Speaking:
evidence from electrophysiology and brain lesions

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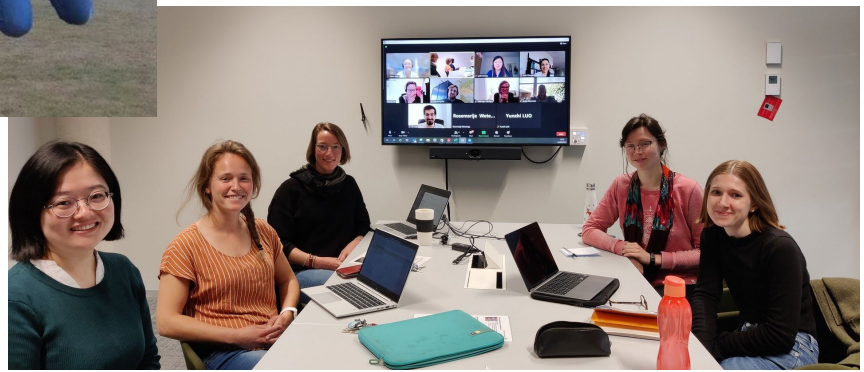
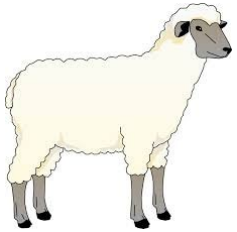
Language Function and Dysfunction Lab



Memory as we speak

The shepherd watched his

The man watched his



Text: “Except in the winter when the snow or ice prevents […]”
Speech: *“Besides in the summer when the snow melts or the ice breaks”*

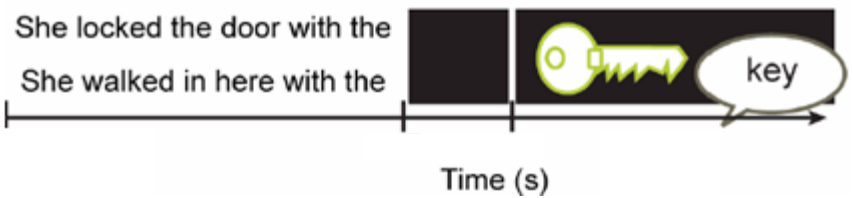
Speaking after brain damage

- Word finding: most common language-related complaint in ageing and after brain damage

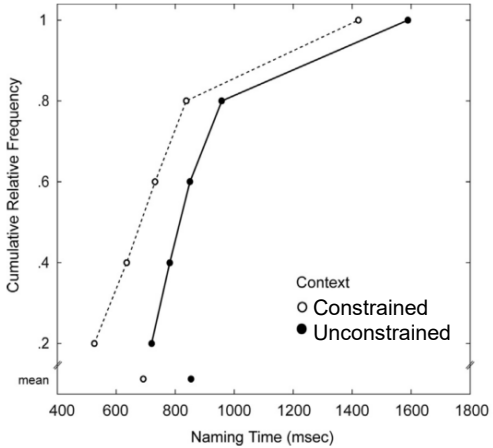
- Role of context (in which we speak) is unknown
    - Most studies on bare picture naming devoid of any context
    - Not how we speak

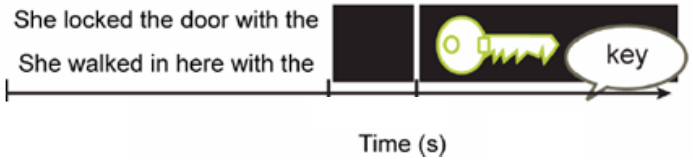
- “Atypical” brain areas involved in ageing and following brain damage
    - Little idea “what” they are doing

Task

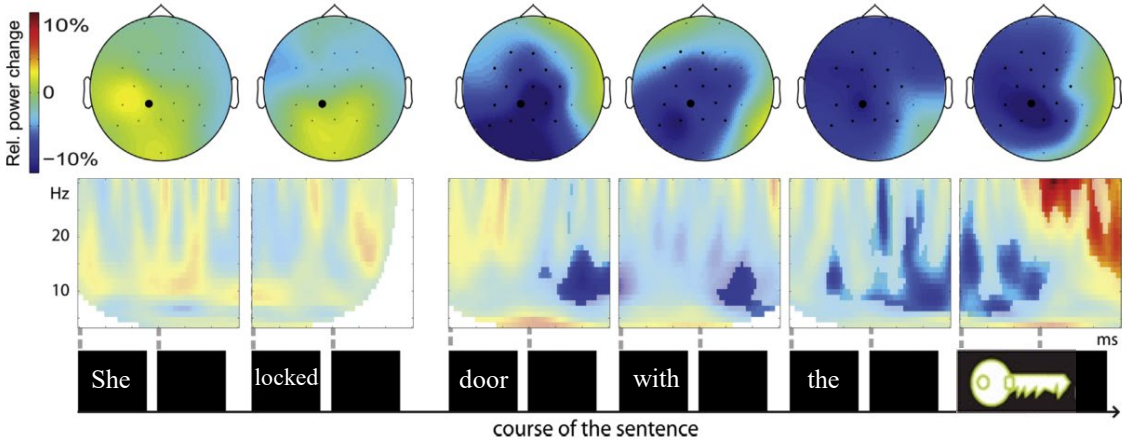

She locked the door with the
She walked in here with the
key
Time (s)

Context-driven word production



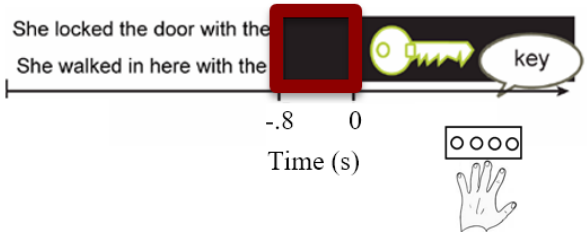


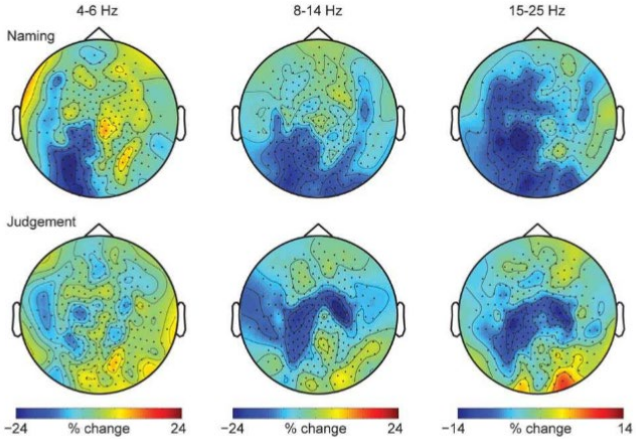
Constrained vs unconstrained

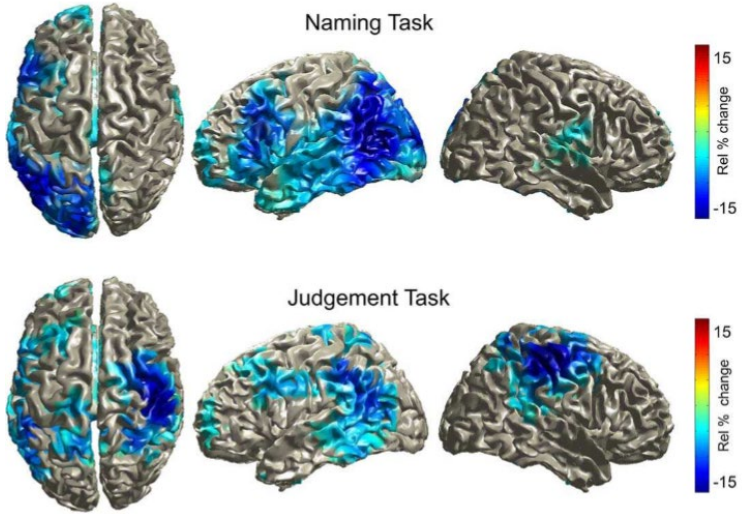


Piai, Roelofs, Maris, 2014

Context-driven word production



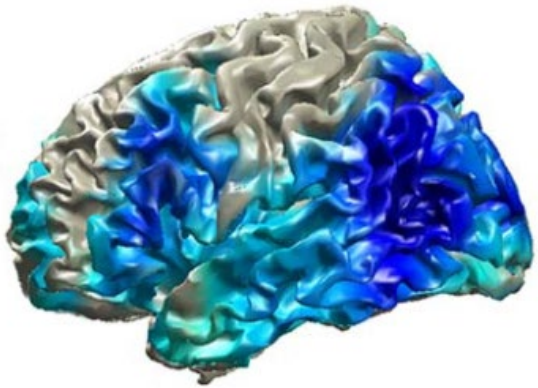


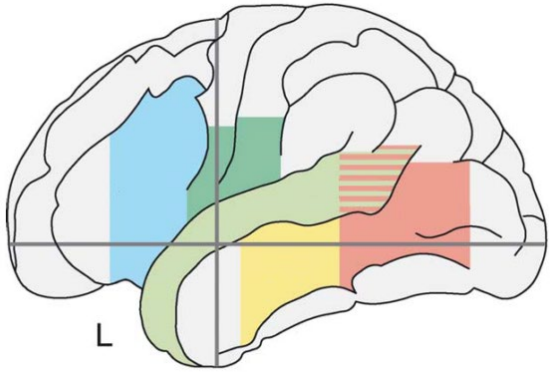


Piai, Roelofs, Rommers, Maris, 2015

Interim conclusion

- Alpha-beta desynchronisation in context-driven word *production*
    - Language-production network
    - Not attention, not motor preparation



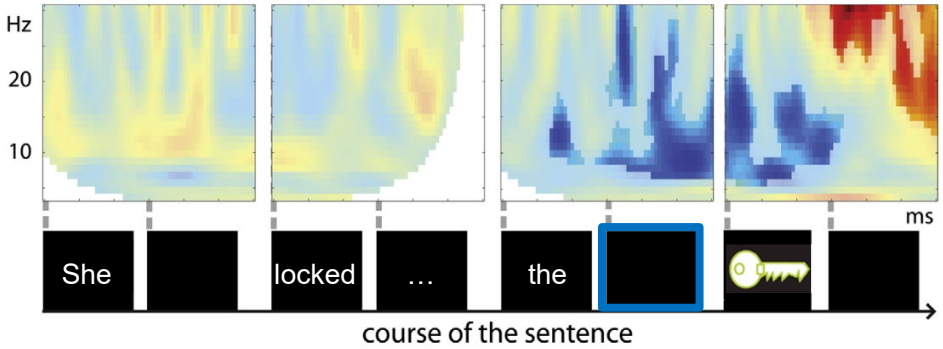


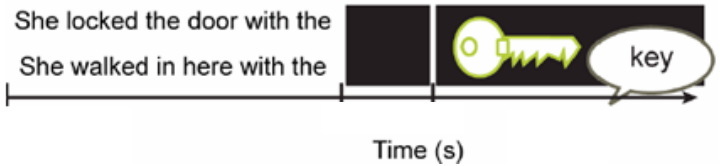
Indefrey & Levelt (2004)

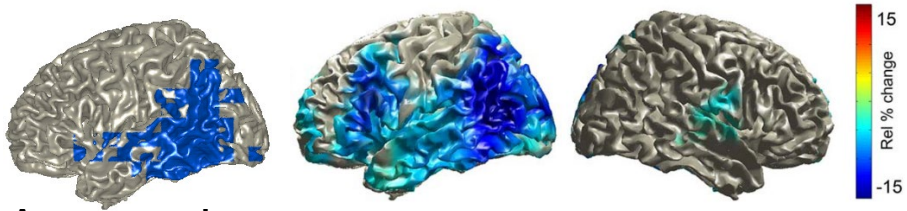
Posterior power decreases are consistent

Natascha Roos

Constrained vs unconstrained







Across-session consistency

Roos & Piai, 2020

Piai, Roelofs, Maris, 2014; Piai, Roelofs, Rommers, Maris, 2015; Roos & Piai, 2020

Yang Cao

Alpha and beta: two phenomena?

