Long-distance lexical predictions in German: Evidence from ERP

Kate Stone[1], Shravan Vasishth[1], Titus von der Malsburg[1,2]

[1] *Potsdam University, Germany*

[2] *Dept. Brain & Cognitive Sciences, MIT, USA*

German particle verbs make a great test case

Sie stellt ihren neuen Mitarbeitern vor.
She put her new colleague before.
'She introduced her new colleague'.

The trunks being now ready, he DE- after kissing his mother and sisters, and once more pressing to his bosom his adored Gretchen, who, dressed in simple white muslin, with a single tuberose in the ample folds of her rich brown hair, had tottered feebly down the stairs, still pale from the terror and excitement of the past evening, but longing to lay her poor aching head yet once again upon the breast of him whom she loved more dearly than life itself, PARTED. – *Mark Twain*

Der G-BA stellt daher aufgrund der deutlich geringeren Patientenanzahl im Reslizumab-Arm, die eine Erhöhungen der OCS-Dosen benötigten, und die dadurch entstehende potentielle Vermeidung bzw. Reduktion von schwerwiegenden Nebenwirkungen der OCS, einen geringen Zusatznutzen von Reslizumab gegenüber der zweckmäßigen Vergleichstherapie für Patienten, die dauerhaft mit oralen Corticosteroiden behandelt werden, fest. – *PayersInsights*

Context can trigger lexical predictions

"The prince dreamt about having the throne of his father. He knew that when his father died, he would finally be able to wear _____"

(Wicha et al., 2004)

"The day was breezy so the boy went outside to fly _____"

(DeLong et al., 2005)

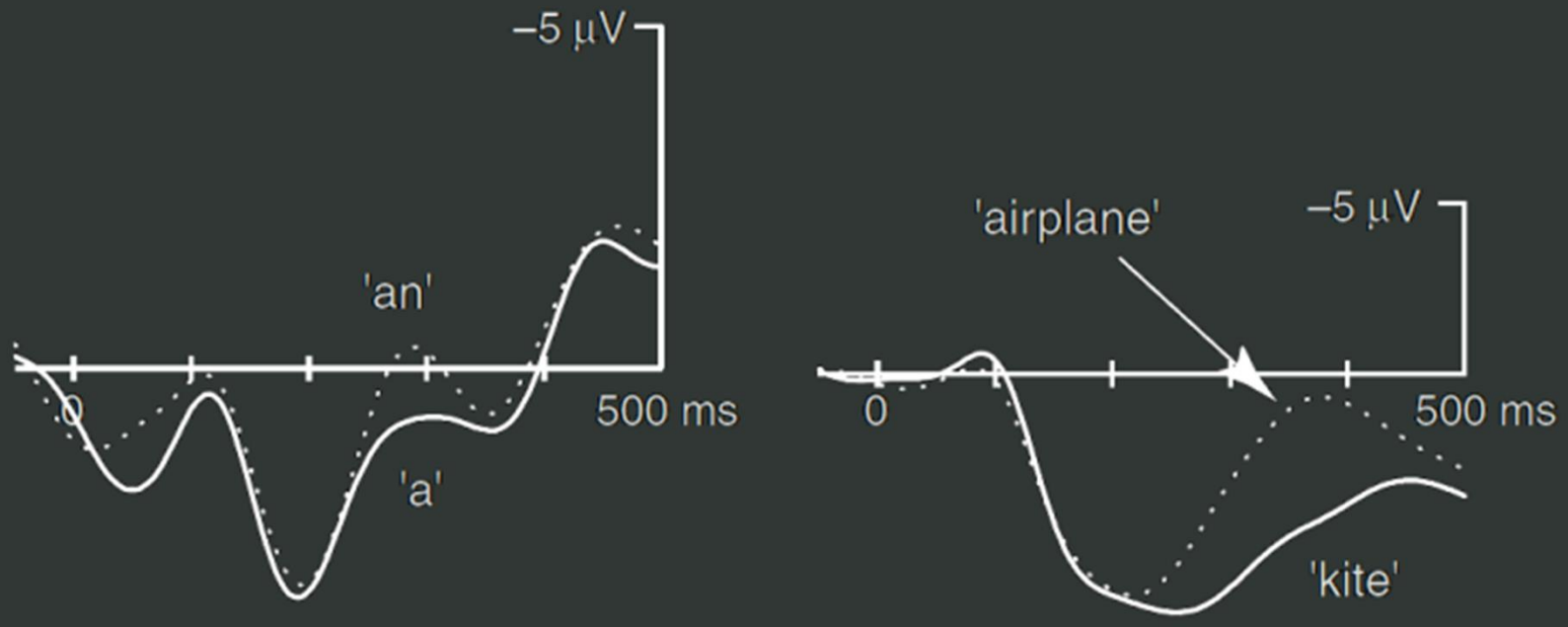
"The burglar had no trouble whatsoever to locate the secret family safe. Of course, it was situated behind a _____ "

(Van Berkum et al., 2005)

Evidence for lexical predictions

…the boy went outside to fly…

(DeLong et al., 2005)



N400 plus P600 at unexpected words

"…roughly a third of the published comparisons show larger late positivities for incongruent than congruent words…"
(Van Petten & Luka, 2012)

Frontal PNP associated with disconfirmed lexical predictions; posterior PNP with reanalysis/checking of incongruent words *(Van Petten & Luka, 2012)*

The stronger the context, the larger the PNP *(Federmeier et al., 2007)*

Lexical predictions triggered in immediate neighbourhood

"The prince dreamt about having the throne of his father. He knew that when his father died, he would finally be able to wear _____"

(Wicha et al., 2004)

"The day was breezy so the boy went outside to fly _____"

(DeLong et al., 2005)

"The burglar had no trouble whatsoever to locate the secret family safe. Of course, it was situated behind a _____ "

(Van Berkum et al., 2005)

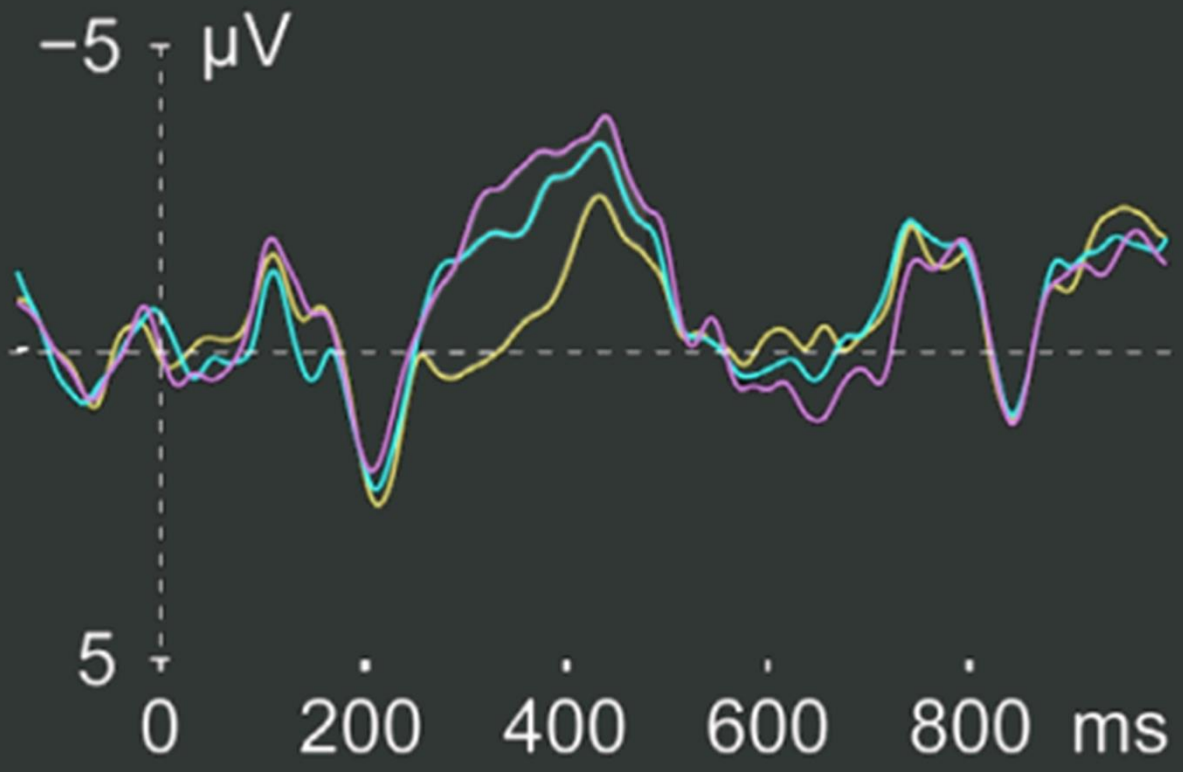
Can lexical predictions be generated and maintained over long distances?

