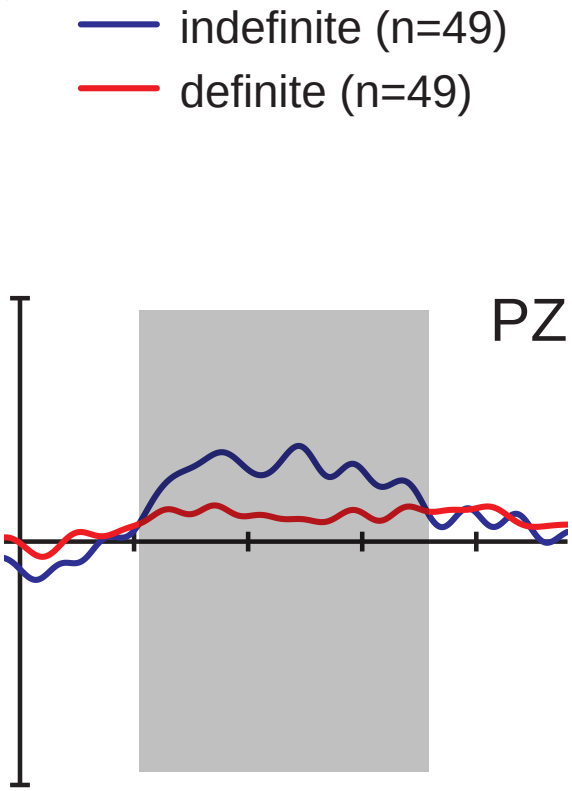


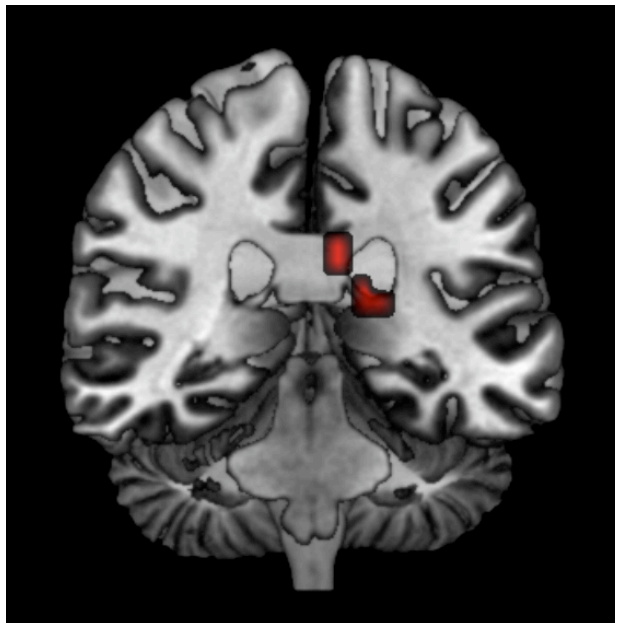
ANOVA window: 000-300ms: $F(1, 48) = 2.17$, $p < 0.147$

ANOVA window: 300-500ms: $F(1, 48) = 9.84$, $p < 0.00291$

Optional Realization

summary





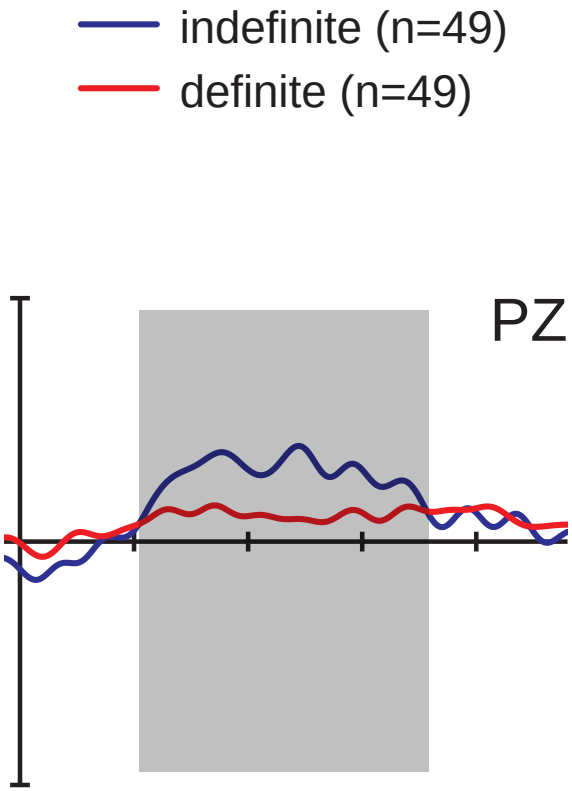
For less prominence:

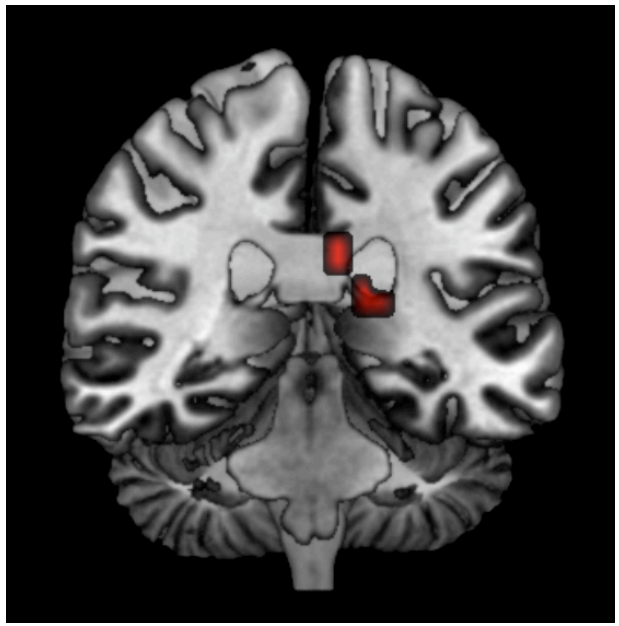
negativity after 300ms

activation in hippocampus and anterior cingulate

Optional Realization

summary





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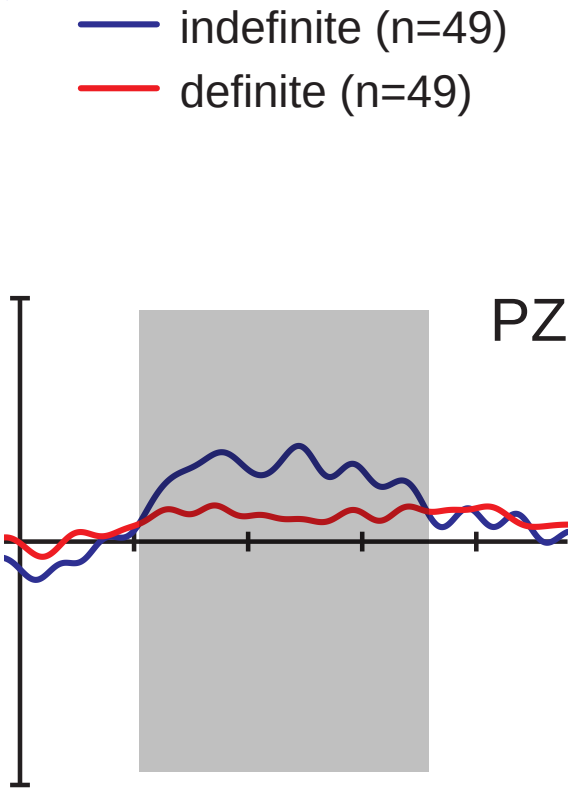

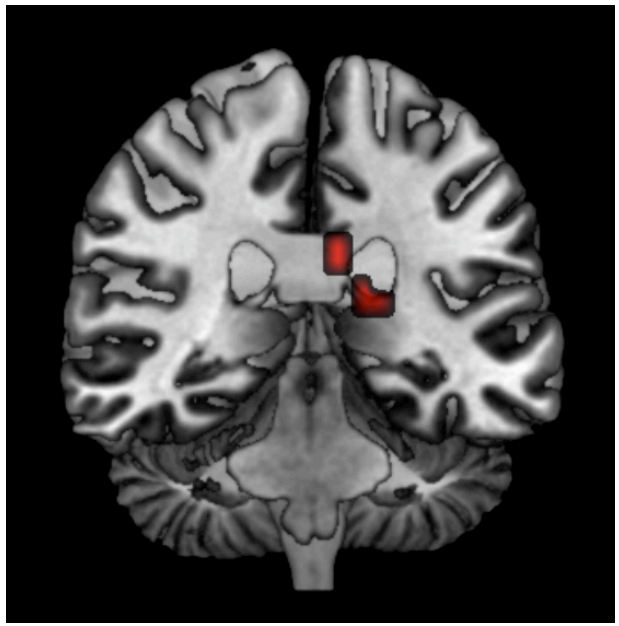

For less prominence:

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Discussion

time to wake up your neighbor

- Feature constrasts reflected neurophysiologically
- Qualitative temporospatial distinction between types of prominence scales
- Universally available actor features: increased broadly distributed negativity between 300 and 500 ms ($\sim$ N400) for lower prominence and activation in a left lateralised network including the inferior temporal and ventral premotor regions
- Language-specific actor features: qualitatively different temporospatial response

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  - possible overlap with more general networks subserving action understanding (e.g. observation of actions in own motor repertoire, Buccino et al. (2004); biological motion, Saygin et al. (2004))
- Language-specific actor features: qualitatively different temporospatial response

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- Language-specific actor features: qualitatively different temporospatial response
  - Earlier positivity and activation in temporal (temporal pole, hippocampus) and parietal regions for higher prominence

Conclusions

make sure he's awake – this is the last talk in the session

- Evidence for the neuropsychological reality of prominence features and actor-based interpretation heuristics independent of specific task demands
- Initial evidence for a neural dissociation between universal and language-specific actor-identification heuristics

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Measurement Points

Onset vs. Availability

Ambiguity at the indefinite article (and possessive adjectives) by masculine and neuter nouns:

- ein schwarzes eisernes Haus
  $\text{a}_{\text{NOM-ACC}}$ $\text{black}_{\text{NOM-ACC}}$ $\text{steely}_{\text{NOM-ACC}}$ $\text{house}_{\text{INANIM,NEUT}}$
- ein wilder Tempelhund
  $\text{a}_{\text{NOM-ACC}}$ $\text{wild}_{\text{NOM,MASC}}$ $\text{temple-dog}_{\text{ANIM,MASC}}$
- ein heiliger Mann
  $\text{a}_{\text{NOM-ACC}}$ $\text{holy}_{\text{NOM,MASC}}$ $\text{man}_{\text{ANIM,MASC}}$
- einen mächtigen Bronzetopf
  $\text{a}_{\text{ACC,MASC}}$ $\text{heavy}_{\text{ACC,MASC}}$ $\text{bronze-pot}_{\text{INANIM,MASC}}$
- ein indisches Mädchen
  $\text{an}_{\text{NOM-ACC}}$ $\text{Indian}_{\text{NOM-ACC,NEUT}}$ $\text{girl}_{\text{ANIM,NEUT}}$

Availability
animacy
morphology