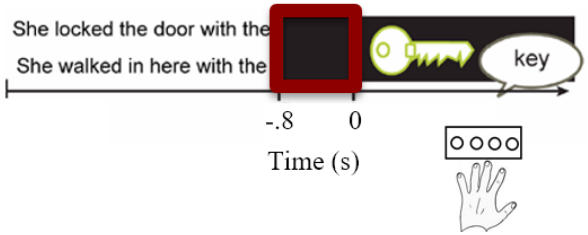
Sensorimotor domain: alpha and beta

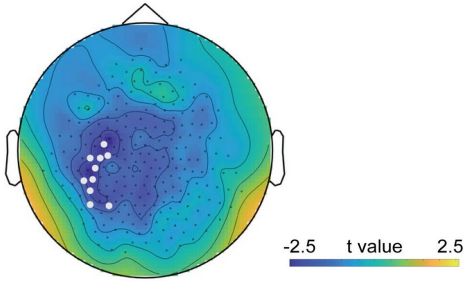
- show partial overlap in spatial distribution and temporally correlated power envelopes
- different features with anatomical and functional specificities
    - e.g., different anatomical distributions, travel along opposite directions across sensorimotor cortex (Stolk et al. 2019)

Cao, Oostenveld, Alday, Piai, 2022

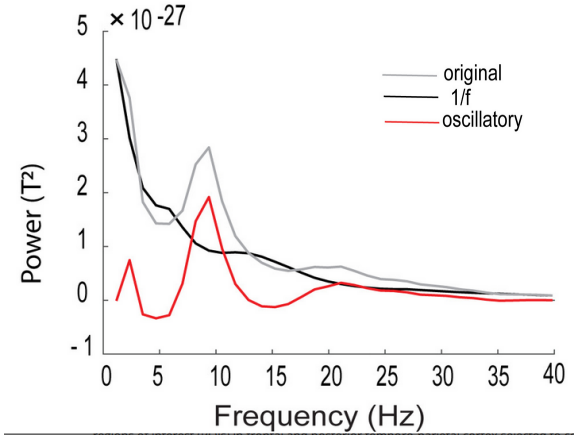
Yang Cao

Alpha and beta: two phenomena?





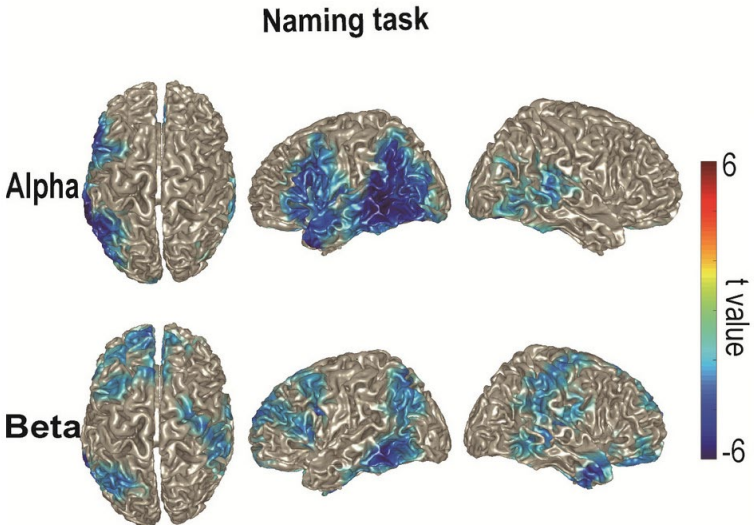
irregular-resampling autospectral analysis (IRASA, Wen & Liu, 2016)

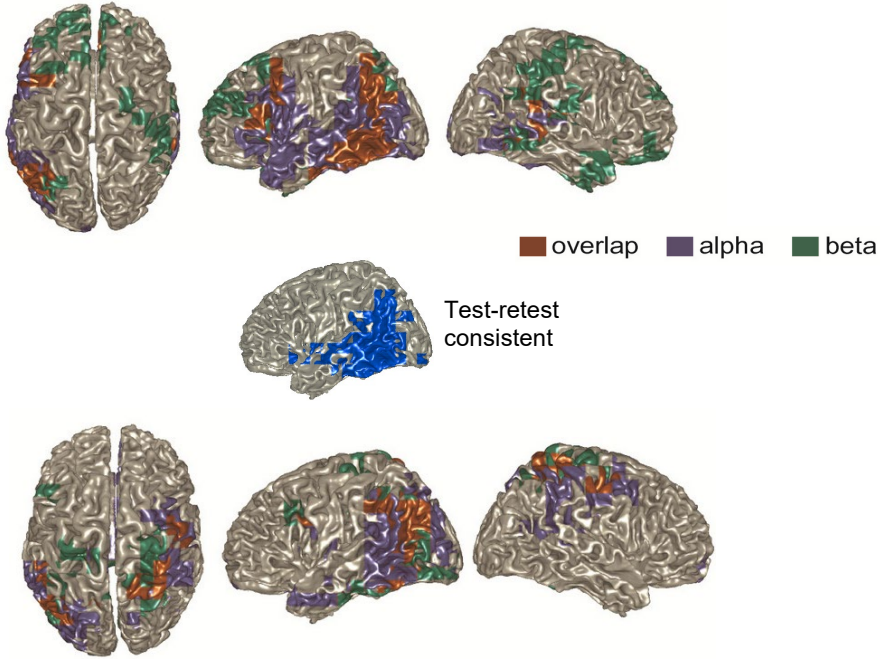


Cao, Oostenveld, Alday, Piai, 2022

Yang Cao

Alpha and beta: two phenomena?





Cao, Oostenveld, Alday, Piai, 2022

Yang Cao

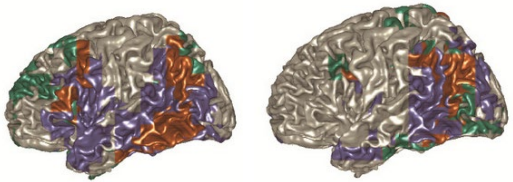
Alpha and beta: two phenomena?

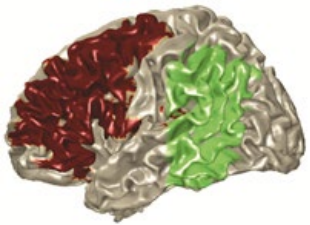
- Earth mover's distance: measure of the distance between two distributions: minimal cost that is required to transform one (spatial) distribution into another distribution (Rubner et al., 2000)

	Naming task		Judgment task	
	EMD	Correlation	EMD	Correlation
Left frontal	0.7745	0.1398	0.3496	0.4762
Left temporal-parietal	0.3662	0.4571	0.5423	0.2195

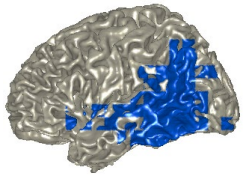
Note

Smaller EMD indicates stronger distribution similarity.





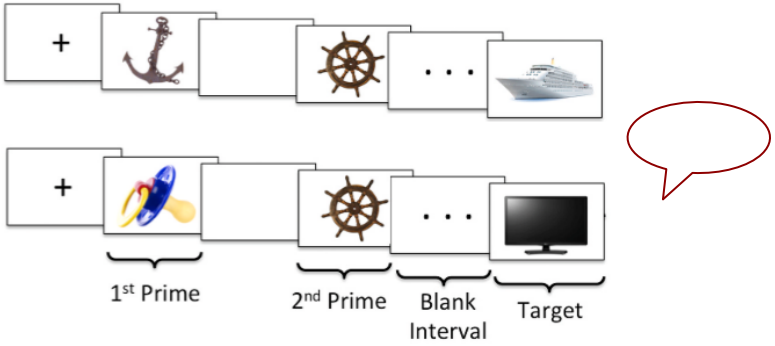
Test-retest consistent

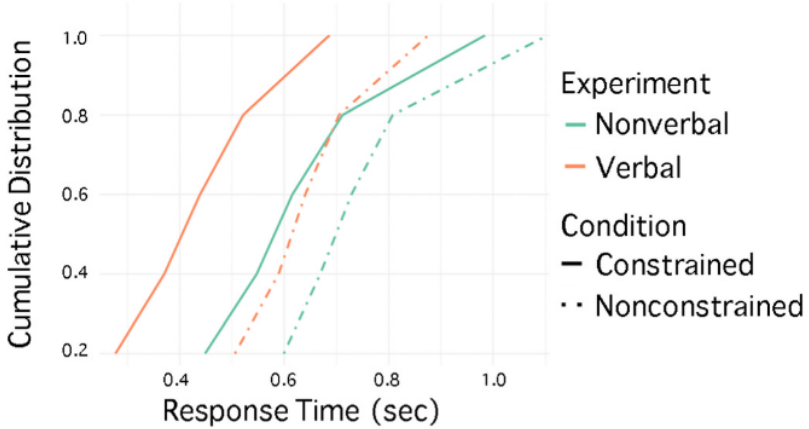


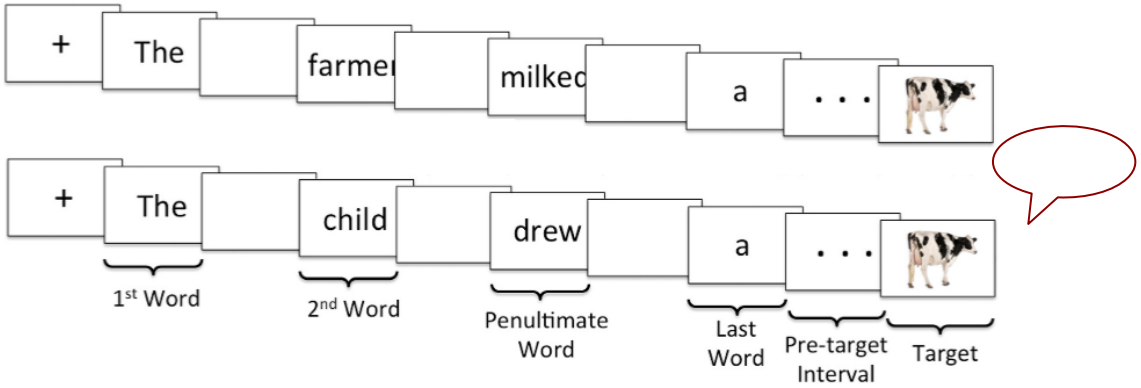
Cao, Oostenveld, Alday, Piai, 2022

Cecília Hustá

Just semantic priming?