Some evidence for long-distance prediction

- Increased reading times when filler-gap dependency is predicted *(Ness & Meltzer-Asscher, 2017)*
- Larger LAN for long versus short object *wh*-questions *(Fiebach et al., 2001)*
- Dutch verbs that take downstream particles elicit larger LANs than those that don't *(Piai et al., 2013)*

Unexpected verb particles elicit N400s

(Piai et al., 2013)



The current study

Lexical prediction could be made early in sentence
Predicted word at long distance
Matched pre- and post-critical regions

HIGH CONSTRAINT
a) The applicant filled the form during the break very carefully out, in order to

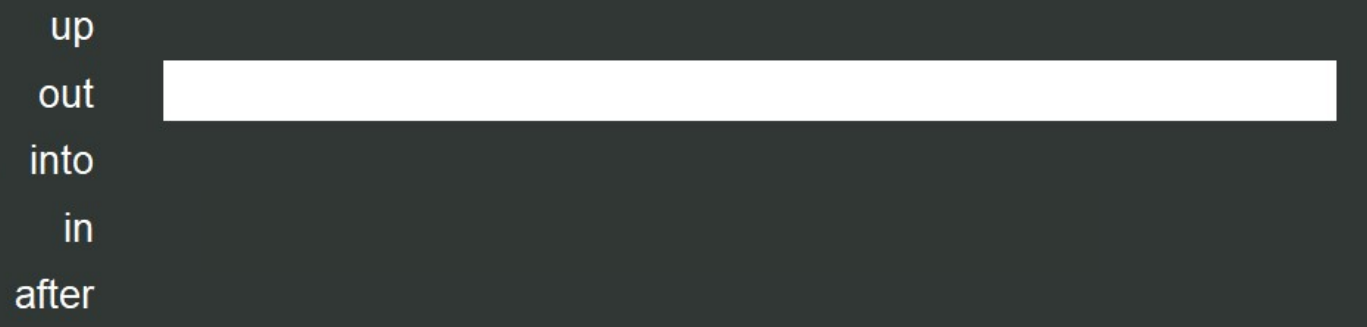
Der Antragssteller füllte das Formular während der Pause sehr vorsichtig aus, um den…

MEDIUM CONSTRAINT
c) The host filled the drink for the guests very carefully up, in order to…

Der Gastgeber füllte das Getränk für die Eingeladenen sehr vorsichtig auf, um den…

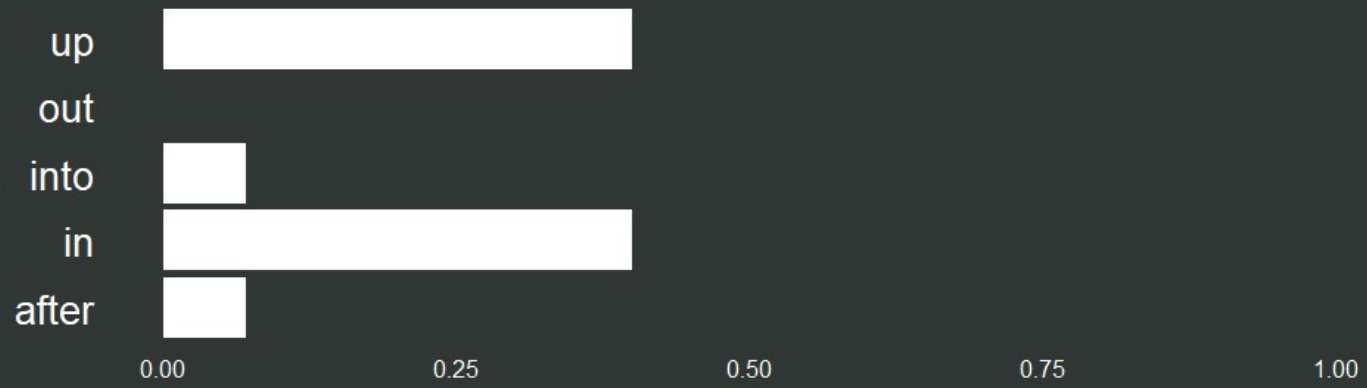
HIGH CONSTRAINT:

(a) The applicant filled the form very carefully…



MEDIUM CONSTRAINT:

(c) The host filled the drink very carefully…



The current study

Lexical prediction could be made early in sentence
Predicted word at long distance
Matched pre- and post-critical regions
Implausible violation

HIGH CONSTRAINT
a) The applicant filled the form during the break very carefully out, in order to
b) The applicant filled the form during the break very carefully *at, in order to..

*Der Antragssteller füllte das Formular während der Pause sehr vorsichtig aus/*an, um den...*

MEDIUM CONSTRAINT
c) The host filled the drink for the guests very carefully up, in order to...
d) The host filled the drink for the guests very carefully *at, in order to...

*Der Gastgeber füllte das Getränk für die Eingeladenen sehr vorsichtig auf /*an,, um den...*

The current study

Lexical prediction could be made early in sentence
Predicted word at long distance
Matched pre- and post-critical regions
Implausible violation

HIGH CONSTRAINT
a) The applicant filled the form during the break very carefully out, in order to
b) The applicant filled the form during the break very carefully *at, in order to..

Der Antragssteller füllte das Formul *e sehr vorsichtig aus/*an, um den...*

MEDIUM CONSTRAINT
c) The host filled the drink fo efully up, in order to...
d) The host filled the drink for t arefully *at, in order to...

