Laboratory of cognitive psychophysiology

https://social.hse.ru/psy/cognpp/

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Location: Кривоколенный пер., д. 3, room 101

Project:

Word meaning acquisition

How do we instantaneously perceive word meaning?

How do we learn word meaning?

Topic: Acquisition of word meaning through trial-and-error learning

(in cooperation with Tatiana Stroganova, MEG-centre MSUPE)

Goals:

The project aims at understanding the brain mechanism responsible for acquisition of word meaning during rapid associative learning.

Questions:

Is meaning of newly learnt words processed in the brain in the same fast automatic way it deals with real words of a language?

What brain areas are involved in rapid world meaning acquisition?

Are somatotopic motor areas involved in acquisition and storage of action word meaning?

Are high-level motor planning areas (such as pre-SMA and DLPC) involved in acquisition and storage of word meaning?

Topic: Acquisition of word meaning through trial-and-error learning

(in cooperation with Tatiana Stroganova, MEG-centre MSUPE)

Methods:

- pseudowords
- trial-and-error learning
- MEG (sensor level and distributed source level):
  - evoked fields,
  - time-frequency analysis
  - connectivity

Topic: Acquisition of word meaning through trial-and-error learning

(in cooperation with Tatiana Stroganova, MEG-centre MSUPE)

Theoretical framework:

- automatic and distributed word meaning processing
- "embodied cognition" ("grounded cognition") → somatotopic motor representations
- articulatory mechanisms related to word working memory
- anterior temporal lobe as a hub related to semantics

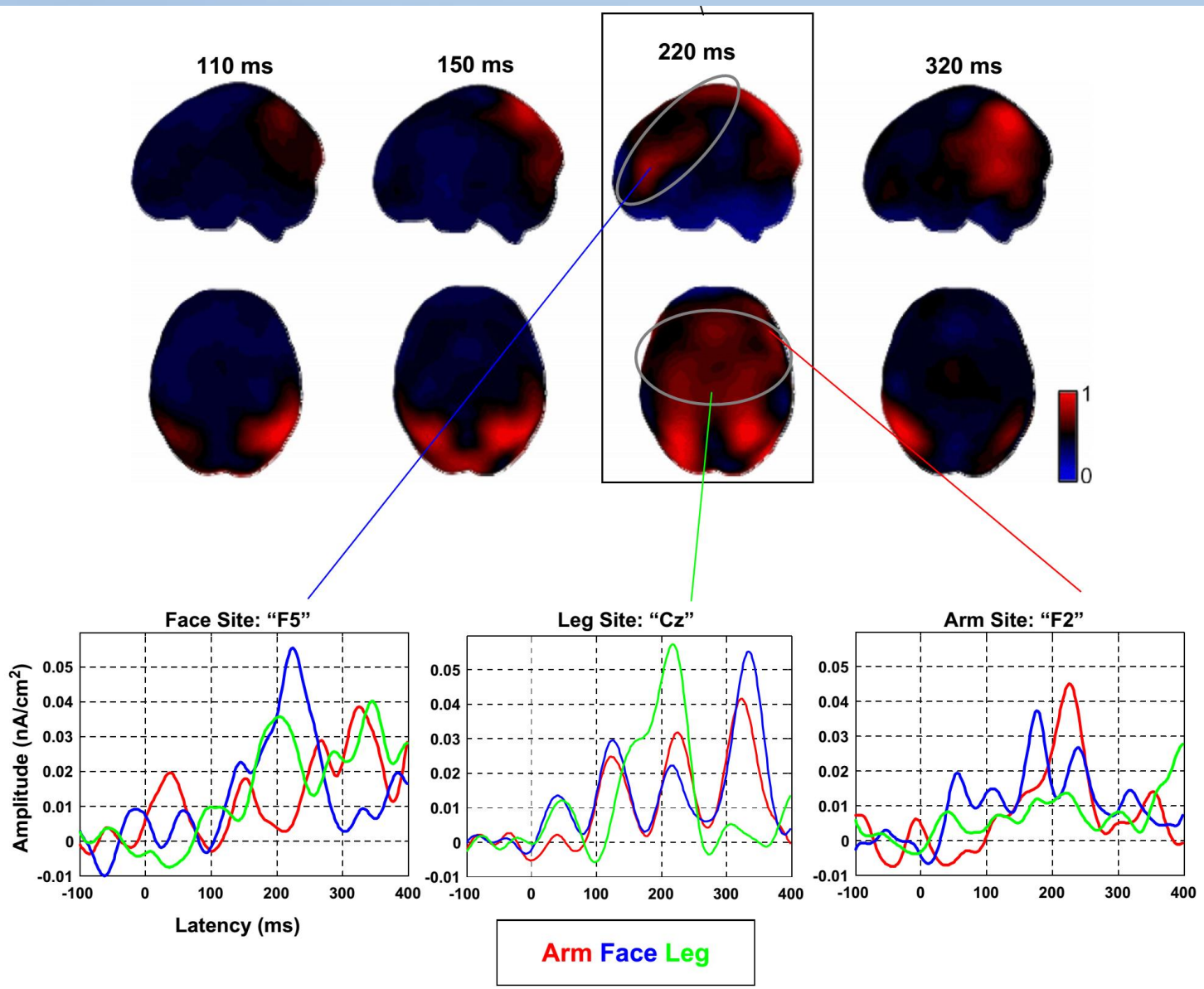
Topic: Acquisition of word meaning through trial-and-error learning

(in cooperation with Tatiana Stroganova, MEG-centre MSUPE)

Methods:

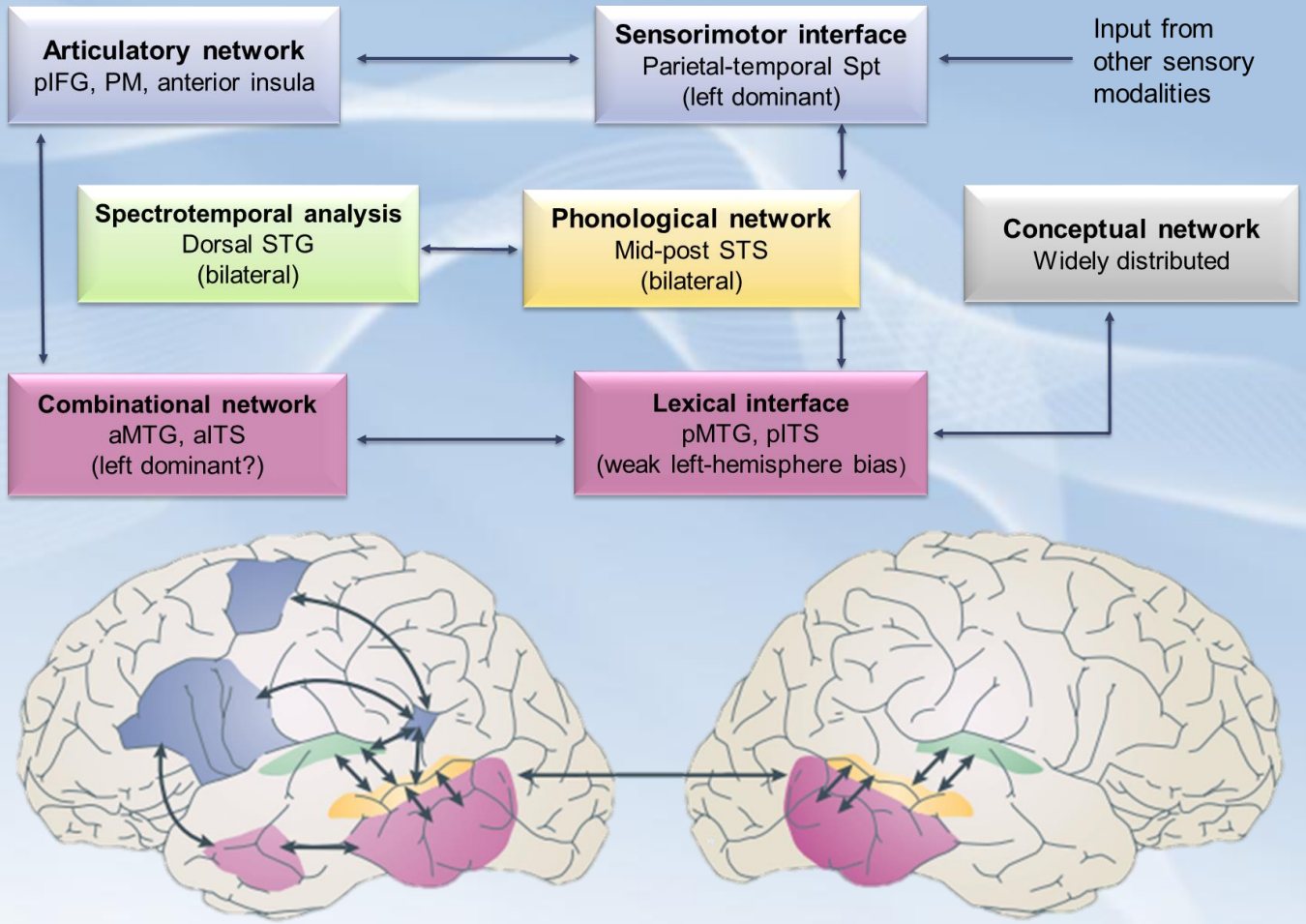
Prerequisites / background:

To participate in this project, a student will have to quickly acquire good skills in Python programming. Acquaintance with other programming languages (such as MATLAB, R, Java) is also welcome.



Action-words are known to induce very early somatotopic activation related to meaning of the words

[Hauk and Pulvermuller, 2004]



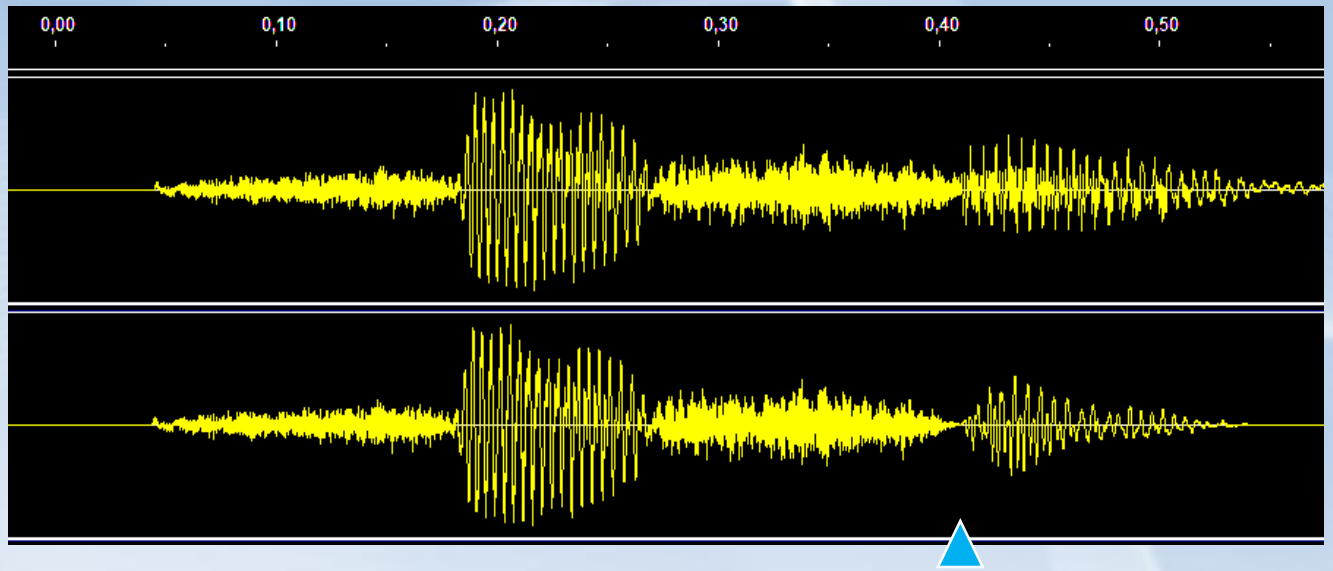
The dual-stream model of the functional anatomy of language

[Hickok & Poeppel, 2007]

During the experiments eight pseudowords are used. Four pseudowords are to be assigned meaning as action-words through associative trial-and-error learning, and four words are used as controls.

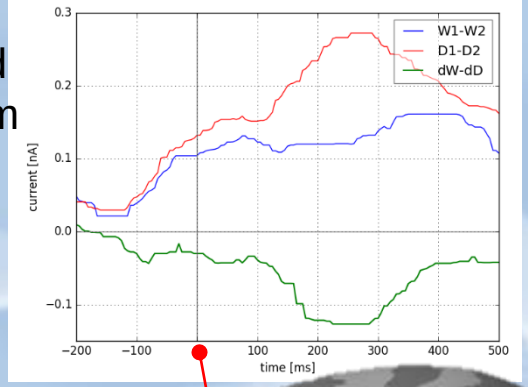
- Passive block 1
- Active block (learning)
- Active block (stable performance)
- Passive block 2

Critical comparison is between passive blocks 1 and 2.



Examples of stimuli: ‘hisha’ (upper trace) and ‘hishu’ (lower trace)

insula and
frontal operculum



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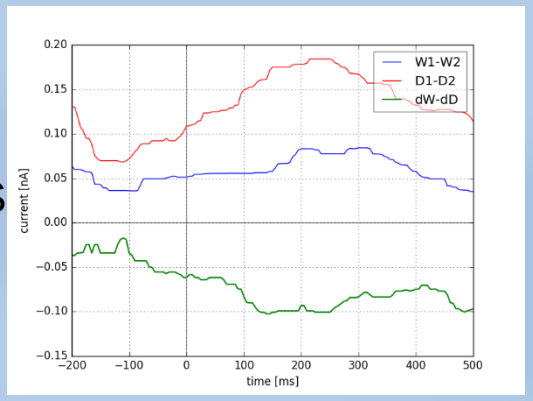
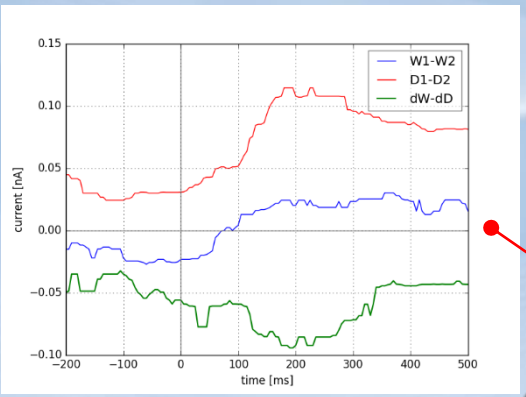
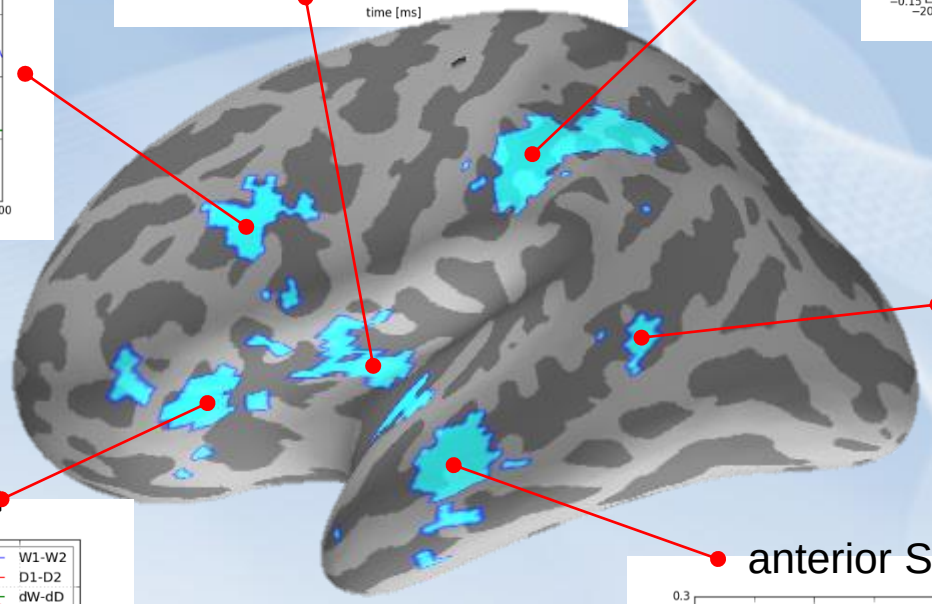
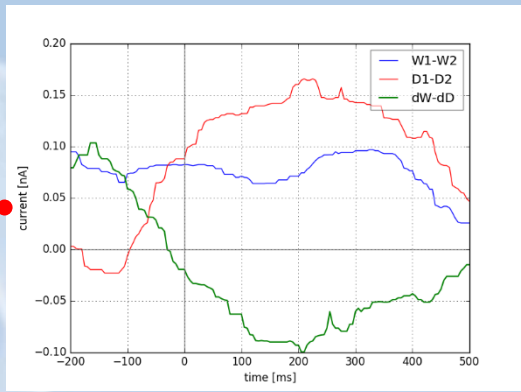