Hustá, Zheng, Papoutsi, Piai, 2021

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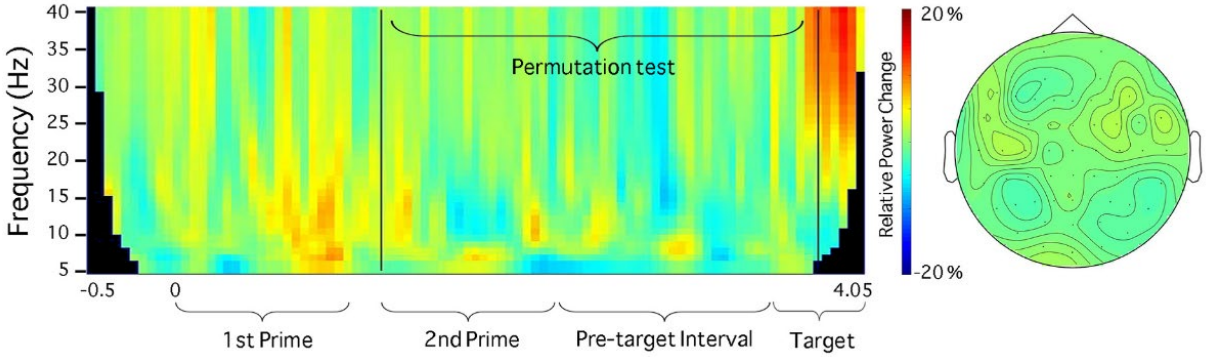
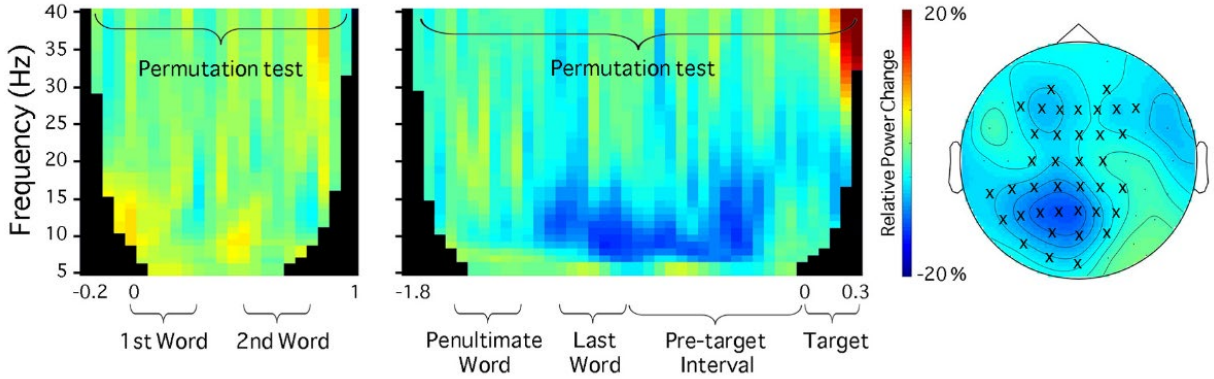
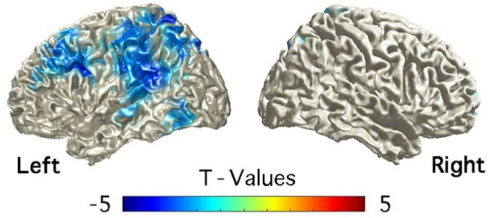
Just semantic priming?

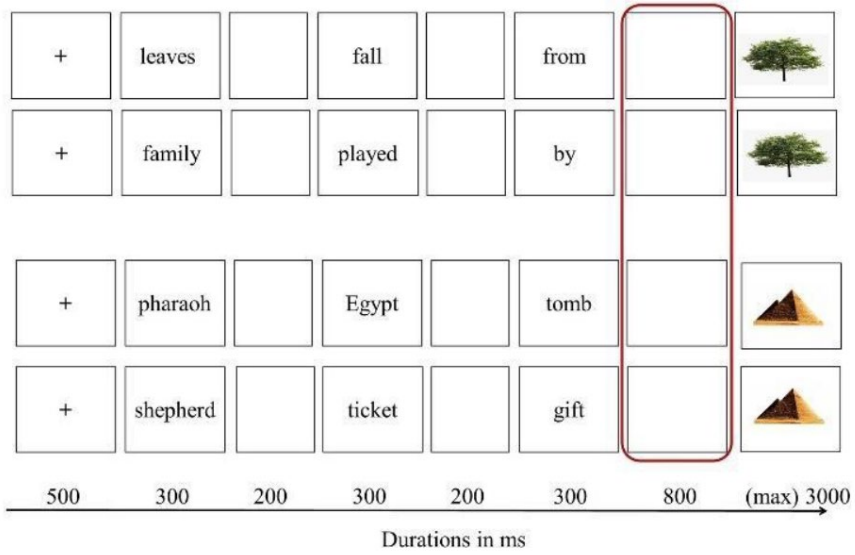


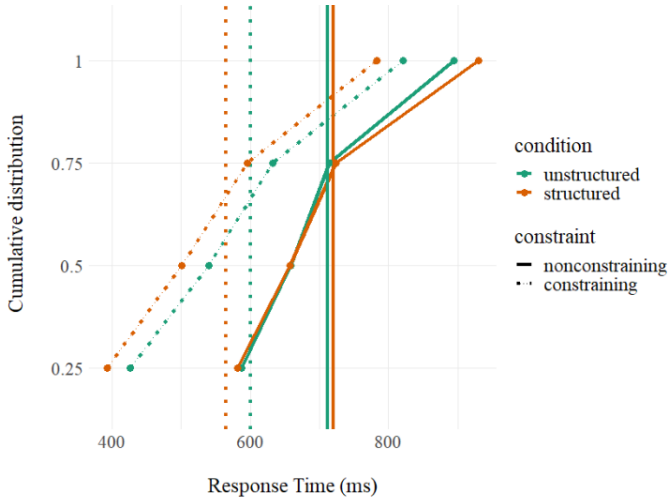




Hustá et al., 2021

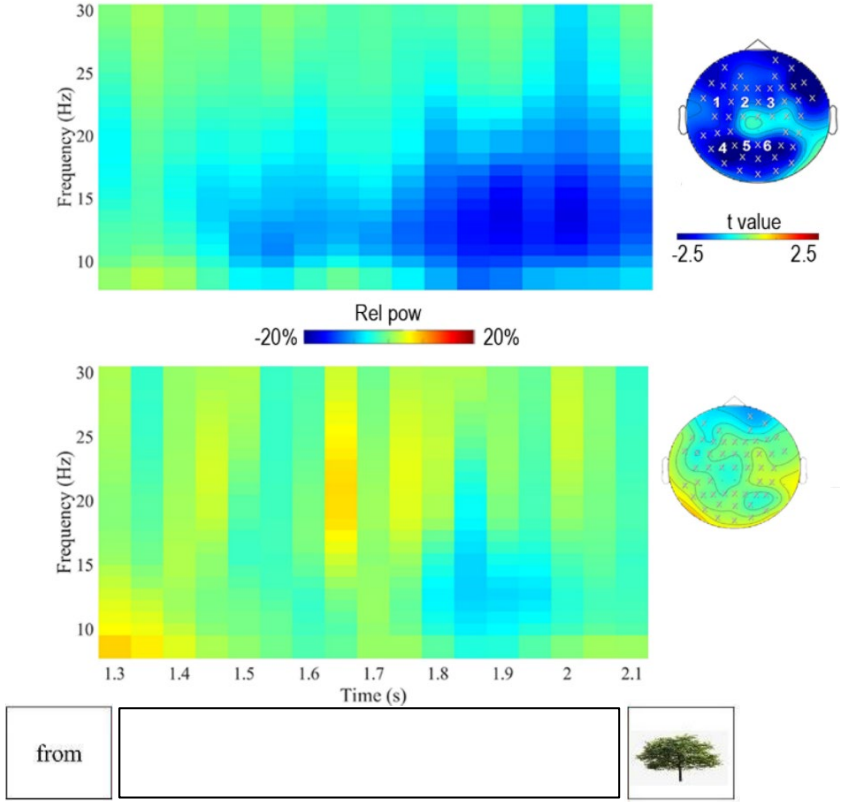
Just semantic priming?

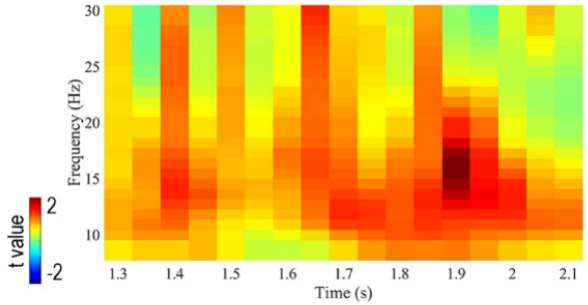




Papoutsi & Piai, *under review*

Just semantic priming?