*Der Gastgeber füllte das Getränk für die Eingeladenen sehr vorsichtig auf /*an,, um den...*

High constraint

The applicant filled the form during the break very carefully…

The host filled the drink for the guests very carefully…

Medium constraint

High constraint

The applicant filled the form during the break very carefully…

The host filled the drink for the guests very carefully…

Medium constraint

High constraint

The applicant filled the form during the break very carefully…

The host filled the drink for the guests very carefully…

Medium constraint

High constraint

The applicant filled the form during the break very carefully…

The host filled the drink for the guests very carefully…

Medium constraint

High constraint

The applicant filled the form during the break very carefully…

The host filled the drink for the guests very carefully…

Medium constraint

High constraint

The applicant filled the form during the break very carefully…

Lower certainty, no commitment

The host filled the drink for the guests very carefully…

Medium constraint

Hypothesis

Violating strong commitment is costlier than violating no commitment

Prediction: P600

- Implausible particles are equally unexpected, but differ in constraint
- P600 should be larger for implausible particles in high constraint condition
- Frontal distribution for failed semantic prediction

Prediction: N400

- Implausible particles are equally incongruous
- N400 should be equally as large

P600

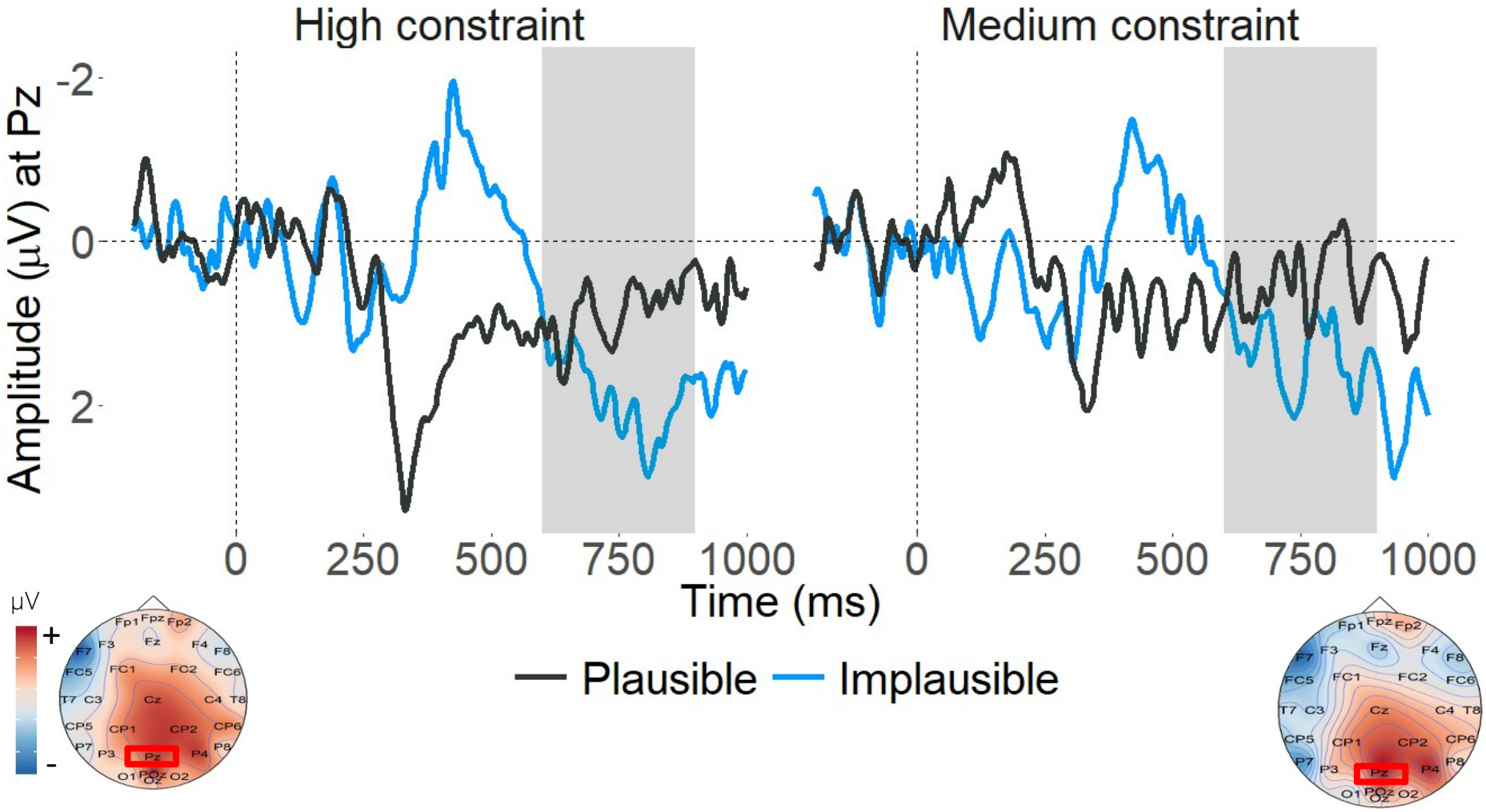
Bayesian LMM | 600-900 ms | *Fz*

N400

Bayesian LMM | 250-500 ms | *Pz*

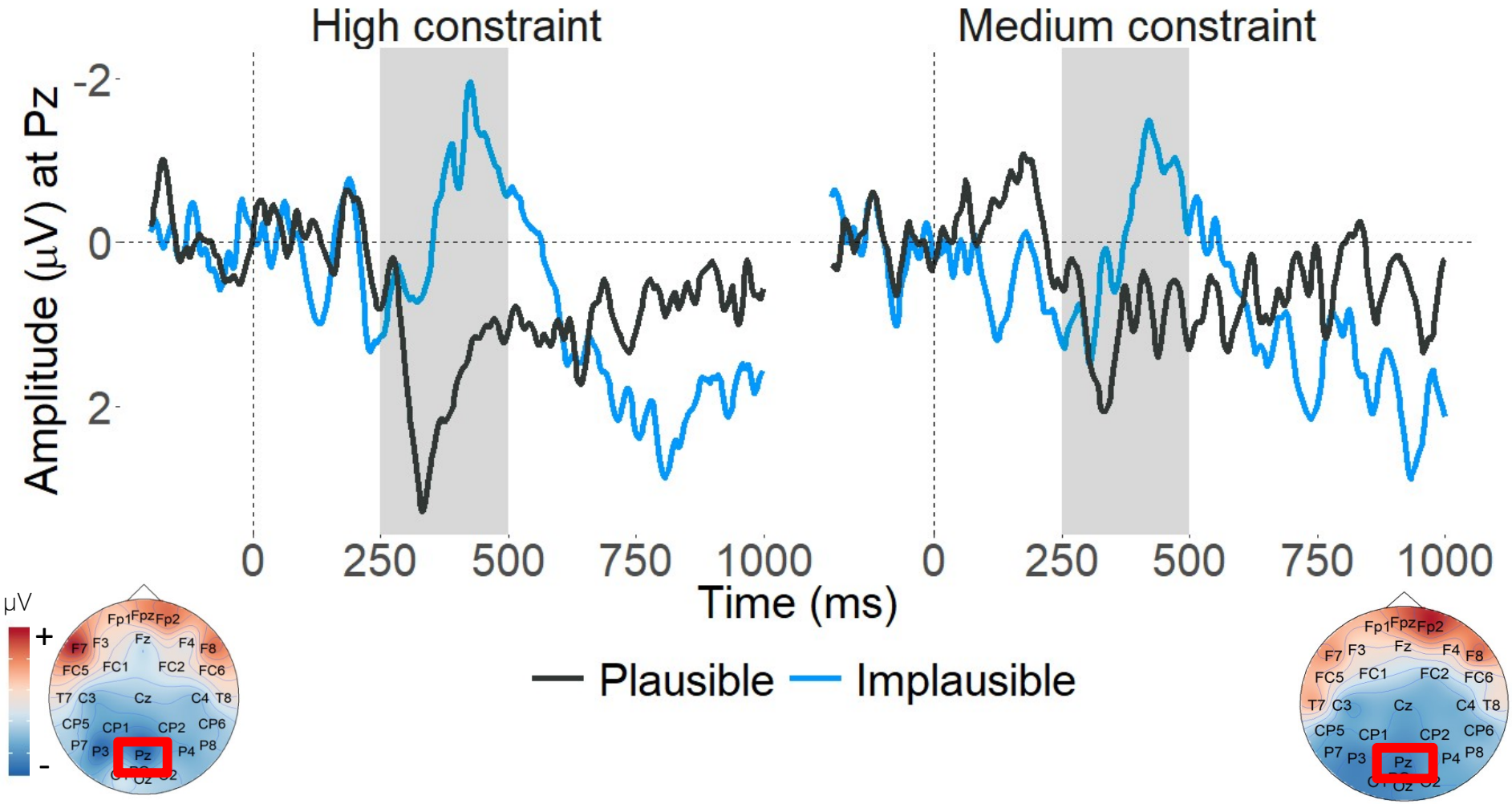
Model: Mean amplitude ~ Constraint

P600: Plausible vs. Implausible particles



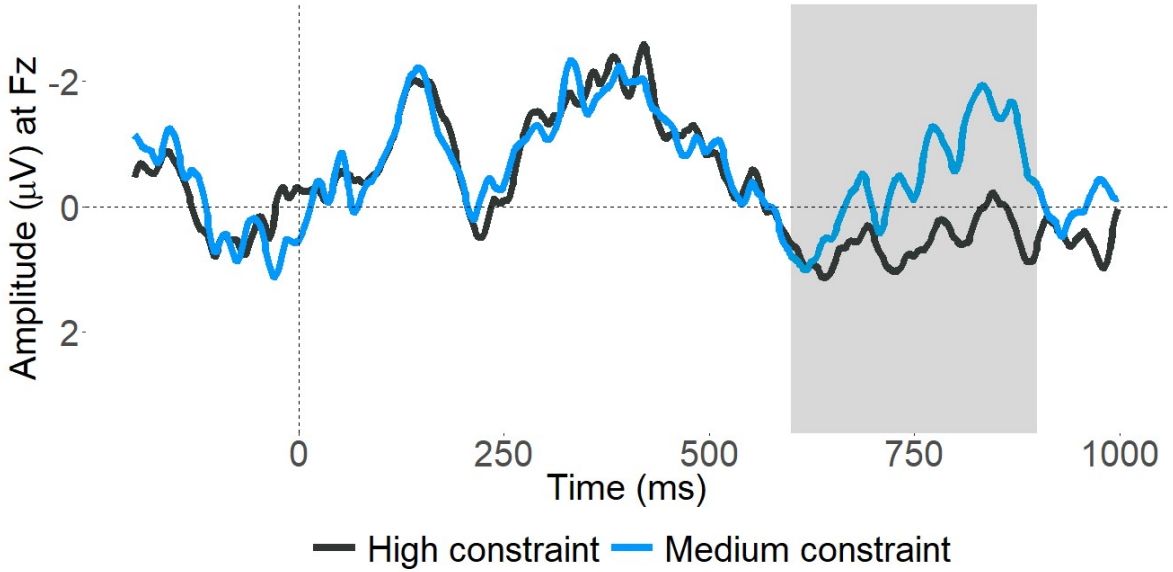
$\hat{\beta}$ = 0.94 μV, 95% CrI: 0.15-1.73 μV, Pr(β>0): 1.00

N400: Plausible vs. Implausible particles



$\hat{\beta}$ = 1.50 μV, 95% CrI: 0.74-2.30 μV, Pr(β>0): 1.00

P600: Implausible particles



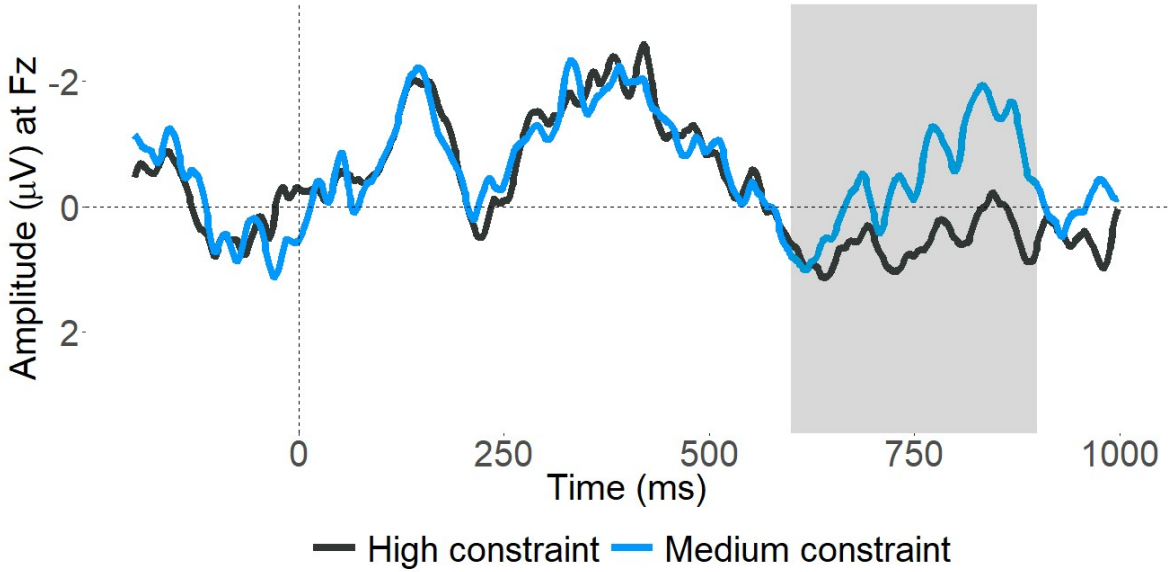
Fz alone:

$\hat{\beta}$ = 0.68 μV

95% CrI: -0.42-1.77 μV

Pr(β > 0): 0.89

P600: Implausible particles

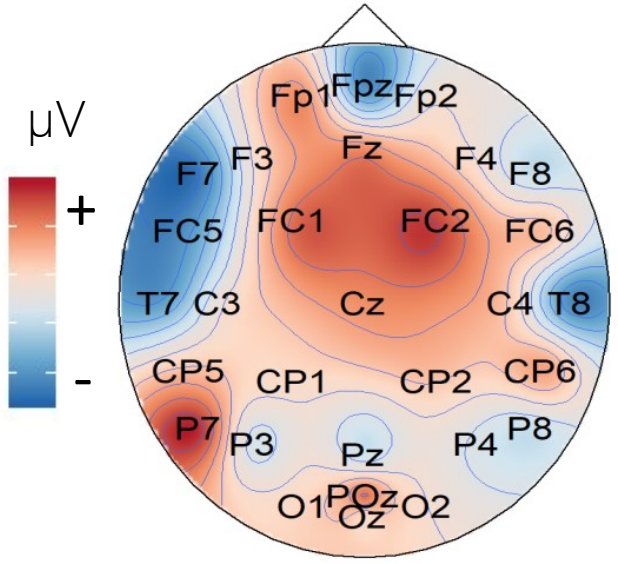


Fz alone:

$\hat{\beta}$ = 0.68 μV

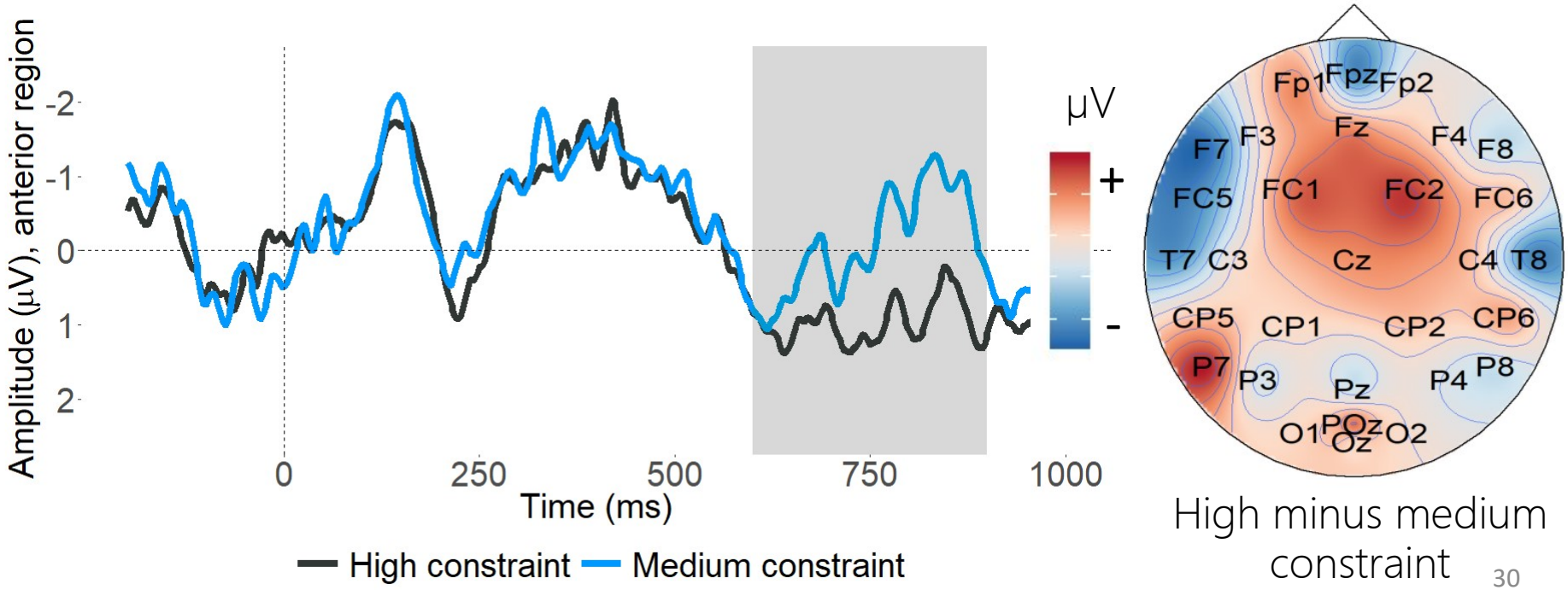
95% CrI: -0.42-1.77 μV

Pr(β > 0): 0.89



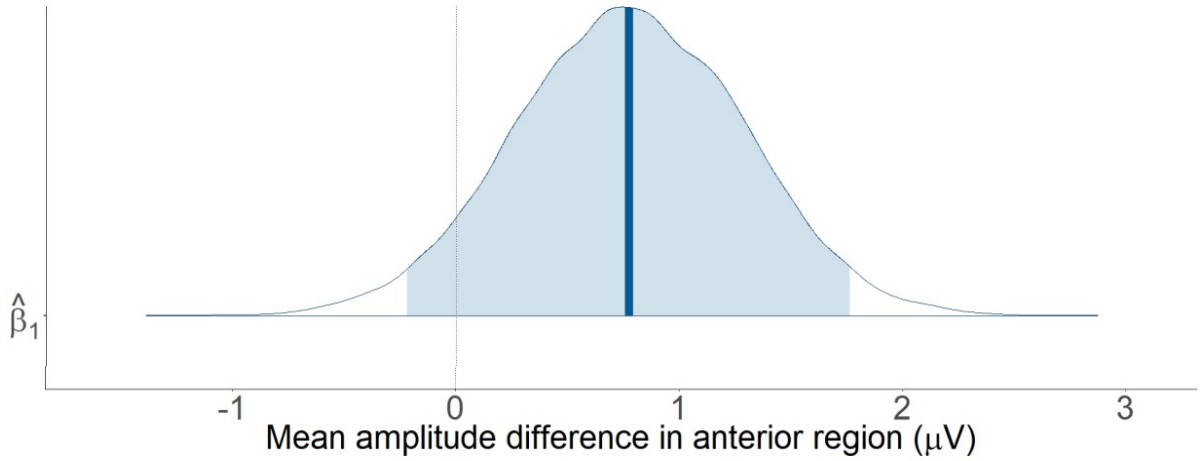
High minus medium constraint

P600: Implausible particles



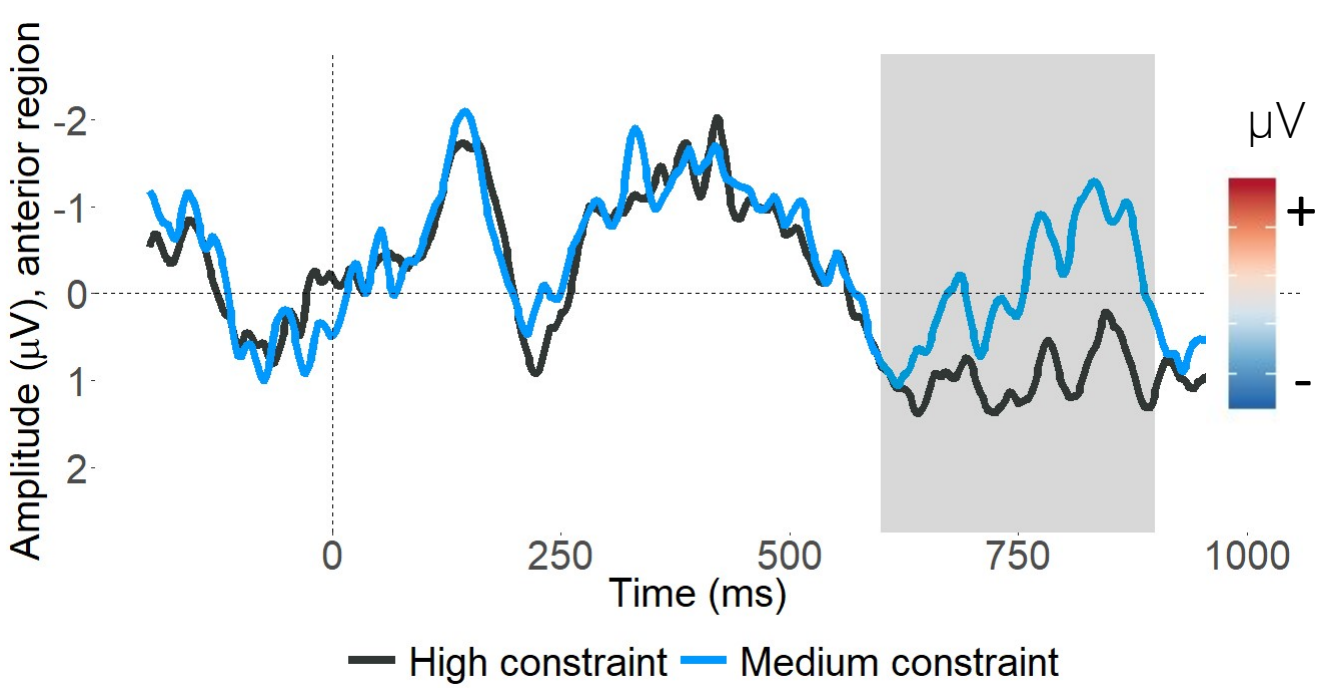
High minus medium constraint

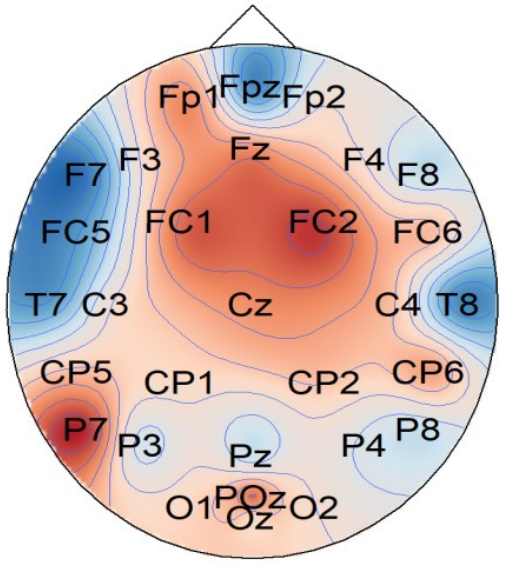
P600: Implausible particles



Anterior region (Fz-FC1-FC2):