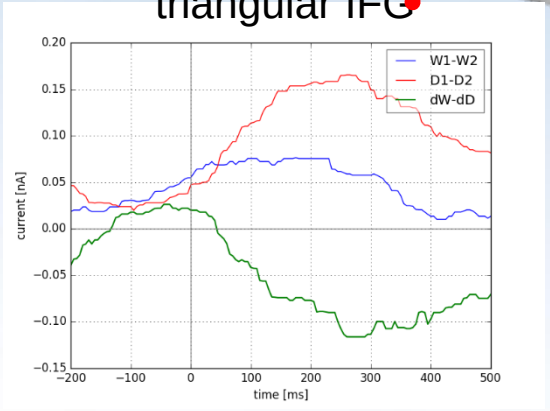
ventral premotor and
ventral prefrontal cortex



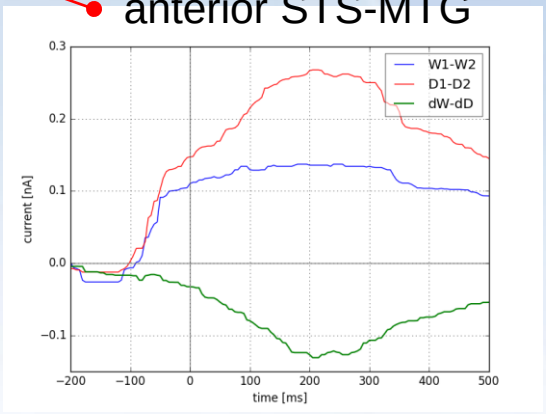


posterior STS

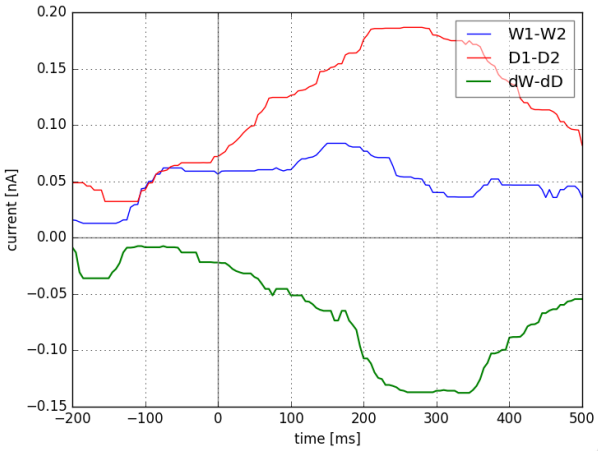
triangular IFG

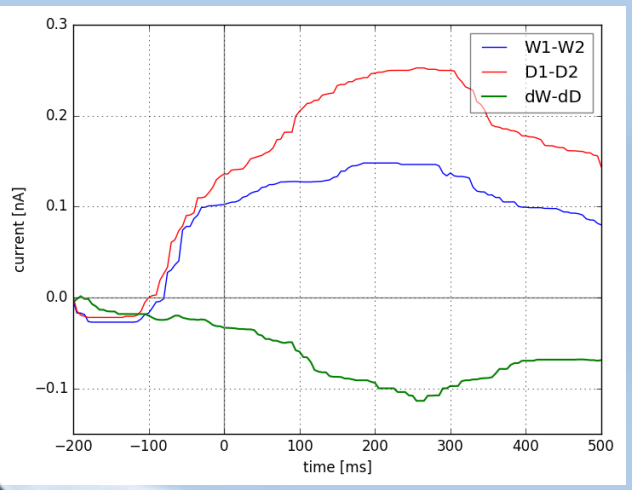


anterior STS-MTG



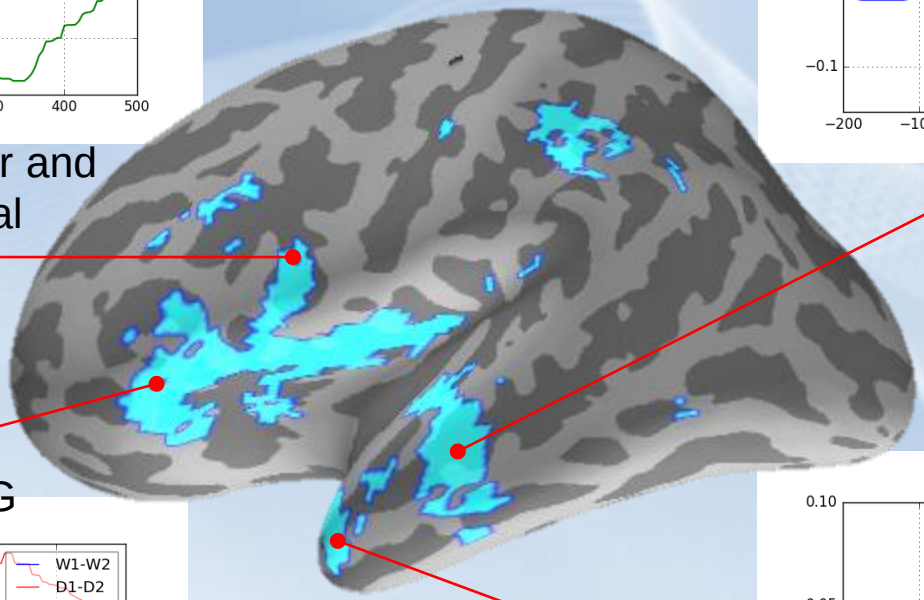
190 ms





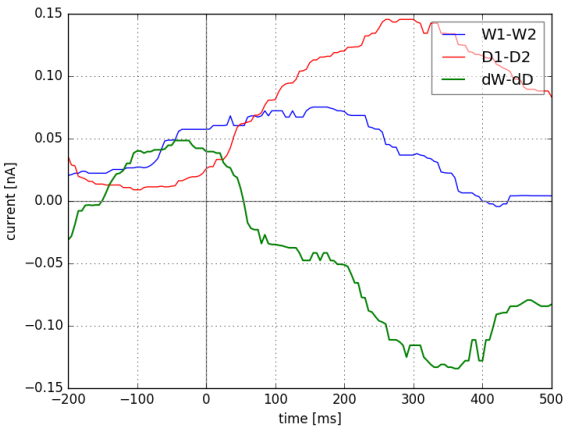
ventral premotor and
ventral prefrontal

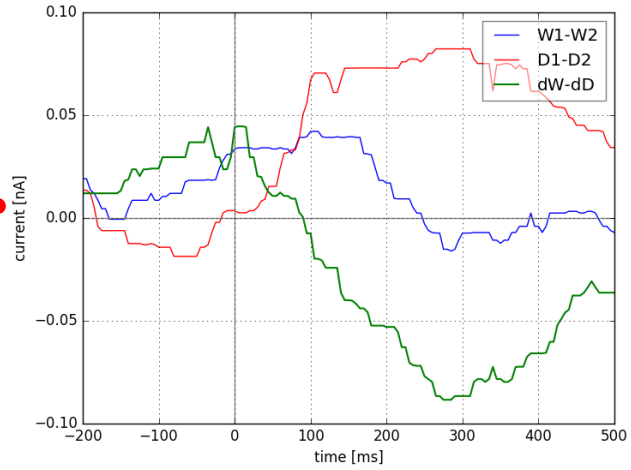
anterior STS-MTG



triangular IFG

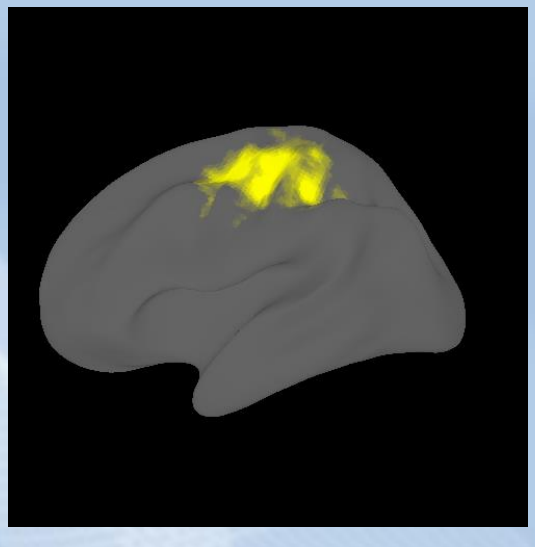