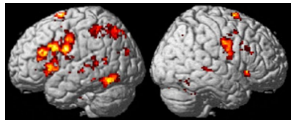


lower power ↔ faster subsequent naming responses

Papoutsi & Piai, *under review*

Interim summary

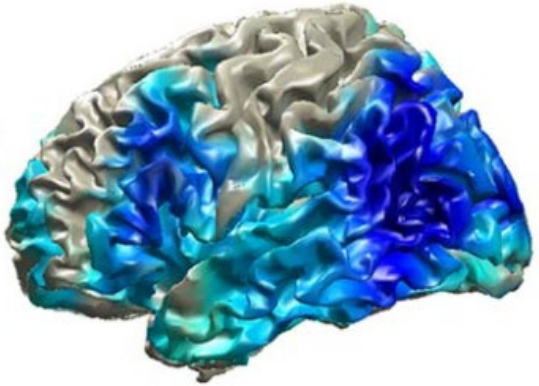
- Replicable alpha-beta power decreases in context-driven word production
- Consistent sources in left posterior temporal and inferior parietal lobe
  - Converging evidence from fMRI (Roos, Takashima, Piai, *under review*)
- Posterior "alpha-beta" effect
  - little frontal overlap between alpha and beta

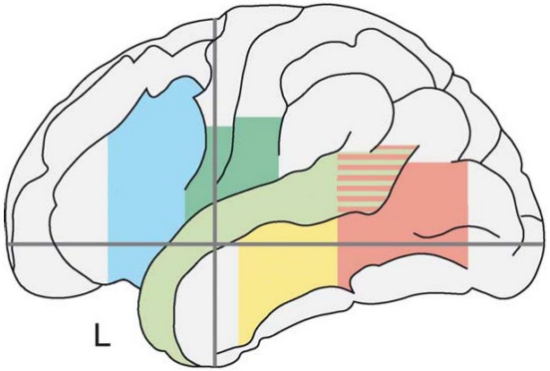


- Alpha-beta power decreases are sensitive to lexical information (Piai, Klaus, Rossetto, 2020)
  - In combination with structure-based syntactic integration processes
- Alpha-beta power decreases cannot be easily explained by attention, prediction, motor preparation

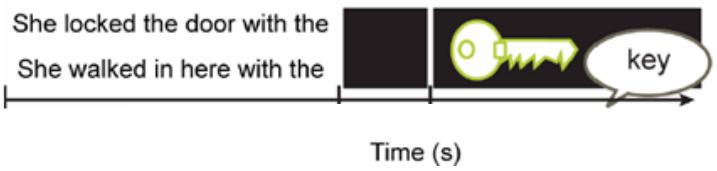
Hustá et al., 2021; Klaus et al., 2020; Piai et al., 2014, 2015, 2017, 2018, 2020; Roos & Piai, 2020