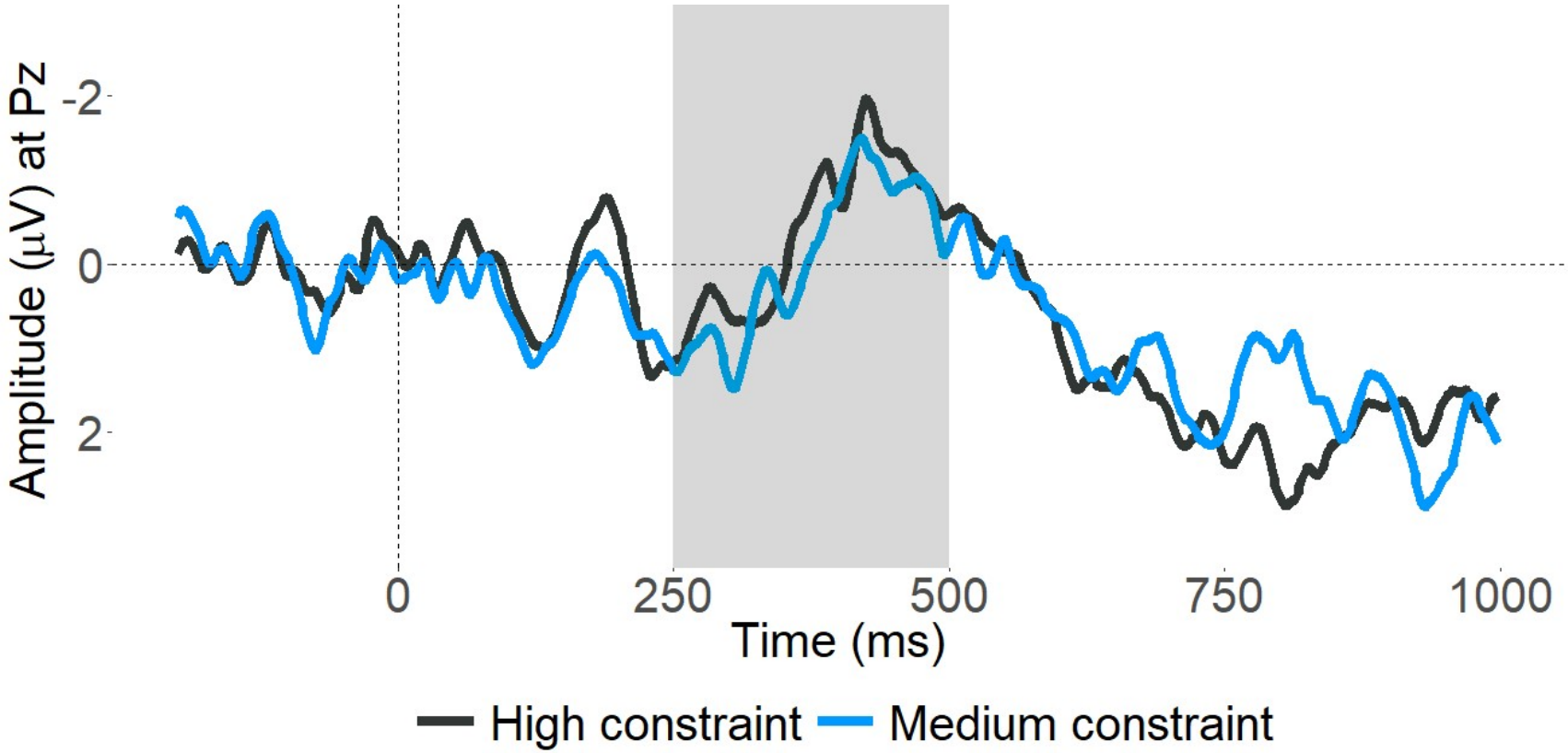
Pr(β > 0): 0.94



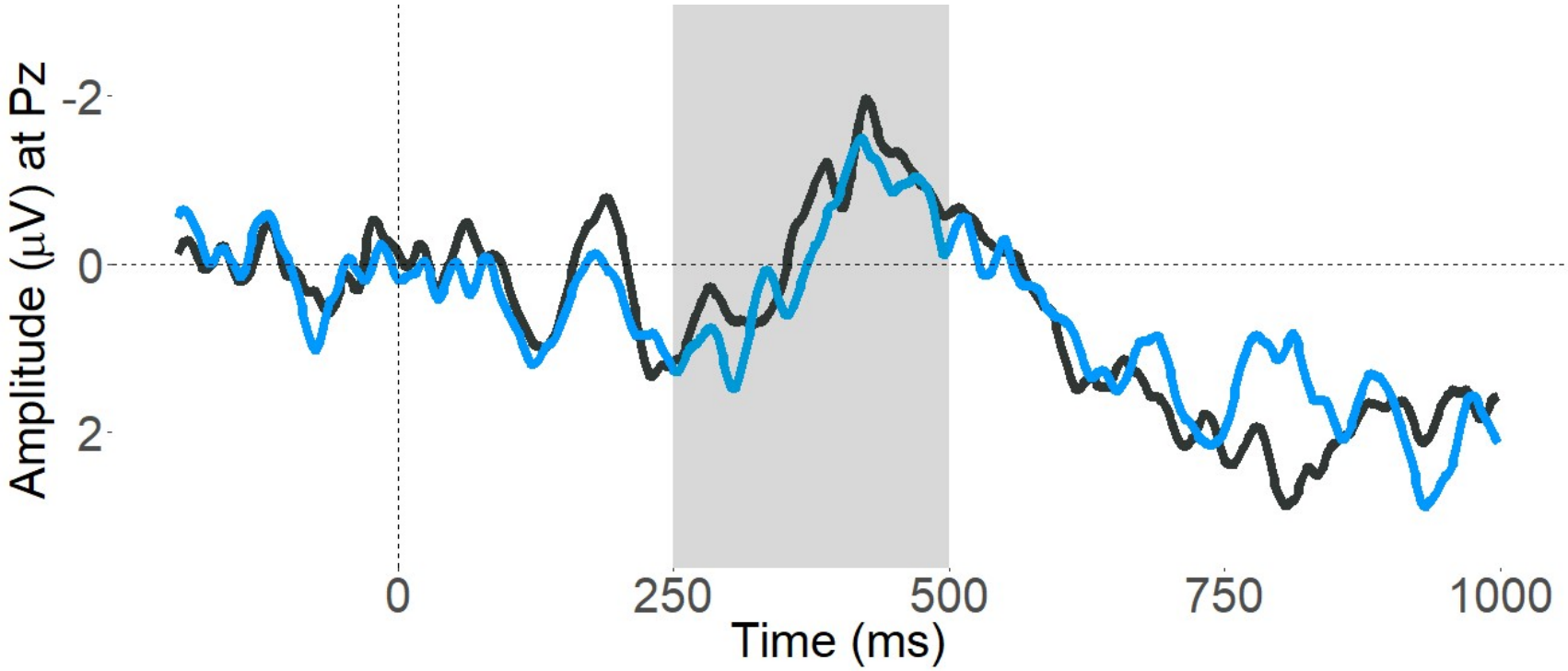


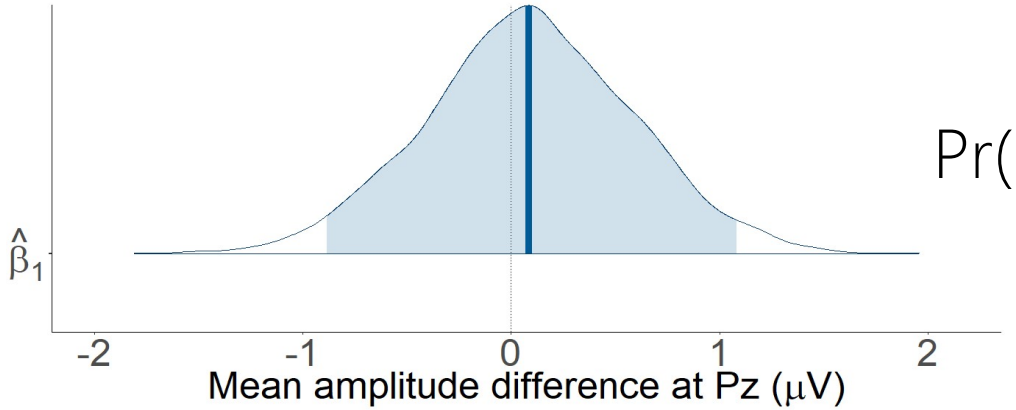
High minus medium constraint

N400: Implausible particles



N400: Implausible particles





Pr(β > 0): 0.69

Implausible particles elicited N400

- Consistent with previous particle verb studies *(Piai et al., 2013; Czypionka et al., 2019)*
- Consistent with lexical access accounts *(e.g. Kutas & Federmeier, 2011)*

Implausible particles elicited P600

x Integration?

x Reactivation of the particles?

x Revision as a preposition?

✓ More resources required to reanalyse or suppress a strong commitment.

Implausible particles elicited P600

- Posterior P600 for implausible (vs. plausible) words consistent with reanalysis/checking post-N400 *(Thornhill & Van Petten, 2012; Pijnacker et al., 2010; DeLong et al., 2014; Kuperberg et al., preprint)*