temporal pole



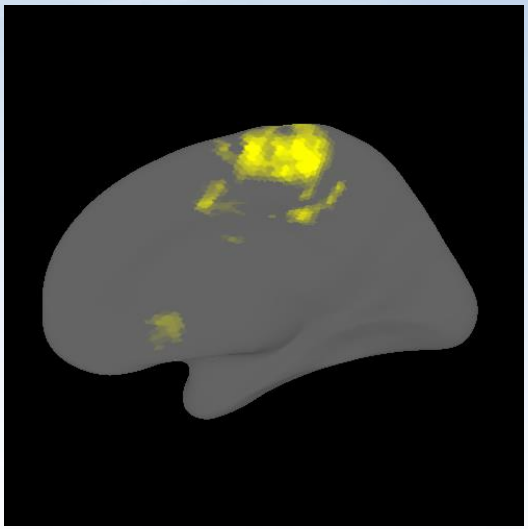


325 ms

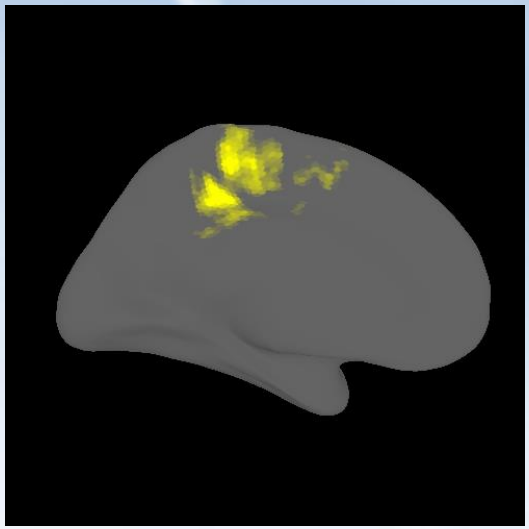
Left hand,
right hemisphere, lateral surface



Right hand,
left hemisphere, lateral surface



Left foot,
right hemisphere, medial surface



Right foot,
left hemisphere, medial surface

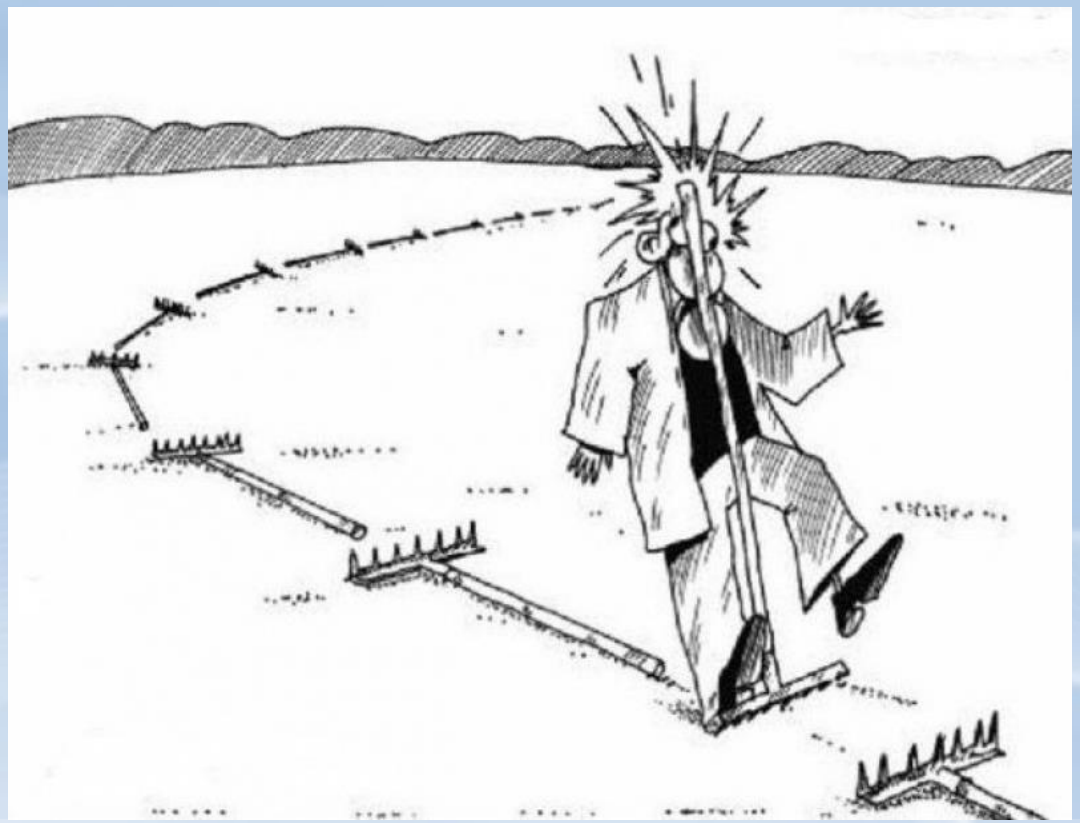
Project:

Cognitive control

Why are we often unaware of things that seem easy to notice?

Why do we commit errors even when we exactly know what should have been done?