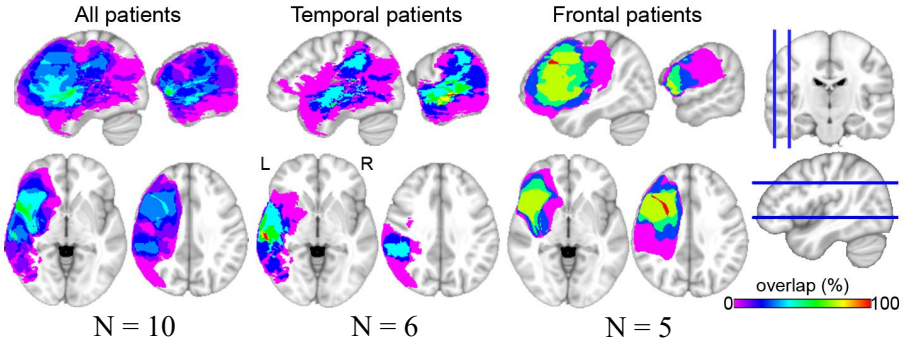
Lesion evidence



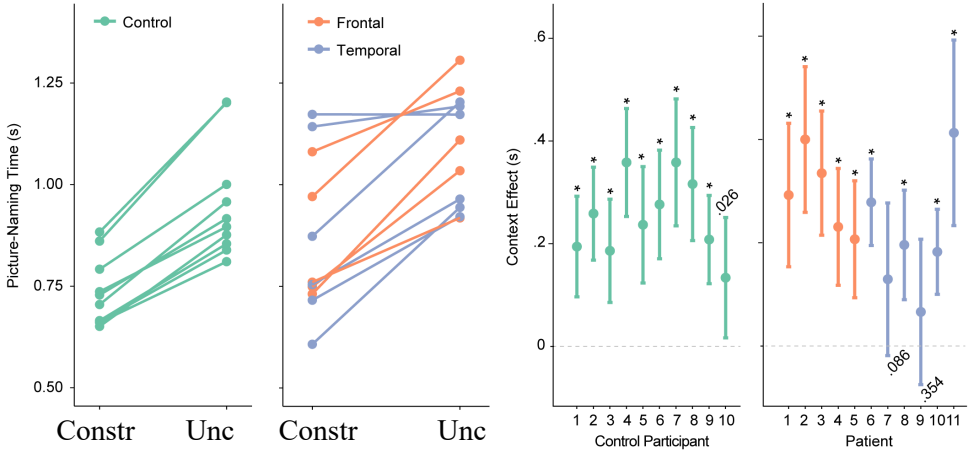


Stroke-induced lesions



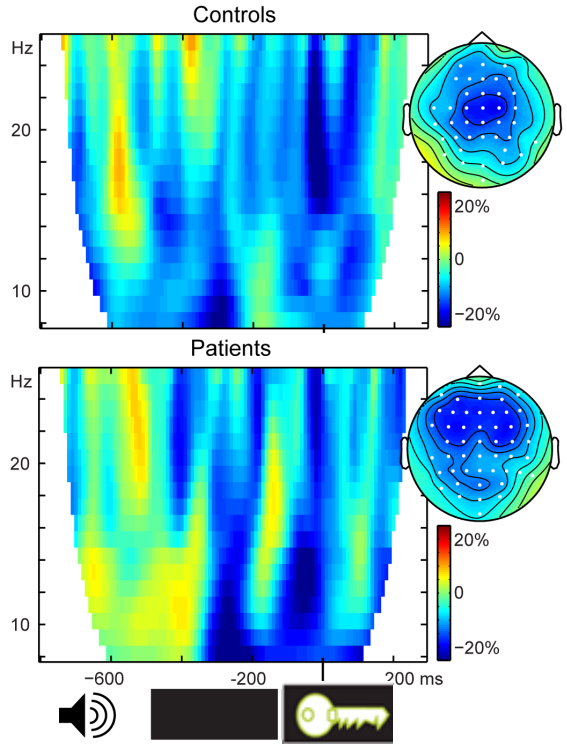


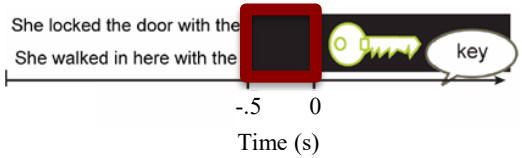
Error bars = 95% CI; * $p < .001$

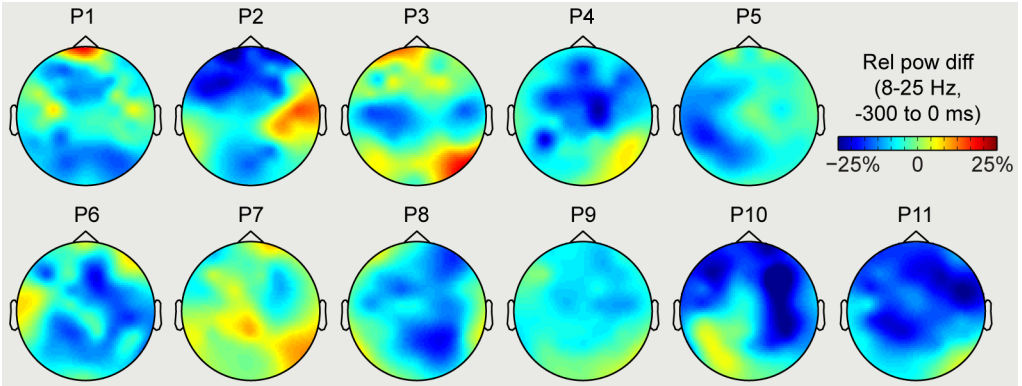


Piai, Rommers, Knight, 2018

Context oscillatory effects

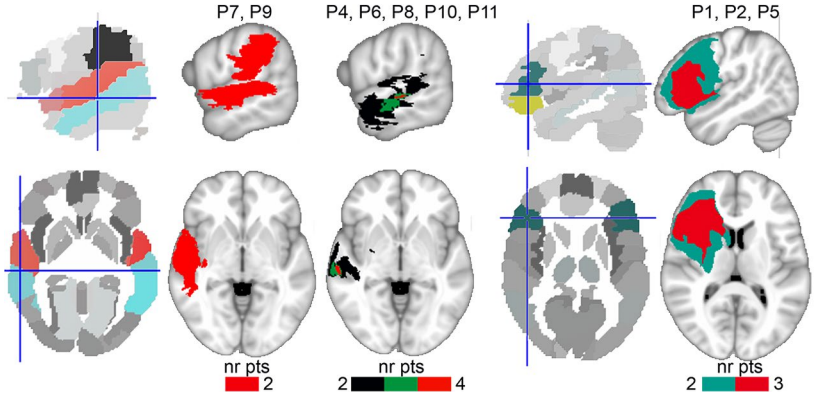


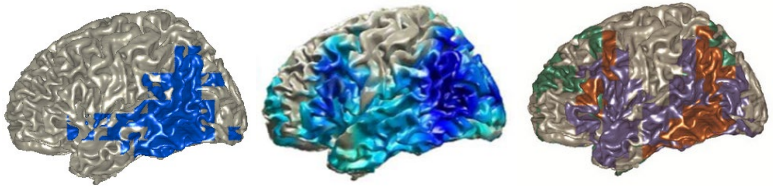


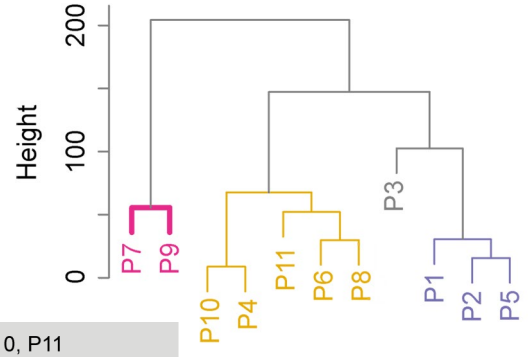


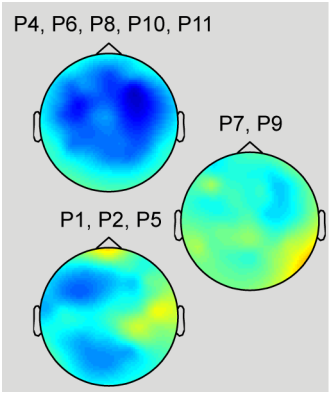
Piai, Rommers, Knight, 2018

Lesion profiles and oscillatory effects



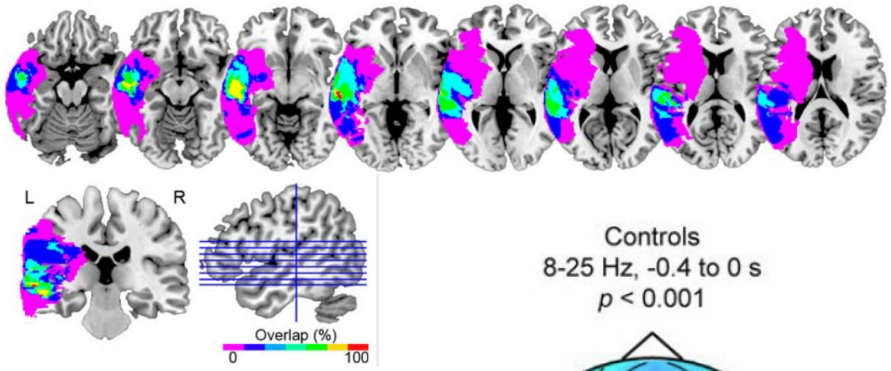


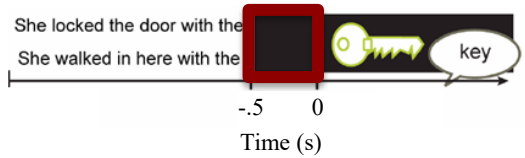


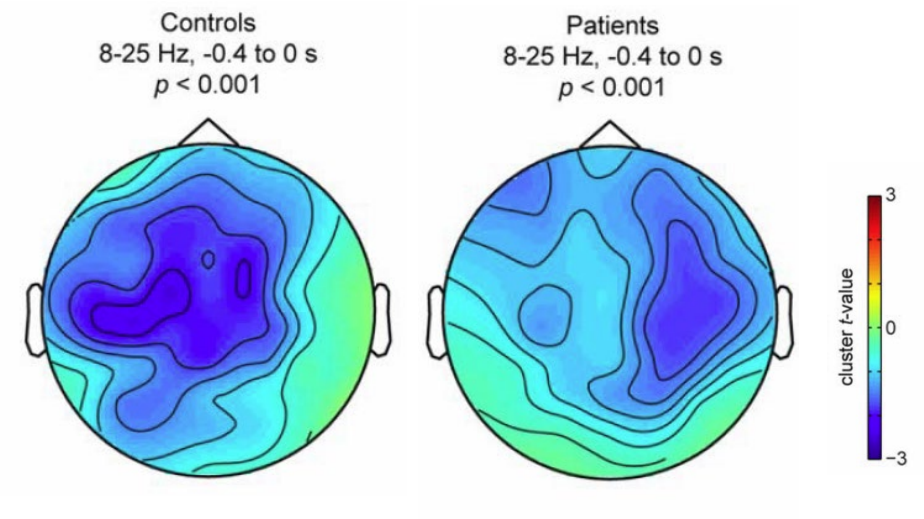


Piai, Rommers, Knight, 2018

Neuroplasticity following left posterior lesions

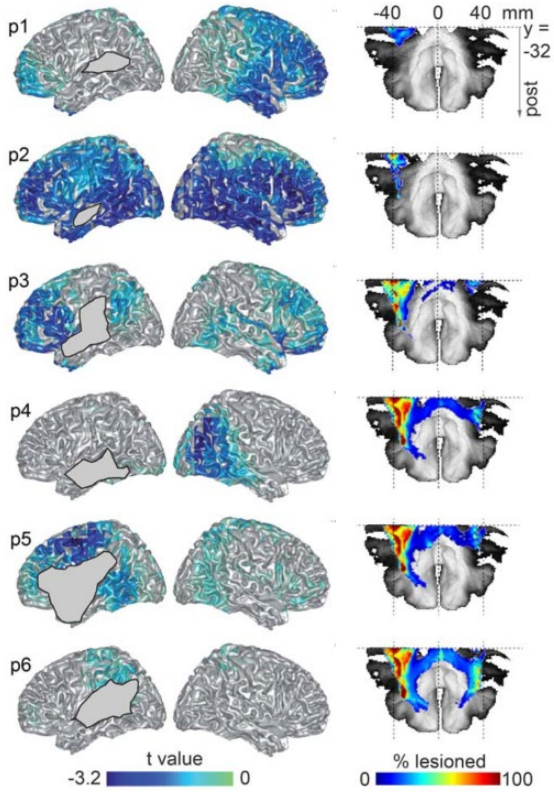






Piai, Meyer, Dronkers, Knight, 2017

Hemispheric reorganisation

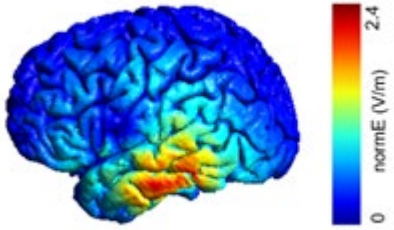


Piai, Meyer, Dronkers, Knight, 2017

Jana Klaus

Probing the limits of plasticity

- Temporal trajectory: time course of adaptation in healthy controls
- Perturbation of left MTG before task



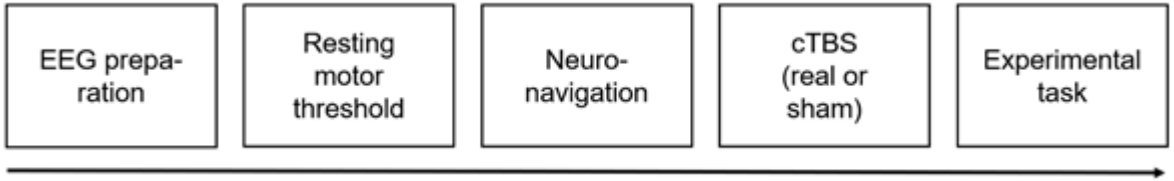
- immediate compensation of function loss in the left temporal lobe?

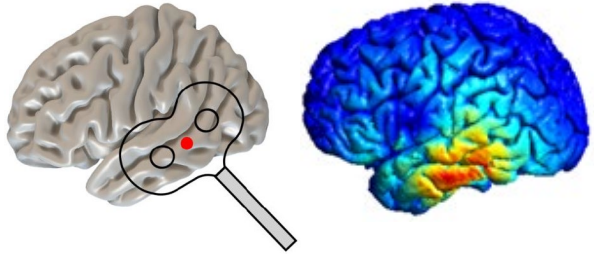
Klaus, Schutter, Piai, 2020

Probing the limits of plasticity

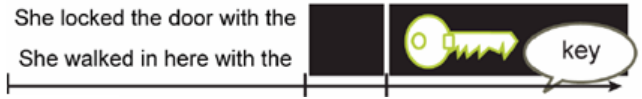
Jana Klaus

Two sessions: perturbation vs sham (counterbalanced)





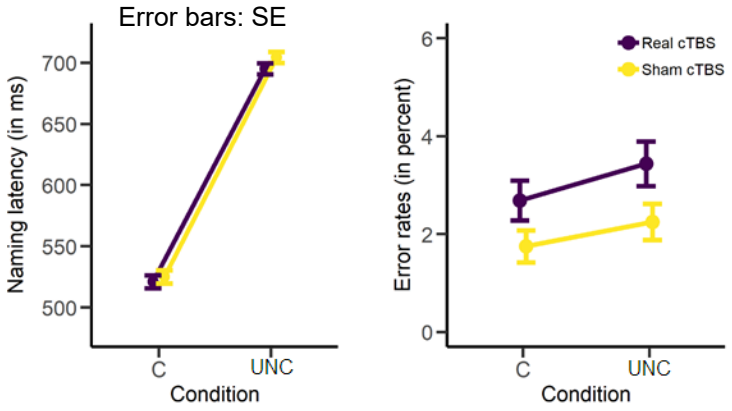
600 pulses, 50 Hz
80% RMT
MNI: $x = -63$
$y = -26$
$z = -2$

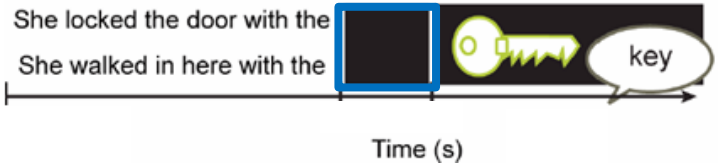


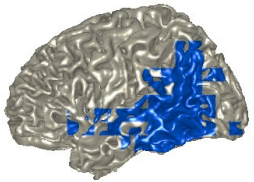
Klaus, Schutter, Piai, 2020

Jana Klaus

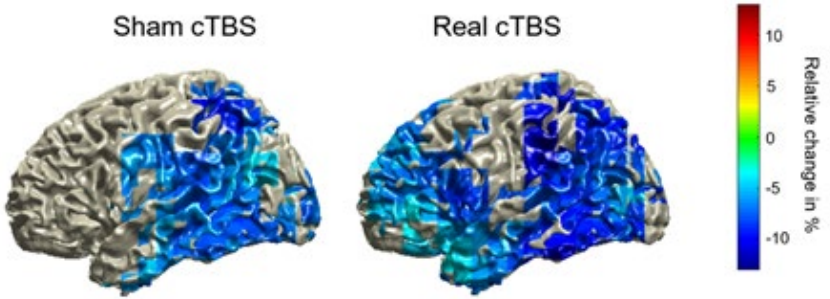
Perturbation results







Test-retest consistent



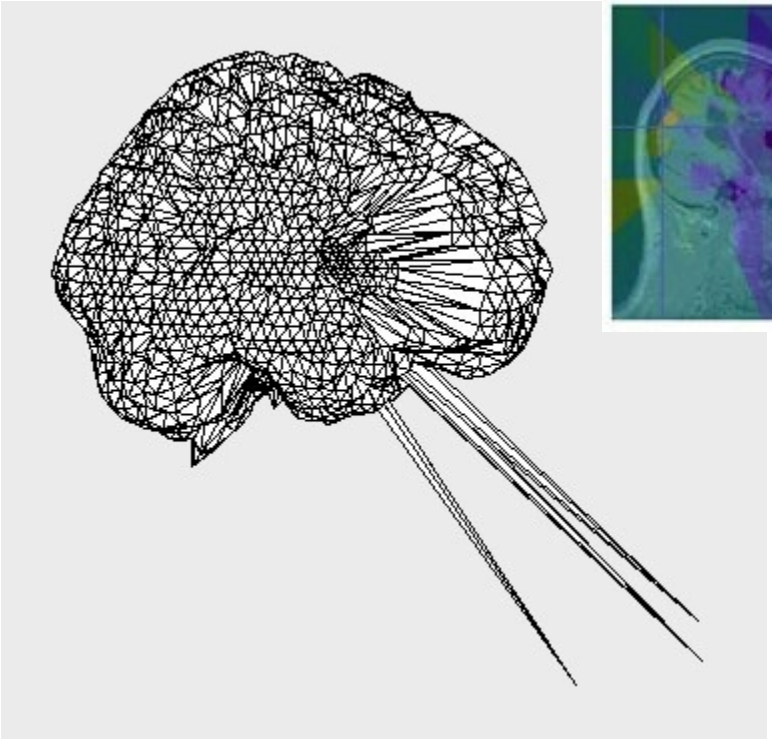
Klaus, Schutter, Piai, 2020

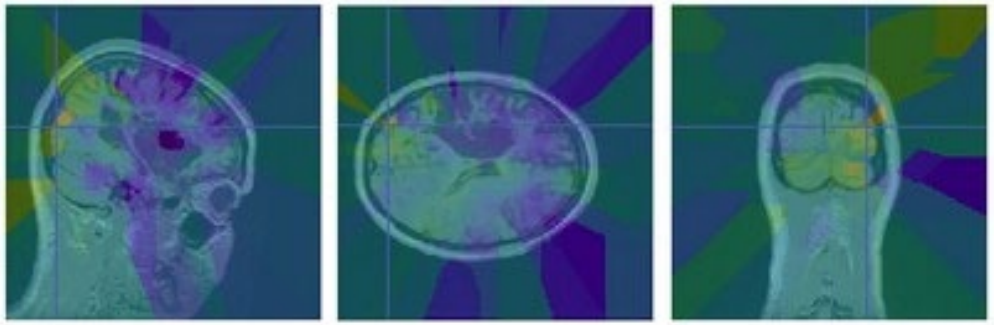
Interim summary

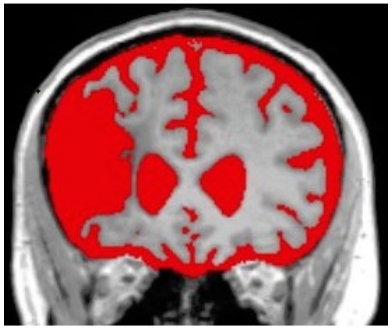
- Causal link between context facilitation, alpha-beta power decreases, and posterior cortex
  - Inferior parietal lobule

- Quick recruitment of LIFG following MTG perturbation
  - Suboptimal to fully support word production
- Recruitment of right hemisphere in chronic stroke
  - Alpha-beta power decreases and similar timing as in controls: Same computations (?)

