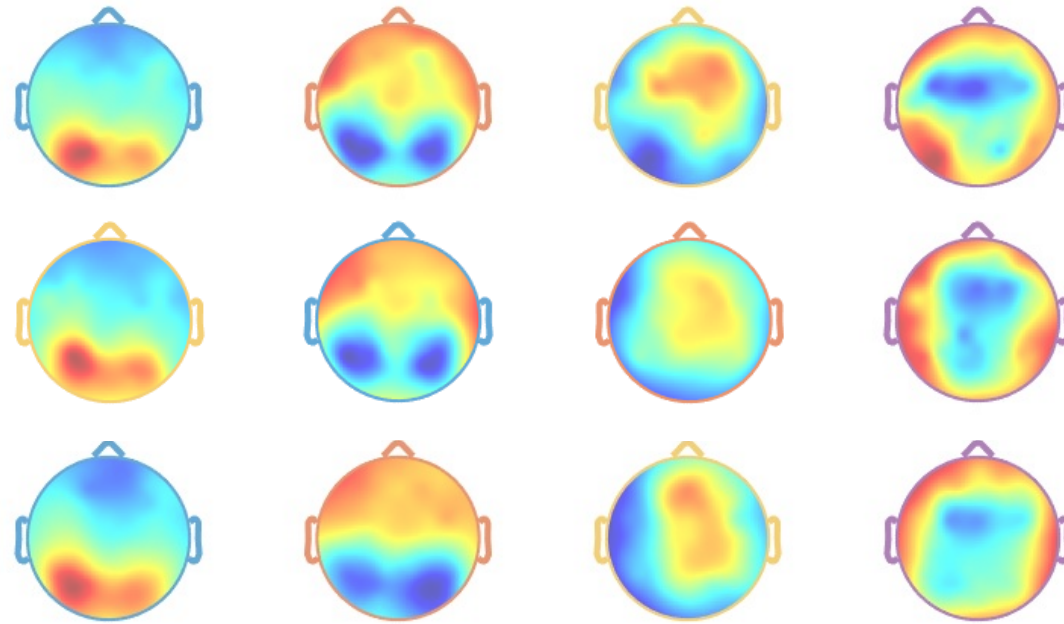


# Inter-Individual Variability in Event-Related Potentials is not Noise