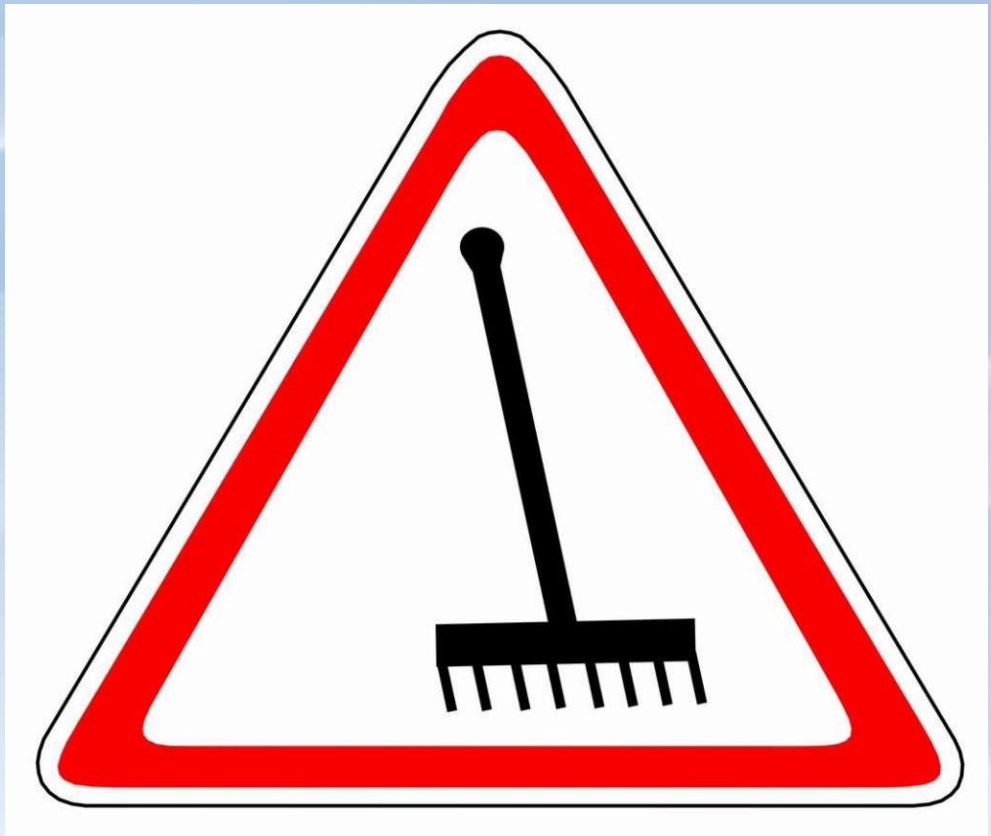
What is the nature of internal uncertainty during decision making and feedback expectation?



What does our brain do if it experiences conflict between response programs, uncertainty, or if it detects an error committed?

What changes for future in such events?

How does the brain respond to positive and negative feedbacks after a response has been made – in certain and uncertain conditions?



How do these brain events improve future behaviour?

Topic: Cognitive control and attention

Goals:

The goal of the project is to reveal brain mechanisms of cognitive control using such experimental variables as certainty/uncertainty, attentional selection, reward expectation and reward prediction, etc.

Additionally, we are going to study conscious awareness of uncertainty/conflict, implicit vs. explicit learning, etc.

Questions:

- What makes us commit errors when we exactly know what to do but fail to do so?

- What our brain does to predict and overcome errors?

- How does the brain deal with uncertainty?

Topic: Cognitive control and attention

Methods:

- condensation task with feedback
- both EEG and MEG
- oscillations (theta, alpha and beta)
- ERPs (ERN, FRN, P2, MMN etc.)

Topic: Cognitive control and attention

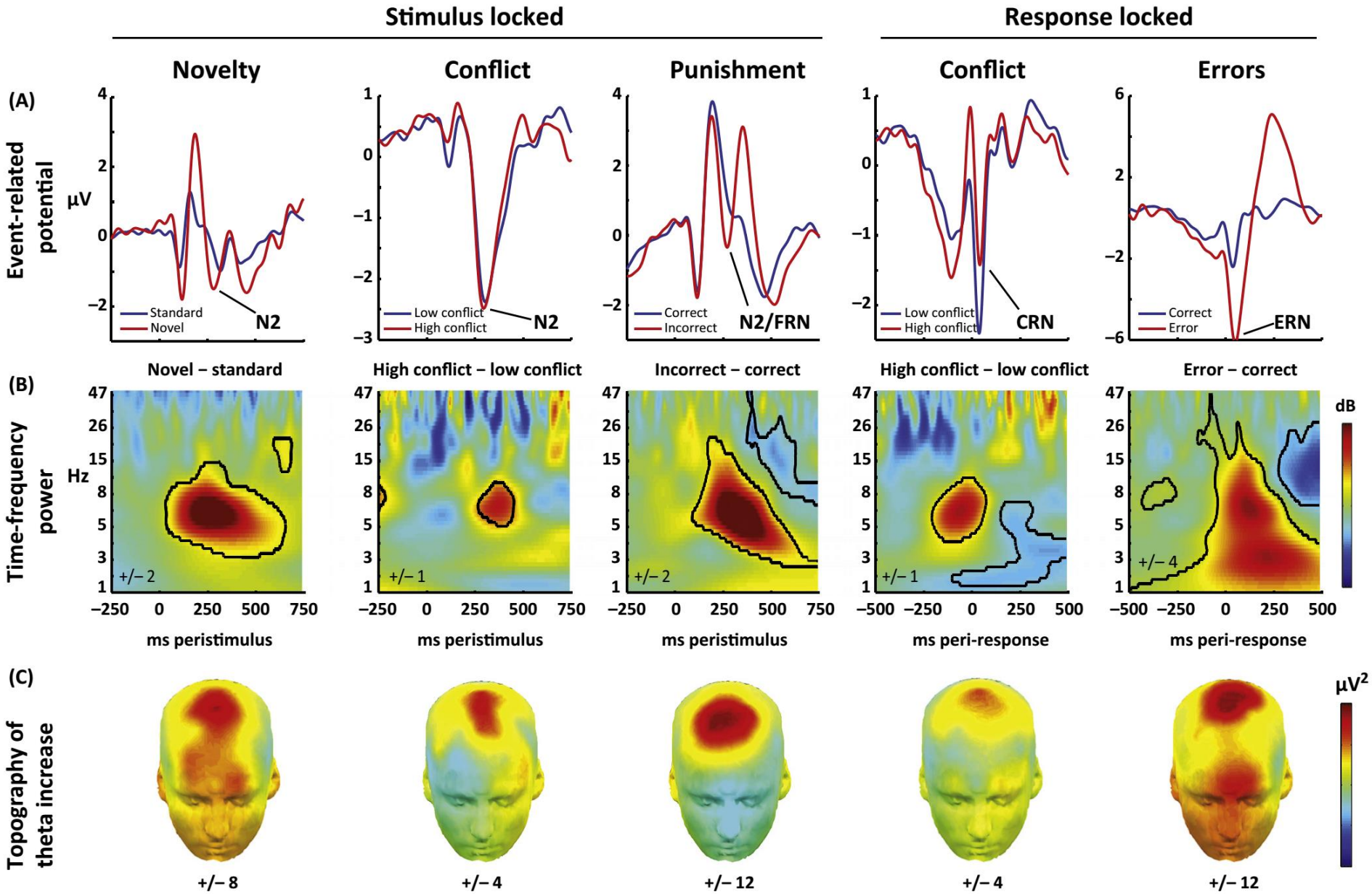
Prerequisites / background:

To participate in this project, a student will have to quickly acquire good skills in MATLAB programming. Acquaintance with other programming languages (such as Python, R, Java) is also welcome.

Topic: Cognitive control and attention

Theoretical framework:

- cognitive control
- competition for attention with other processes
- feature binding
- uncertainty
- prediction errors:
  - signed predictions errors (“punishment”, etc.)
  - unsigned prediction errors (“surprise”, “salience”, etc.)