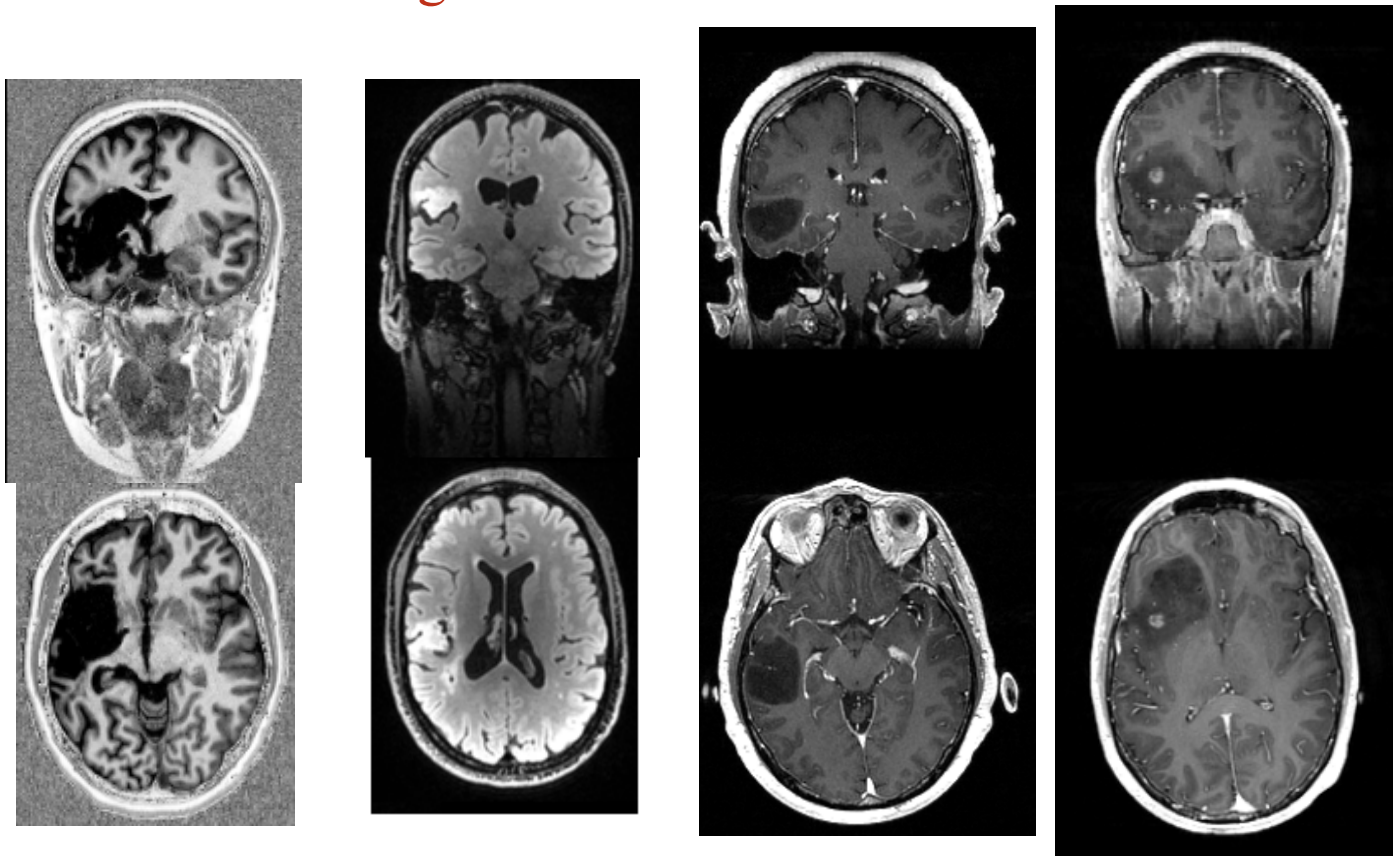
The art of working with brain lesions





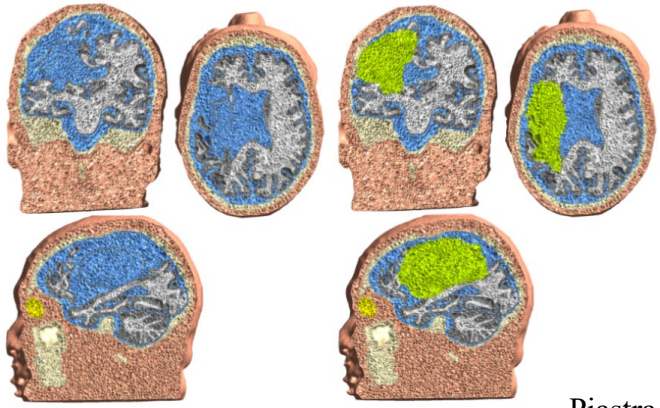


The art of working with brain lesions



Volume conduction

- "Transmission of electric or magnetic fields from a source through biological tissue towards measurement sensors" (Scholarpedia)
- Different tissues have different conductivities
  - Largely affected by brain lesions (e.g., CSF, tumours)
  - Incorrect estimation of location and strength of source



Source:
Piastra et al., 2021

(Not) Taking lesions into account

Maria-Carla Piastra

- Take head model with lesion as “ground truth”
- Use it as forward model to simulate measured MEG data
- Source reconstruction assuming head model with no lesion

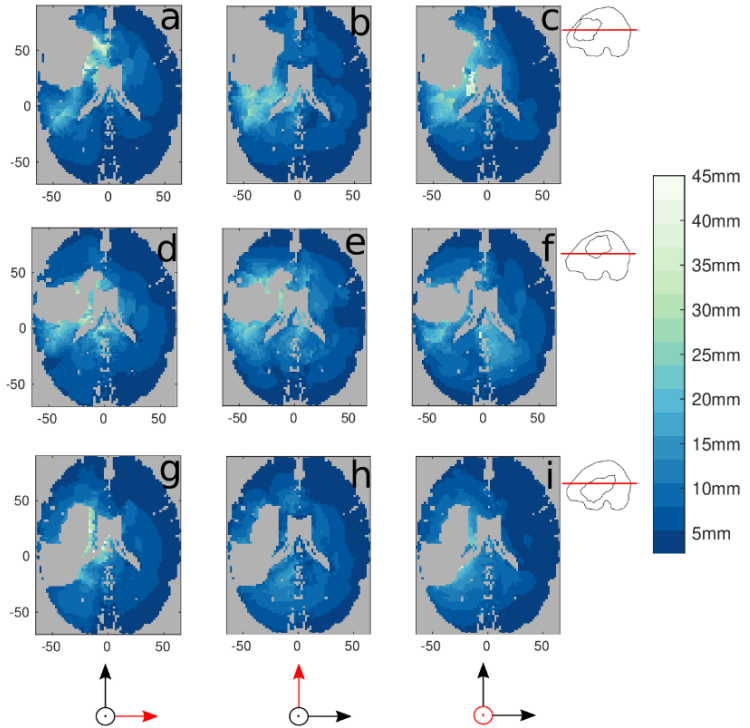
→ *Scenario*: data from patient with stroke lesion neglecting lesion in source analysis of that data

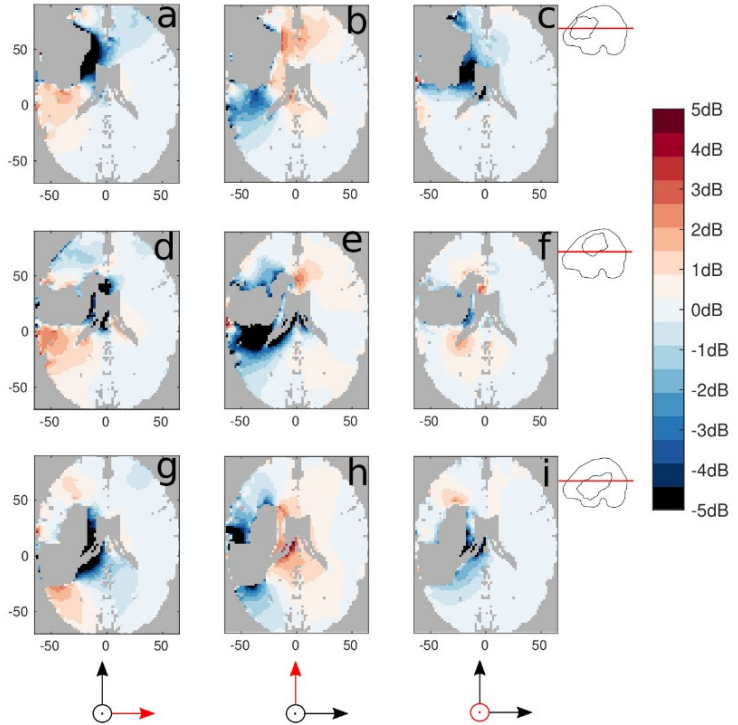
- quantify displacement of estimated source locations
- attenuation/amplification of the amplitude of the reconstructed source activity