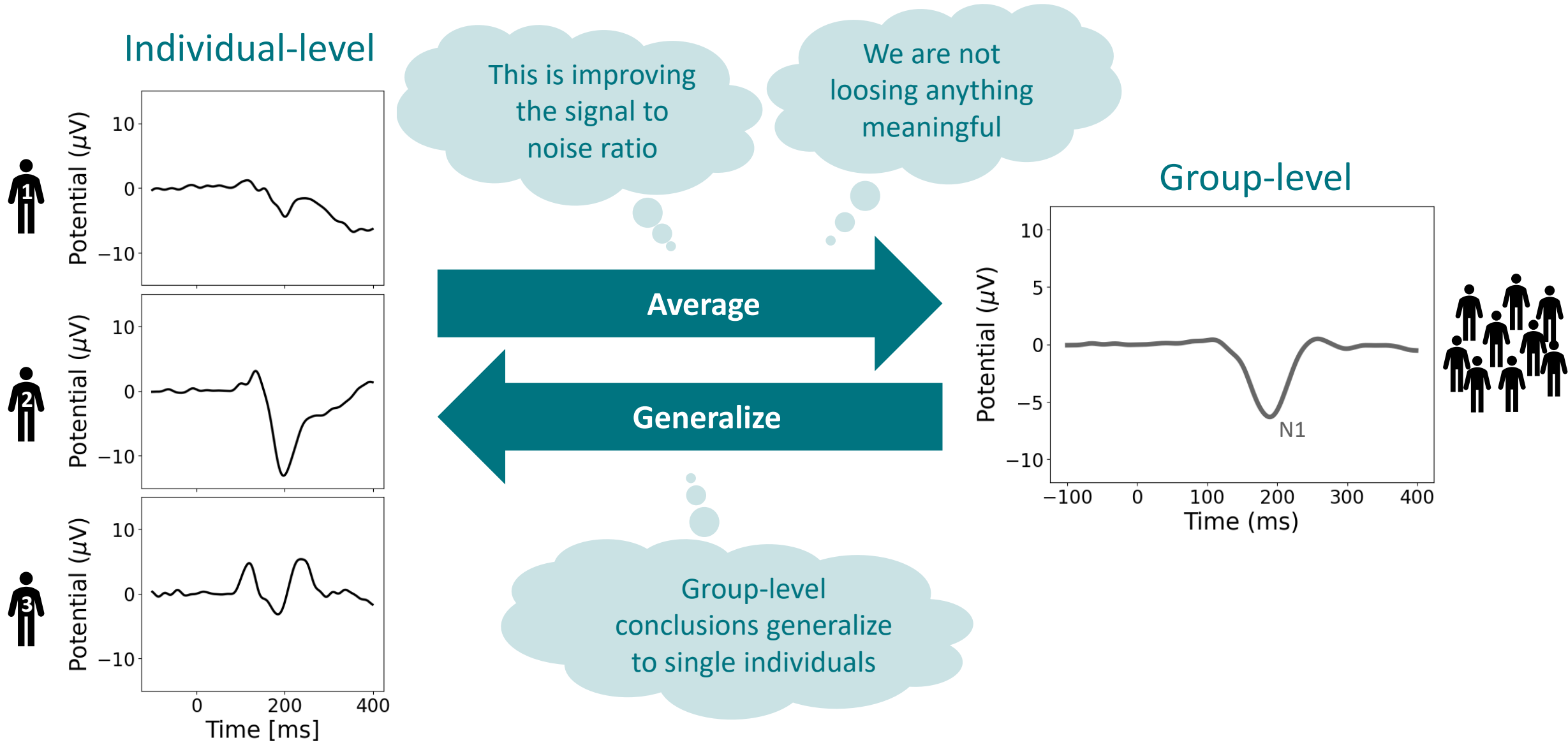


Dr. Dario Gordillo, Prof. Eka Chkonia, Maya Roinshvili, Prof. Michael Herzog

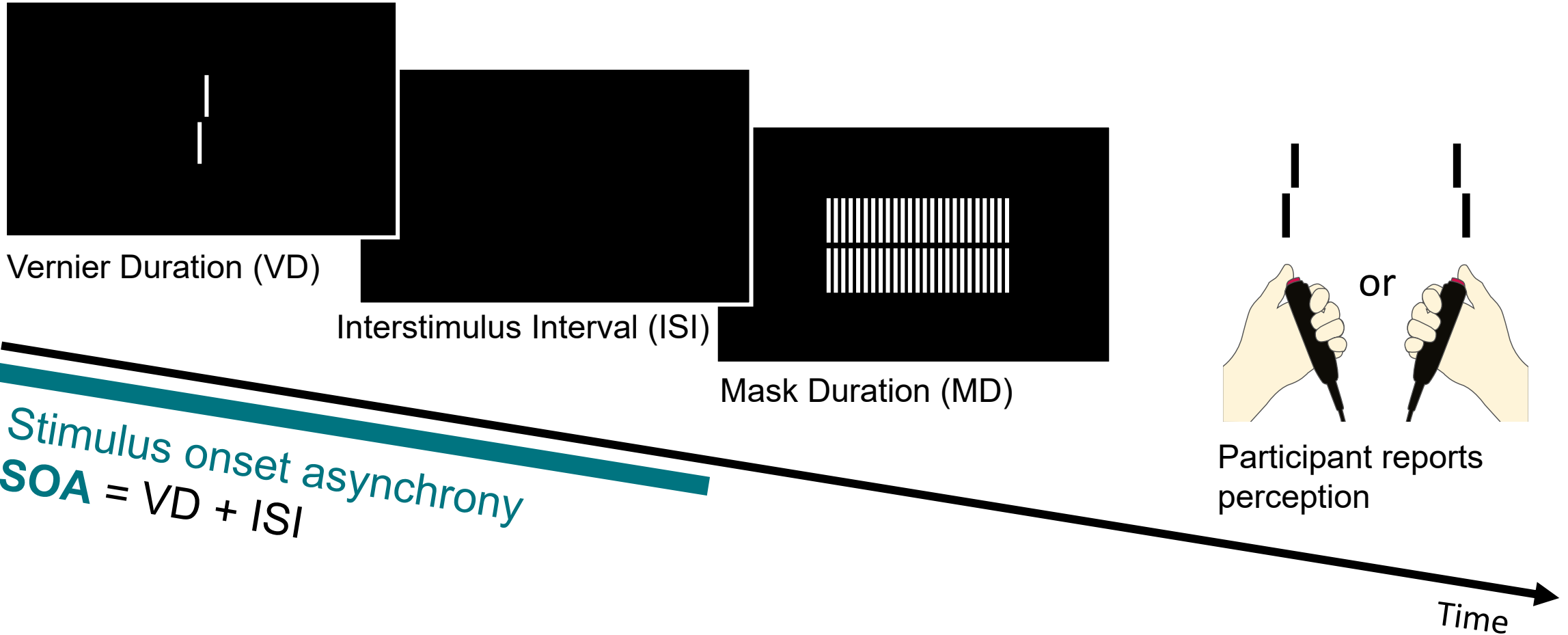
Melissa Faggella

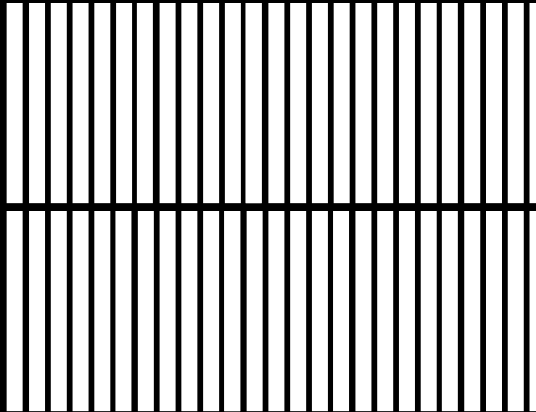
Brain Mind Institute  
Laboratory of Psychophysics