- Fronto-central constraint difference consistent with failed lexical prediction *(Federmeier et al., 2007; Van Petten et al., 2007)*
- But not with successful update *(Thornhill & Van Petten, 2012; DeLong et al., 2014; Kuperberg et al., preprint)*
- Maybe more like suppression *(cf. Kutas, 1993)*

Can lexical predictions be generated and maintained over long distances?

Can lexical predictions be generated and maintained over long distances?

We saw similar effects on the N400 and P600 as seen in shorter distance dependencies

→ not explained by integration or reactivation

Can lexical predictions be generated and maintained over long distances?

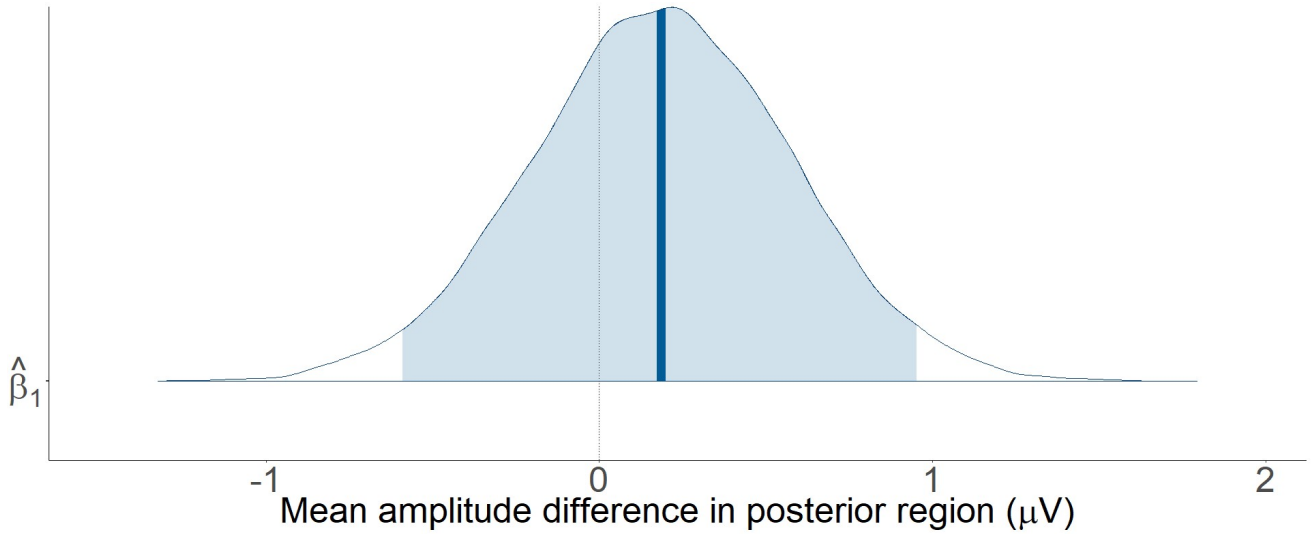
Yes, if certainty is very high

Can lexical predictions be generated and maintained over long distances?