Piastra, Oostenveld, Schoffelen, Piai, *in revision*

(Not) Taking lesions into account

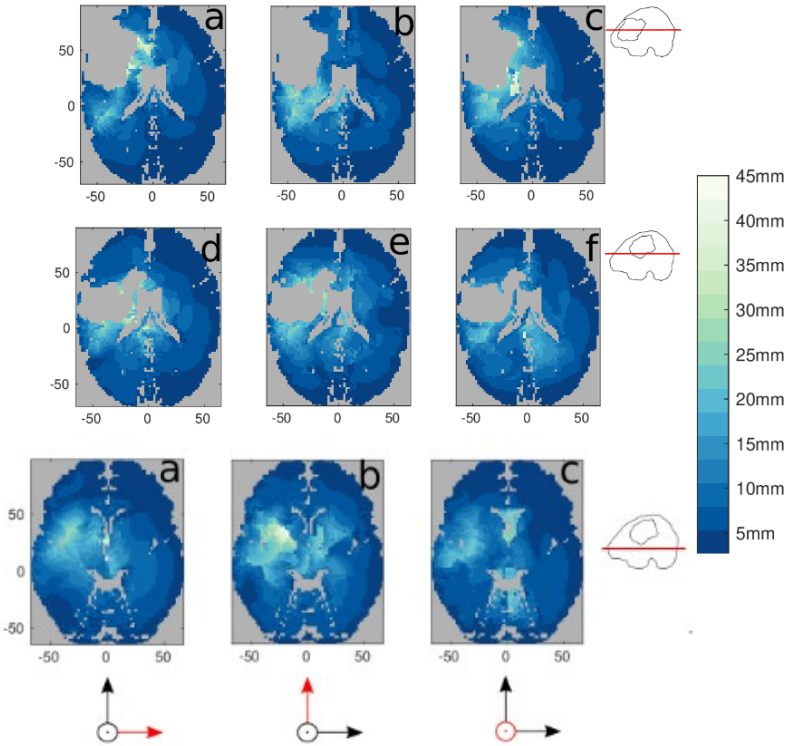
Maria-Carla Piastra

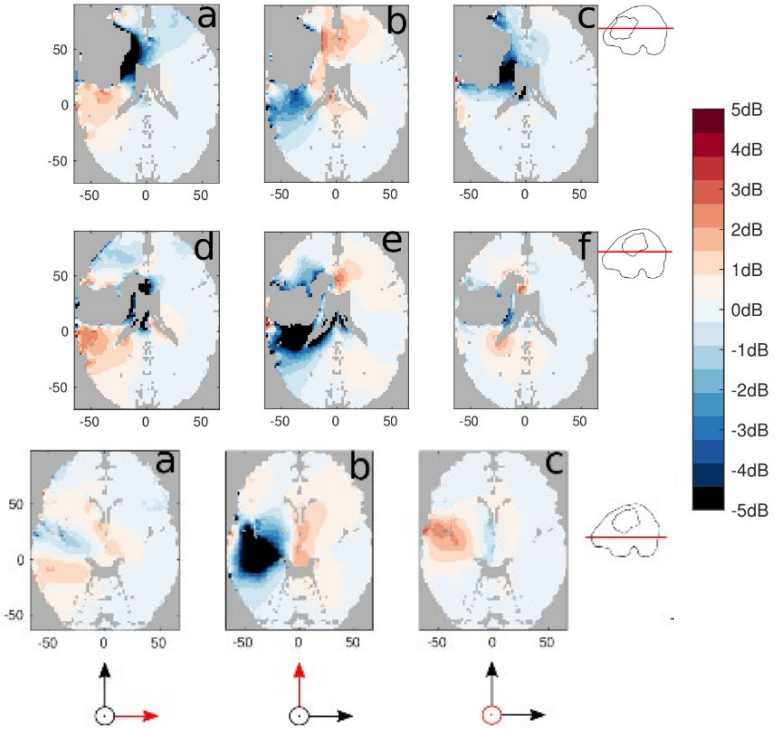




Piastra, Oostenveld, Schoffelen, Piai, *in revision*

(Not) Taking lesions into account





Maria-Carla Piastra

Piastra, Oostenveld, Schoffelen, Piai, *in revision*

(Not) Taking lesions into account

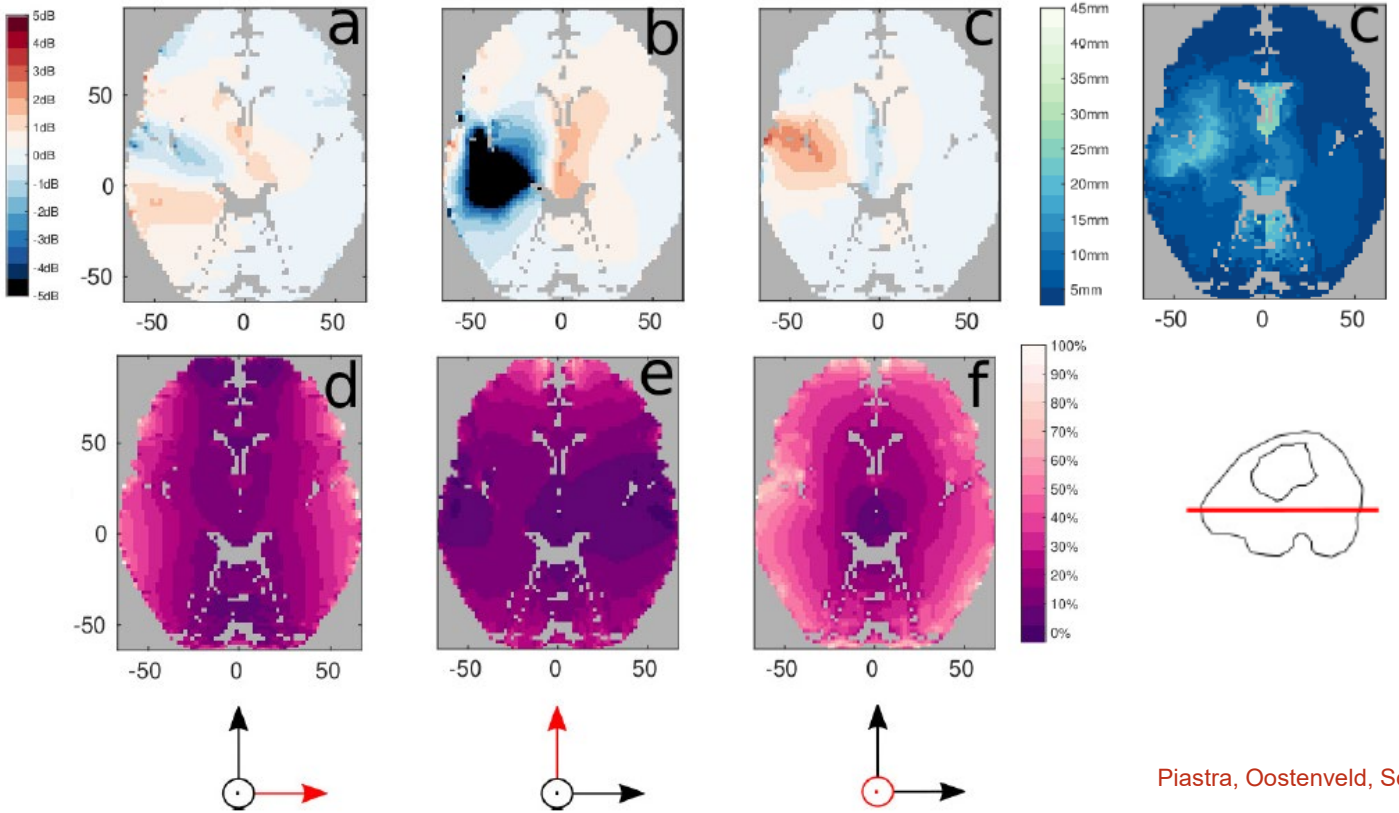
Maria-Carla Piastra

- Amplitude of sensor-level MEG signal varies with location and orientation of source, even if source amplitude is kept constant
- MEG is known to be considerably less sensitive to radially oriented sources compared to tangential sources, and to deep sources compared to superficial sources