Some ERP and theta phenomena related to cognitive control

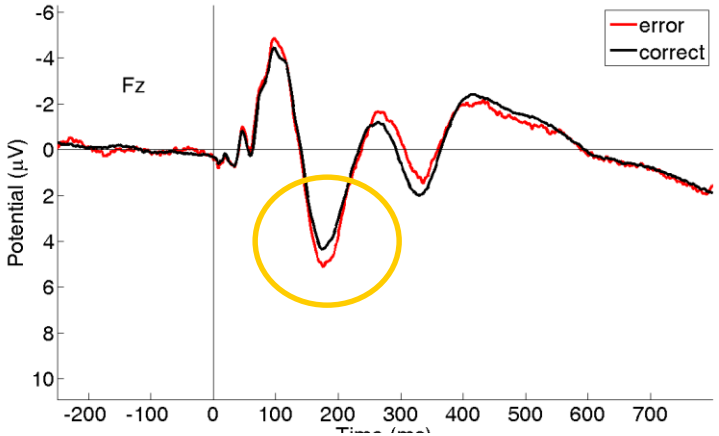
[Cavanagh Frank 2014]

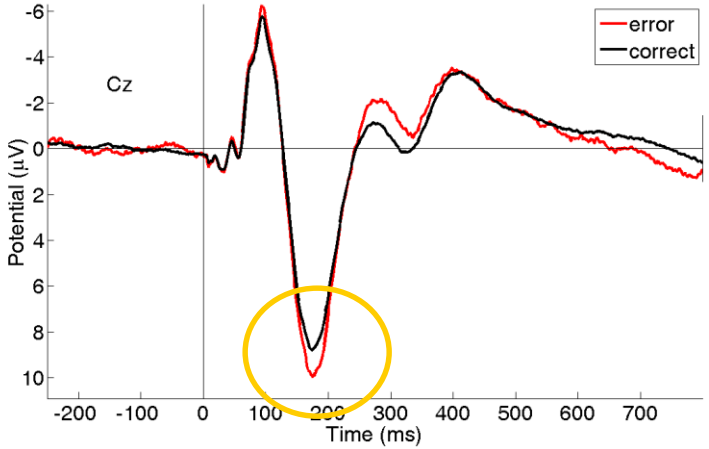
Auditory condensation task

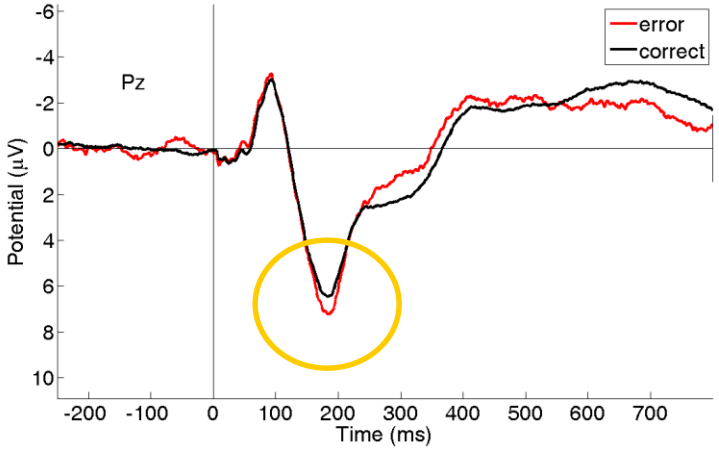
	Violin	★Calliope
High	**L**eft button	**R**ight button
Low	**R**ight button	**L**eft button

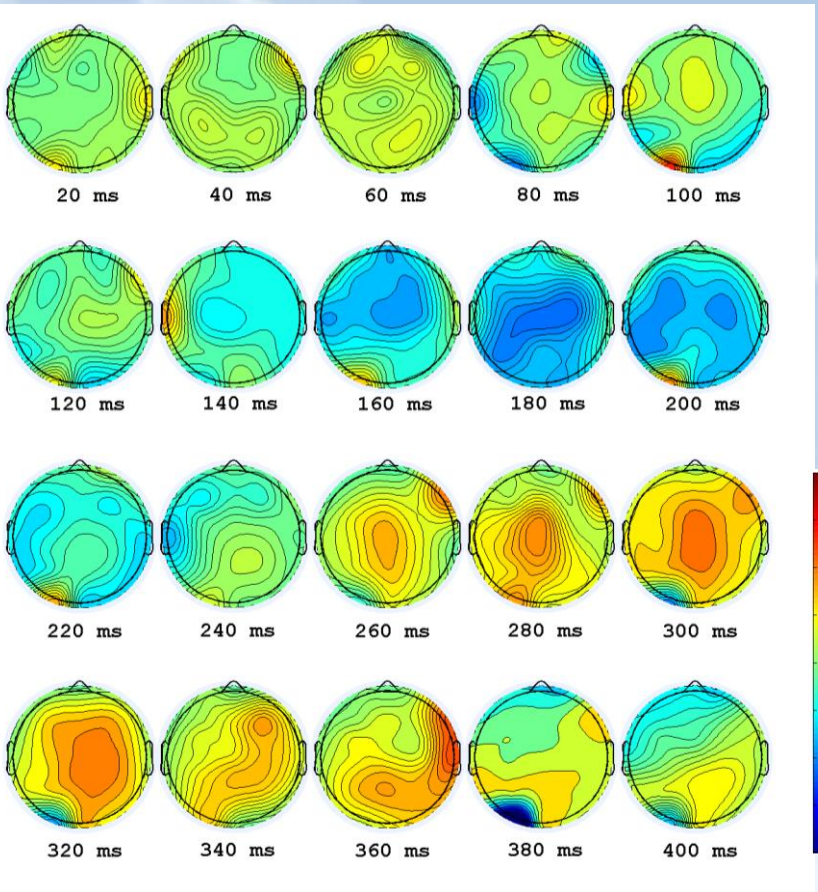
ERP grand mean for correct and erroneous responses.

(N = 52, F(1, 51) = 24.516, p < .0001)