# Individual differences in event-related potentials (ERP)

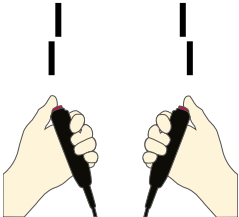


# Visual Backward Masking (VBM)



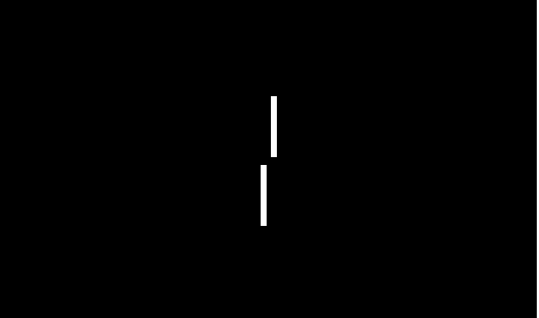


# EEG Visual Backward Masking paradigm



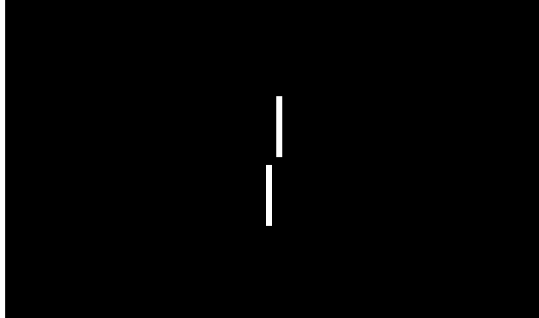
## Vernier only

VD : 30 ms



## Short SOA

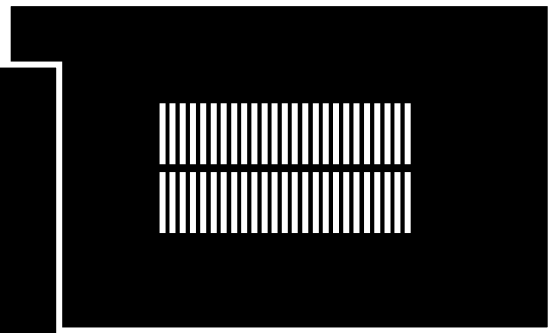
VD : 30 ms



ISI : 30 ms

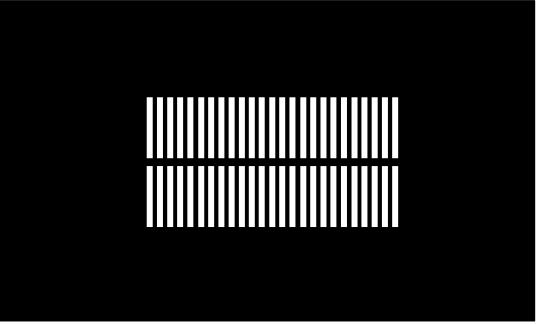


MD : 300 ms



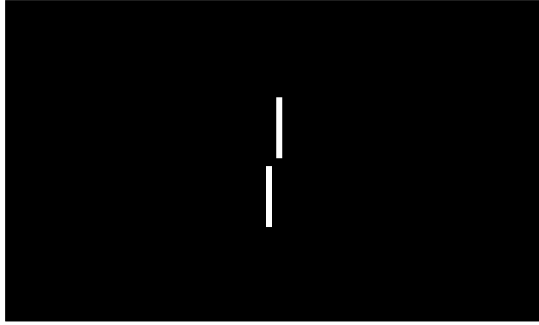
## Mask only

MD : 300 ms

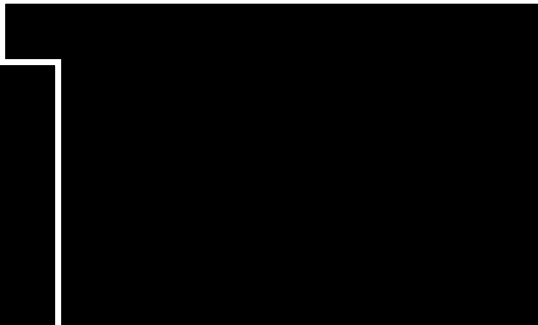