Yes*, if certainty is very high

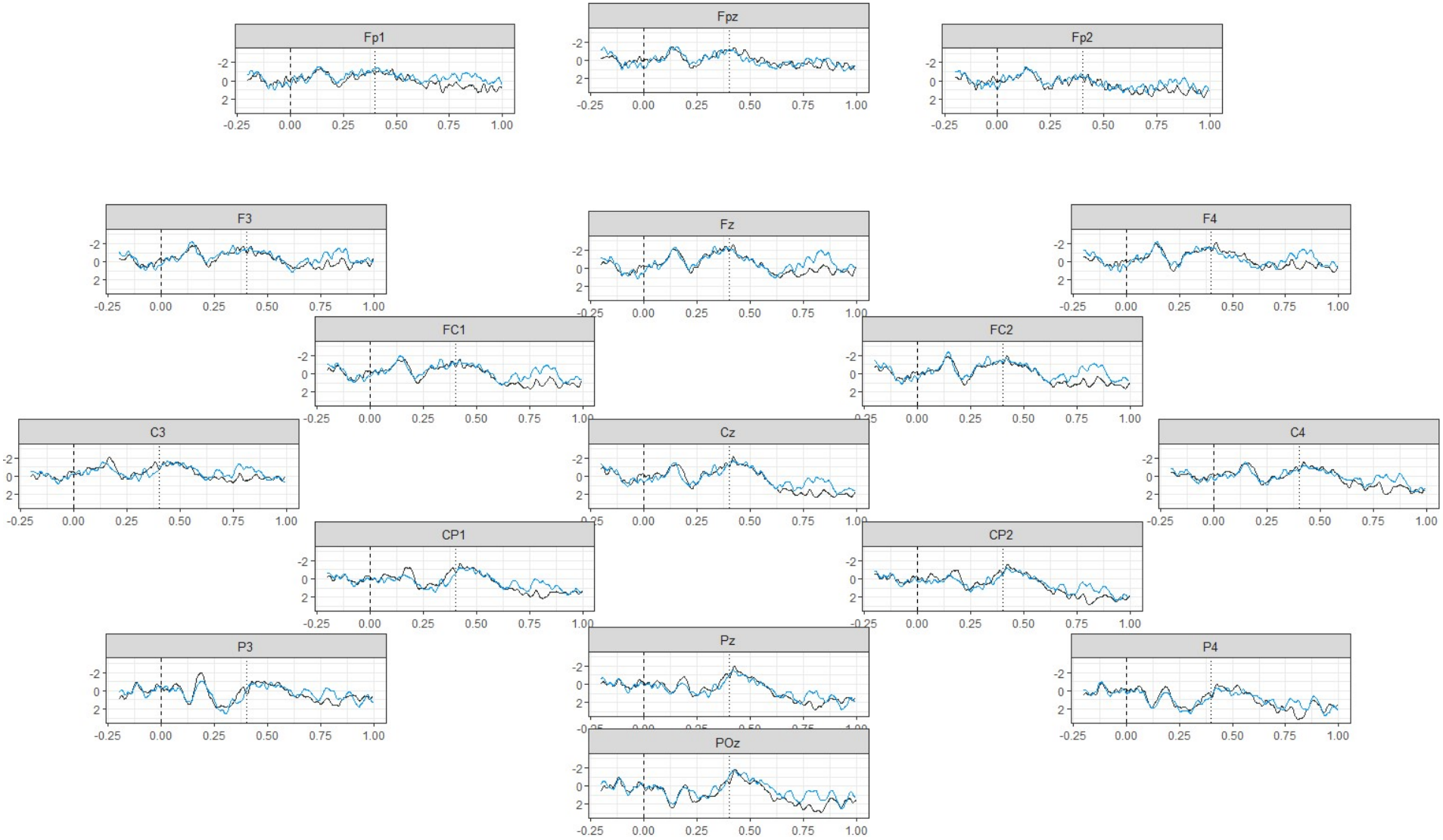
*replication pending

N400: Implausible particles @ Avg(Cz-CP1-CP2-Pz)

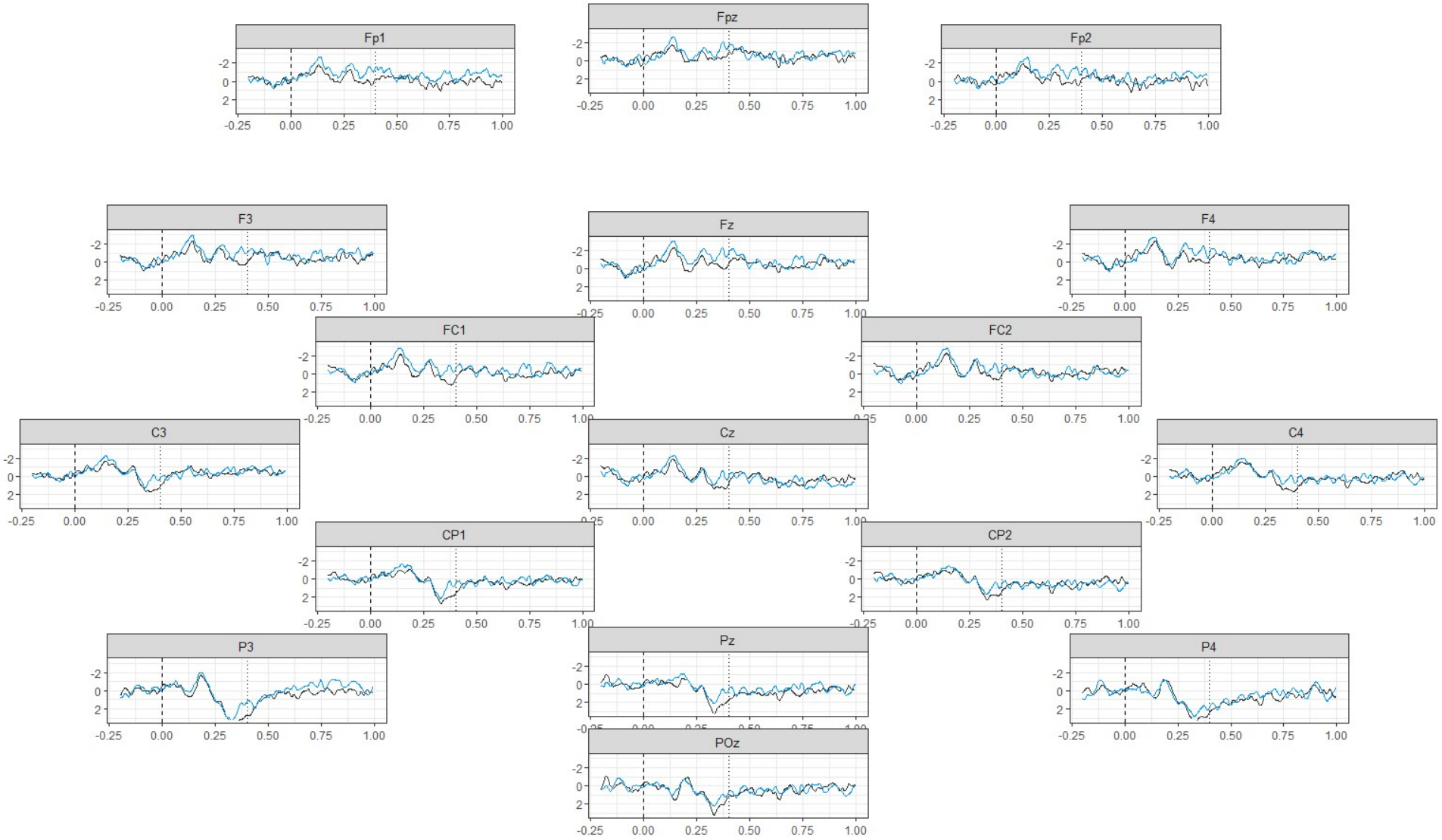


Pr(β > 0): 0.69

Implausible



Plausible


Fp1
Fpz
Fp2
F3
Fz
F4
FC1
FC2
C3
Cz
C4
CP1
CP2
P3
Pz
P4
POz
-0.25 0.00 0.25 0.50 0.75 1.00
-2 0 2
High constraint
Medium constraint