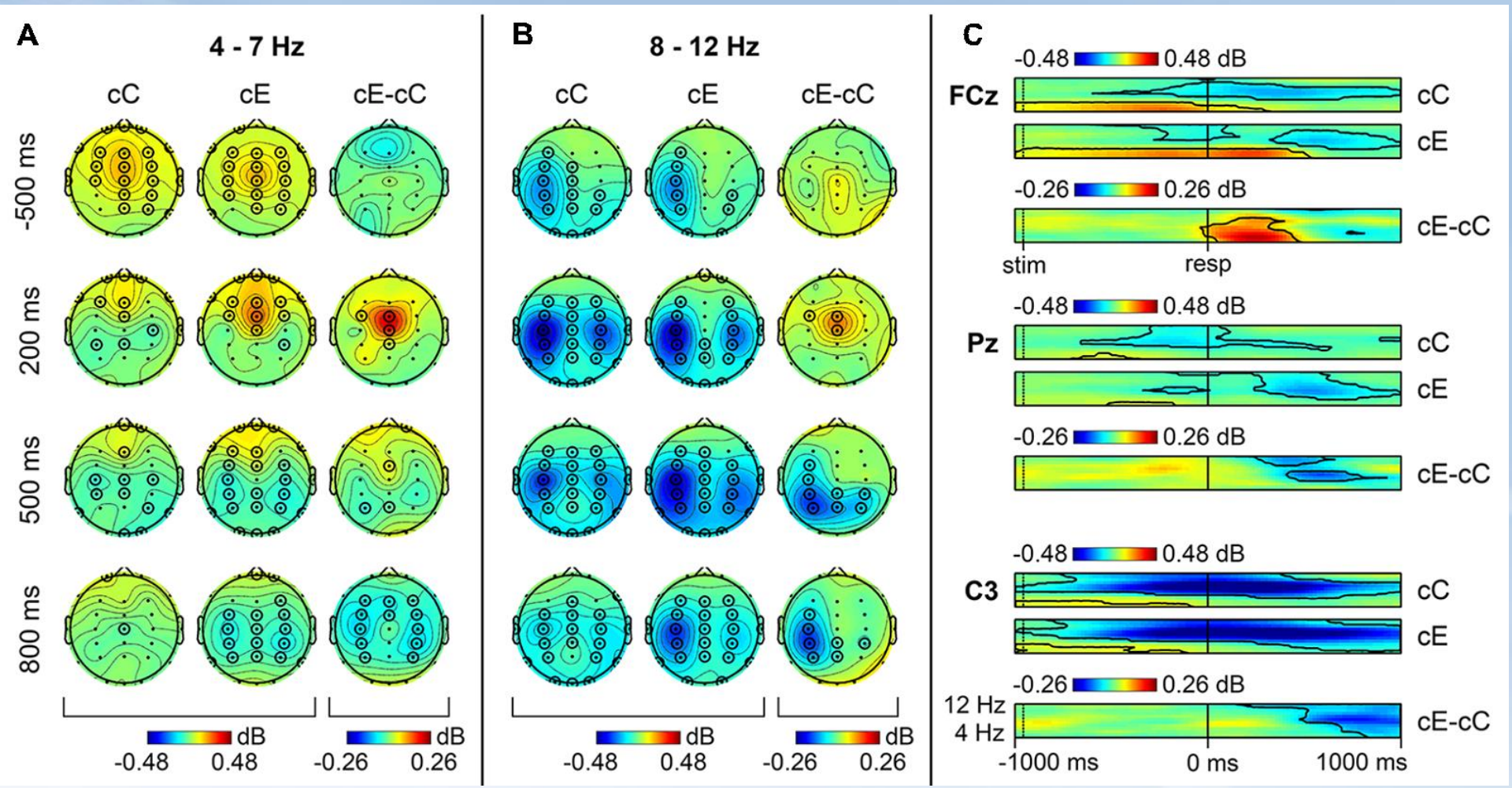
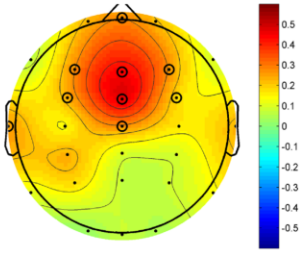
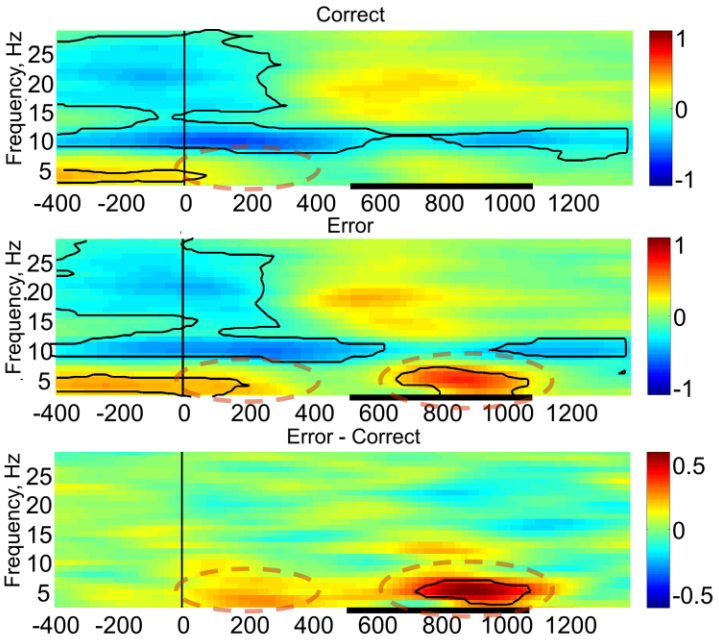


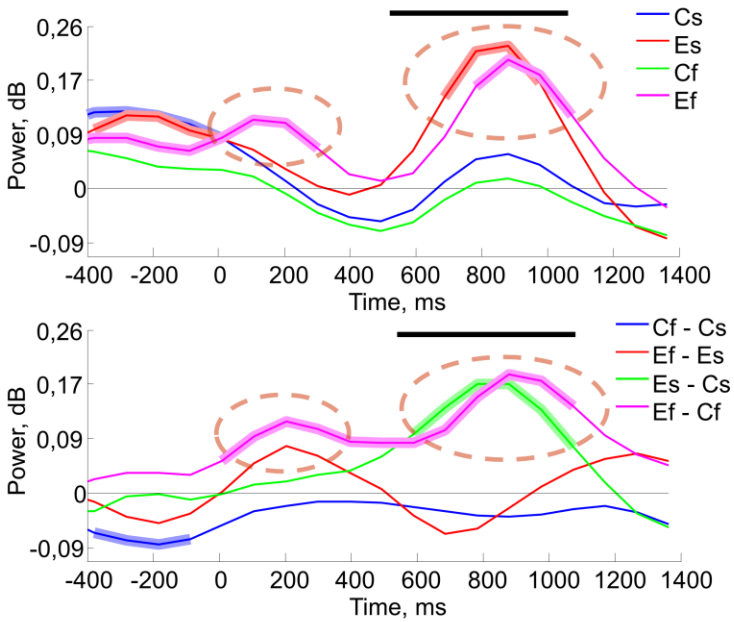
FIGURE 1 | Non-phase locked oscillatory activity in theta and alpha range on cC and cE trials. Topographical maps of theta **(A)** and alpha **(B)** band activity at time points relative to the response. Left: spatial distribution of ERSP on cC trials; middle: spatial distribution of event-related spectral perturbations (ERSP) on cE trials; right: spatial distribution of cE–cC log-power difference. Each map is averaged over data bins falling into 50 ms time interval. Significant electrodes ($p < 0.05$, 4-D TFCE) are highlighted by black circles (each electrode is highlighted if at least one time bin is significant within 50 ms interval). **(C)** Time-frequency plots of theta and alpha band activity at FCz, Pz, and C3 electrodes. Black contours show significant areas ($p < 0.05$, 4-D TFCE). Top: dynamics of ERSP on cC trials; middle: dynamics of ERSP on cE trials; bottom: dynamics of cE–cC log-power difference.



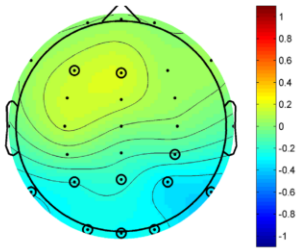
Differential topographical map of theta-band activity (errors minus correct responses, averaged over 800 to 850 ms relative to response). Significant electrodes highlighted with black circles (p<0.05, TFCE, permutation statistics).



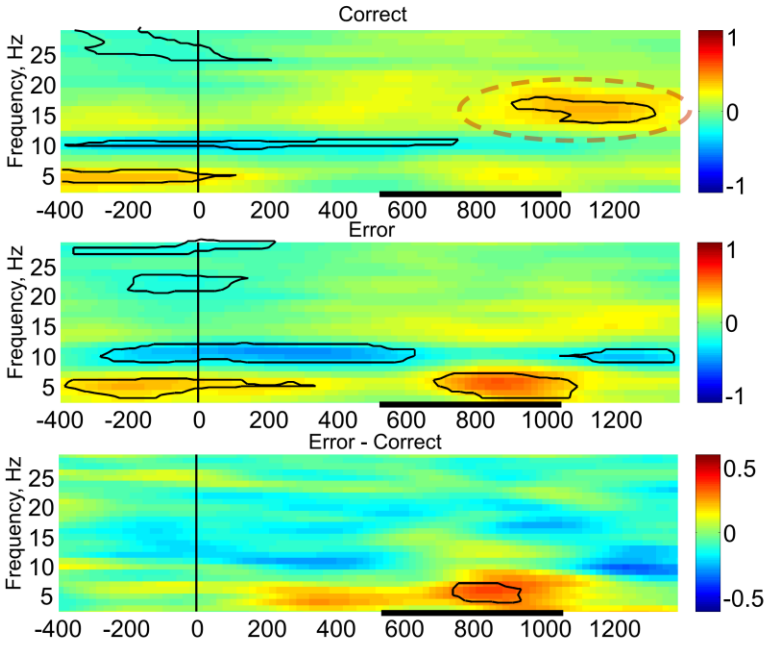
Time-frequency plots at Fcz electrode. Black outlines indicate p<0.05 (TFCE, permutation statistics). Horizontal black line represents feedback presentation.