Piastra, Oostenveld, Schoffelen, Piai, *in revision*

(Not) Taking lesions into account

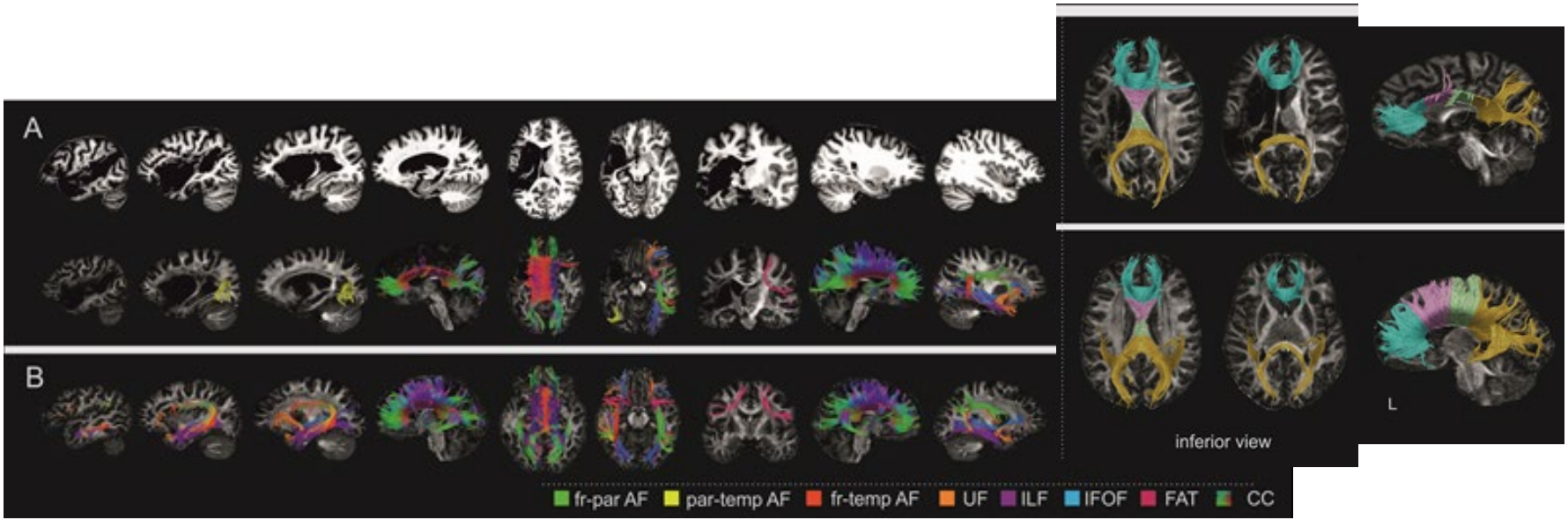
Maria-Carla Piastra



Piastra, Oostenveld, Schoffelen, Piai, *in revision*

Extensive left-hemisphere stroke

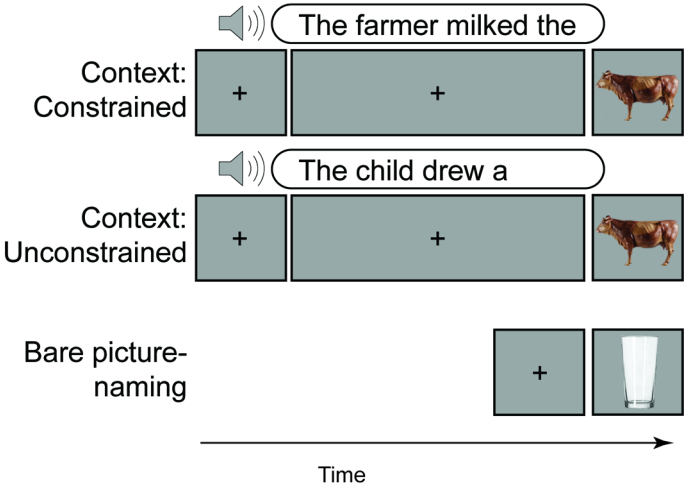
Irina Chupina

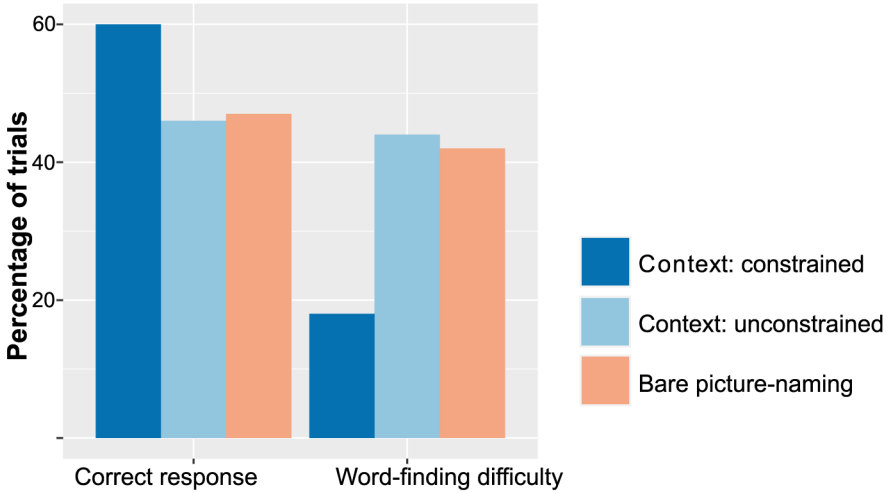


Chupina, Sierpowska, Zheng, Dewenter, Piastra, Piai, *in revision*

Extensive left-hemisphere stroke

Irina Chupina

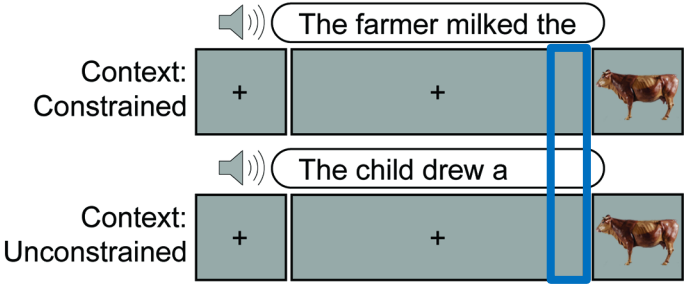


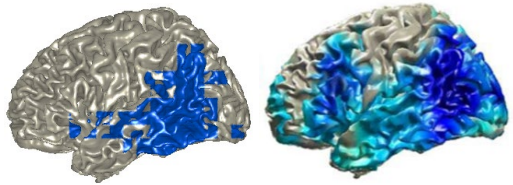


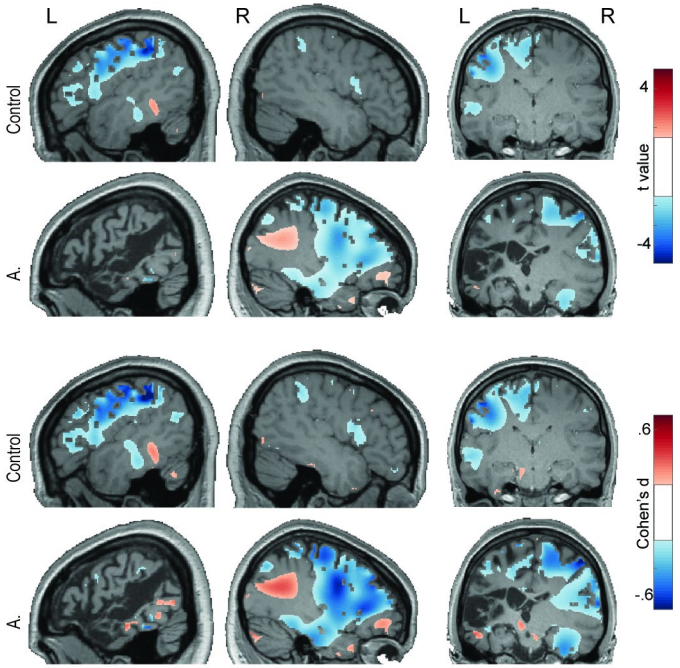
Chupina et al., *in revision*

Extensive left-hemisphere stroke

Irina Chupina

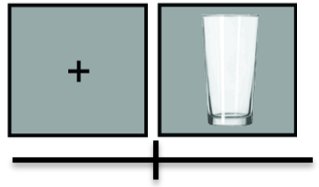






Chupina et al., *in revision*

Event-related responses



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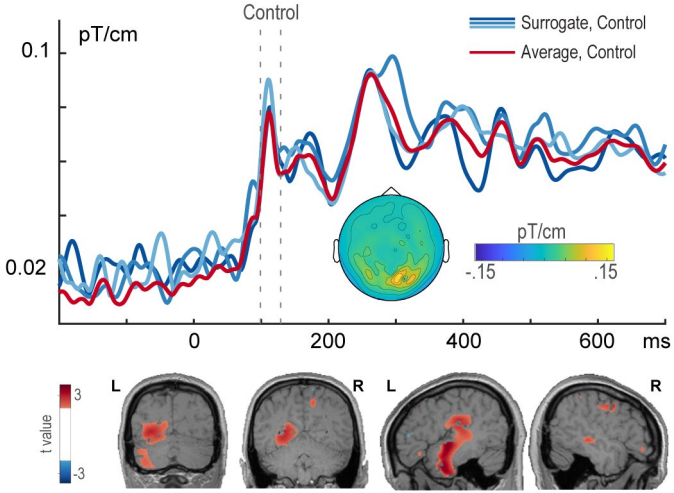
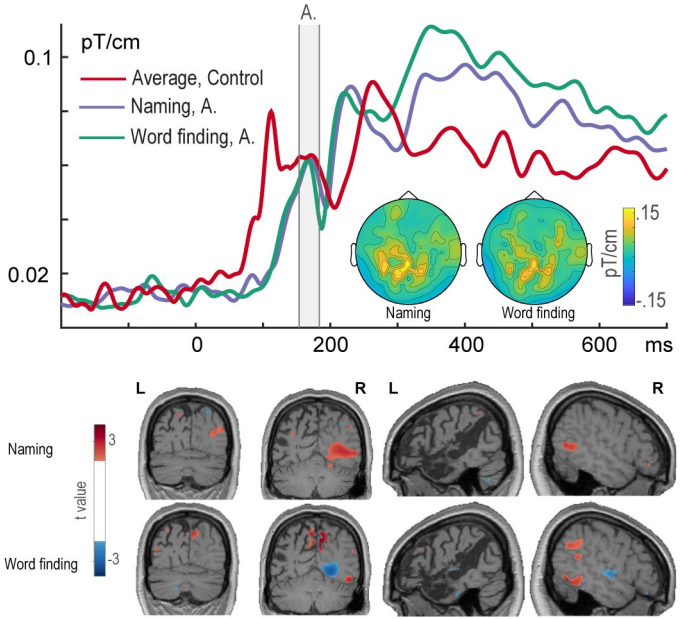
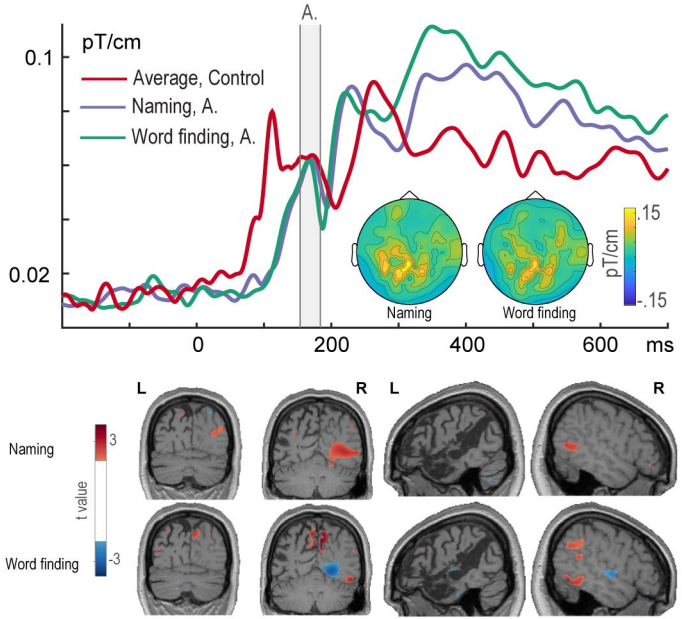
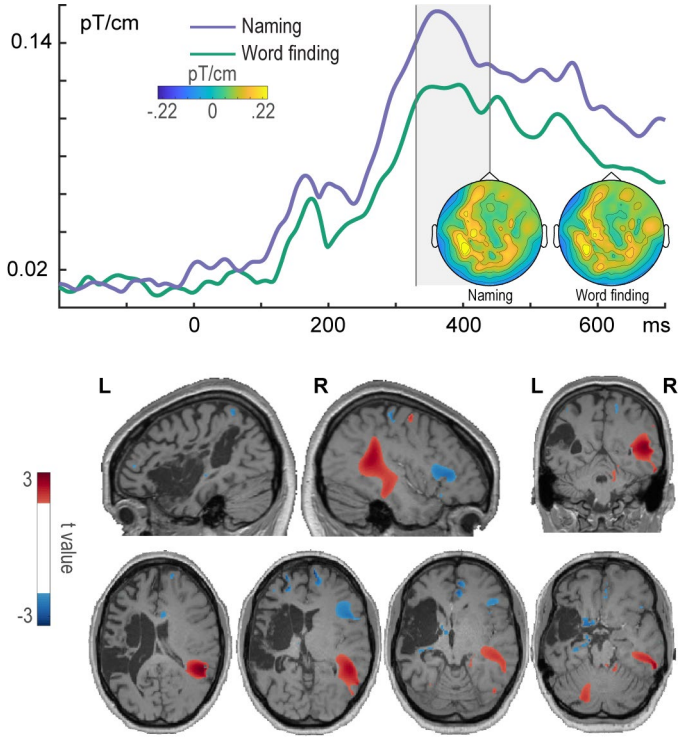




Chupina et al., *in revision*

Event-related responses





Timely right-hemisphere responses

Spatial dissociation between successful and unsuccessful naming

Irina Chupina

Chupina et al., *in revision*

Conclusions

- Sentence context activates conceptual/lexical representations
  - Reflected in alpha-beta oscillations in left posterior temporal and inferior parietal cortex
    - Causally

- "Atypical" brain areas involved following brain damage may be performing same "operations" as typical areas
  - Show similar neurophysiological phenomena
  - Timely responses, yet not sufficient (?)

- Importance of taking lesions into account!

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Thank you for your attention!

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