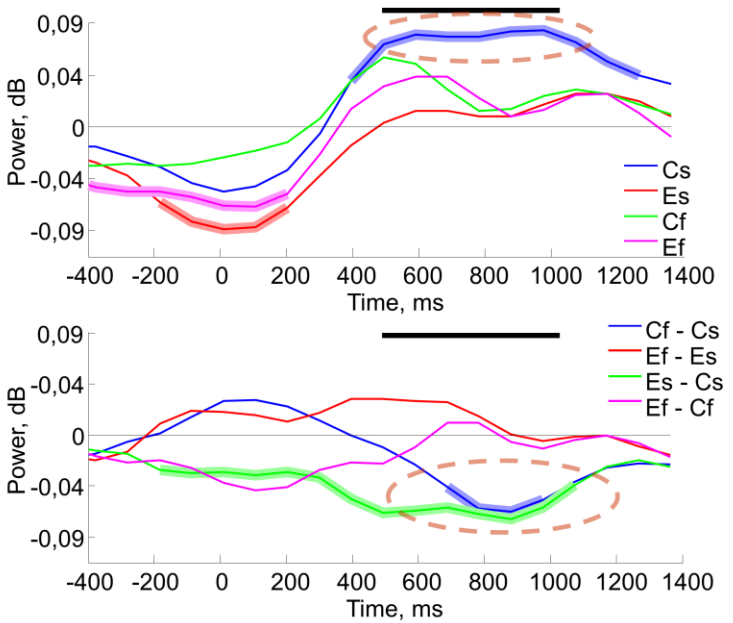
Time course of theta-band activity averaged across Fz, Fcz and Cz electrodes and 4-7 Hz frequency range. Thick lines indicate p<0.05 (TFCE, permutation statistics). Horizontal black line represents feedback presentation.



Topographical map of beta-band activity (correct responses, averaged over 900 to 950 ms relative to response). Significant electrodes highlighted with black circles ($p<0.05$, TFCE, permutation statistics).

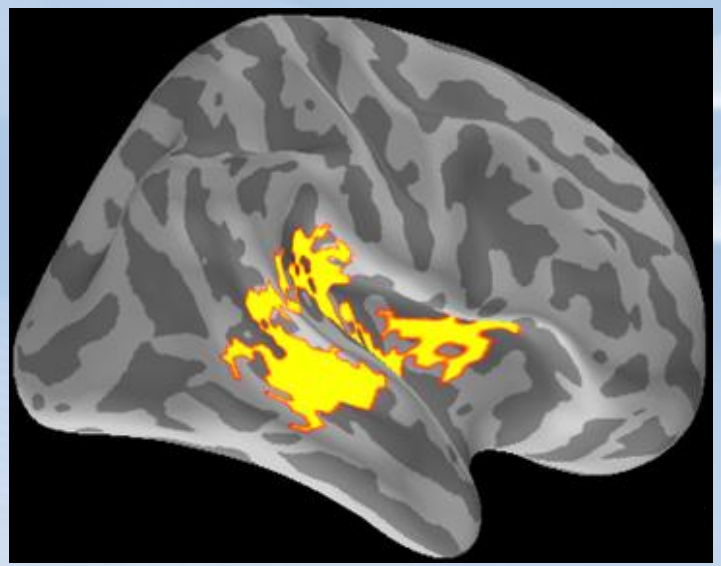


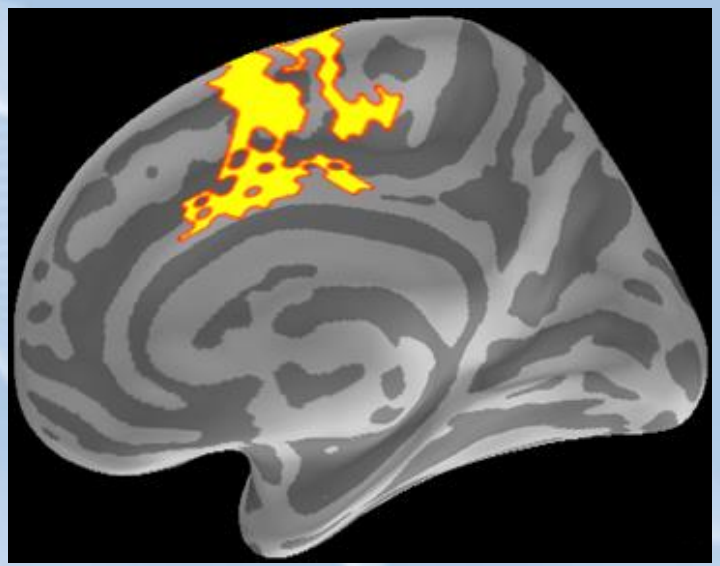
Time-frequency plots at F3 electrode. Black outlines indicate $p<0.05$ (TFCE, permutation statistics). Horizontal black line represents feedback presentation.

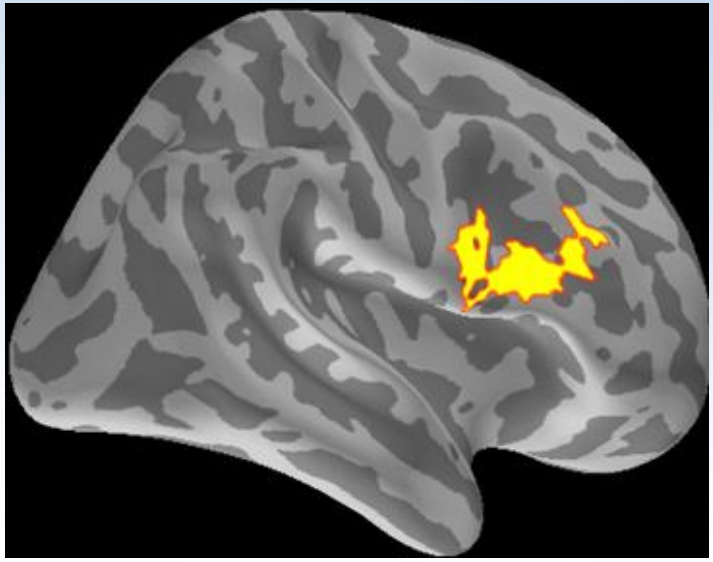


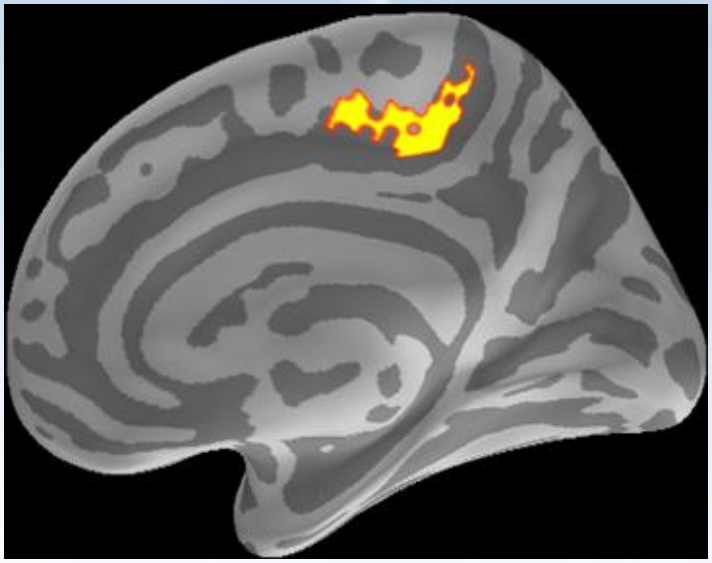
Time course of beta-band activity averaged across F3, Fz and F4 electrodes and 15-25 Hz frequency range. Thick lines indicate $p<0.05$ (TFCE, permutation statistics). Horizontal black line represents feedback presentation.

Тета осцилляции (МЭГ)









Laboratory of cognitive psychophysiology

https://social.hse.ru/psy/cognpp/

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