## Long SOA

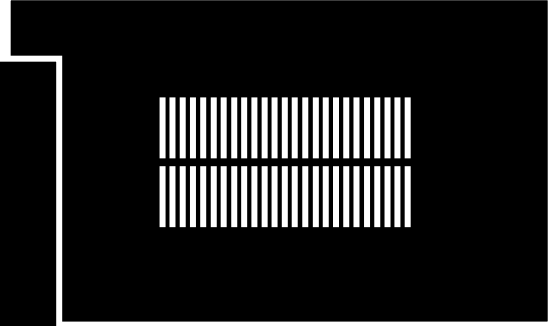
VD : 30 ms






ISI : 120 ms



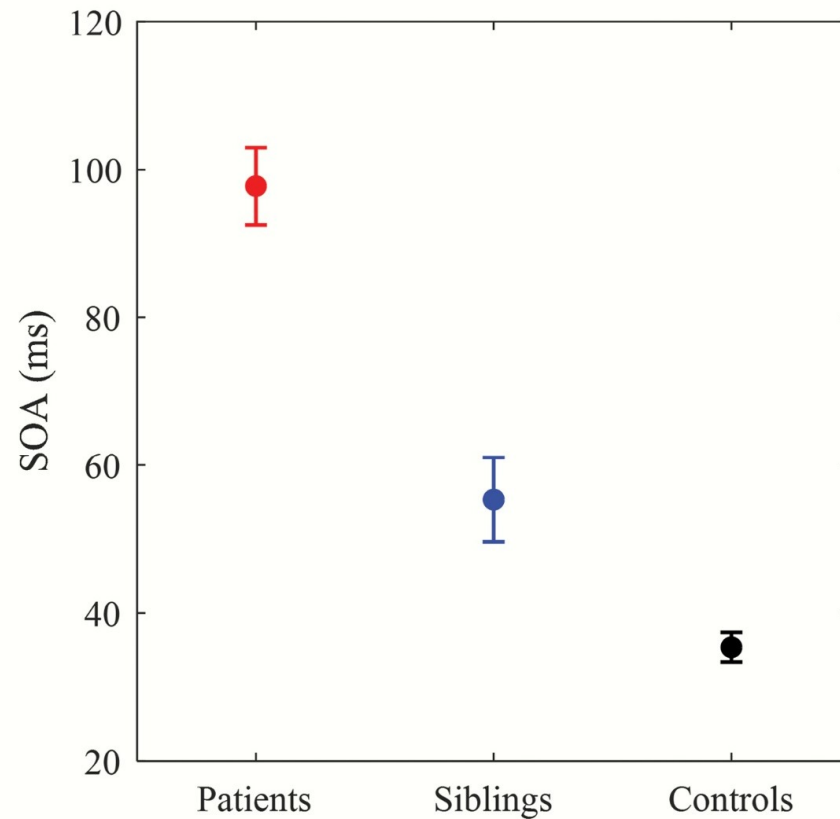
MD : 300 ms



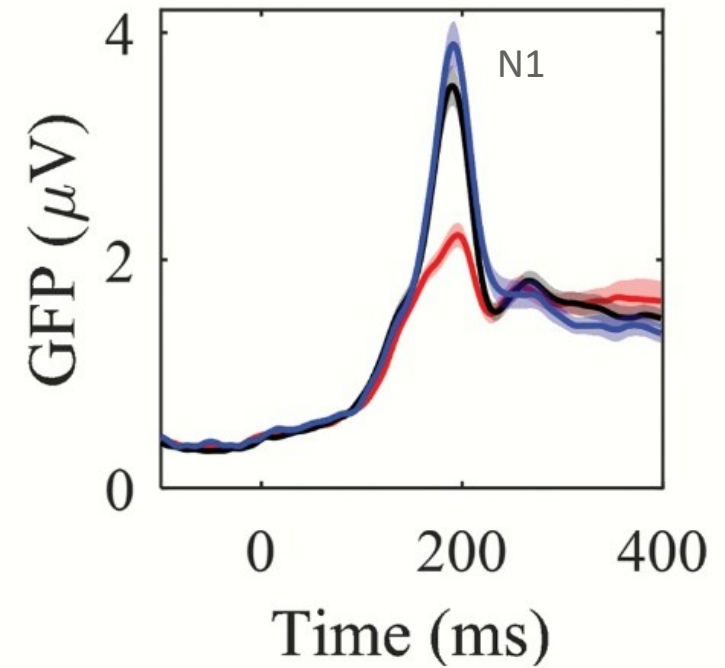
# Visual Backward Masking (VBM)

-  Schizophrenia Patients (SZ)
-  Patients First-Degree Relatives (REL)
-  Healthy Controls (CON)




## Behavioural paradigm



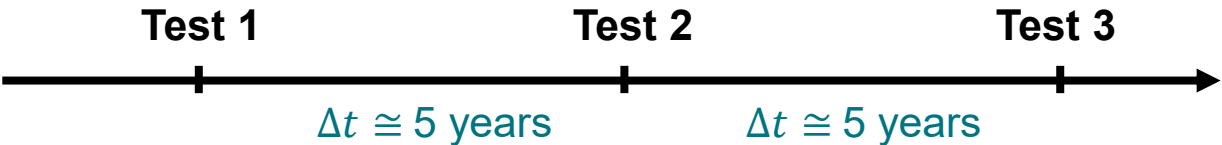
## Electrophysiological paradigm



# Longitudinal study design

-  Schizophrenia Patients (SZ)
-  Patients First-Degree Relatives (REL)
-  Healthy Controls (CON)

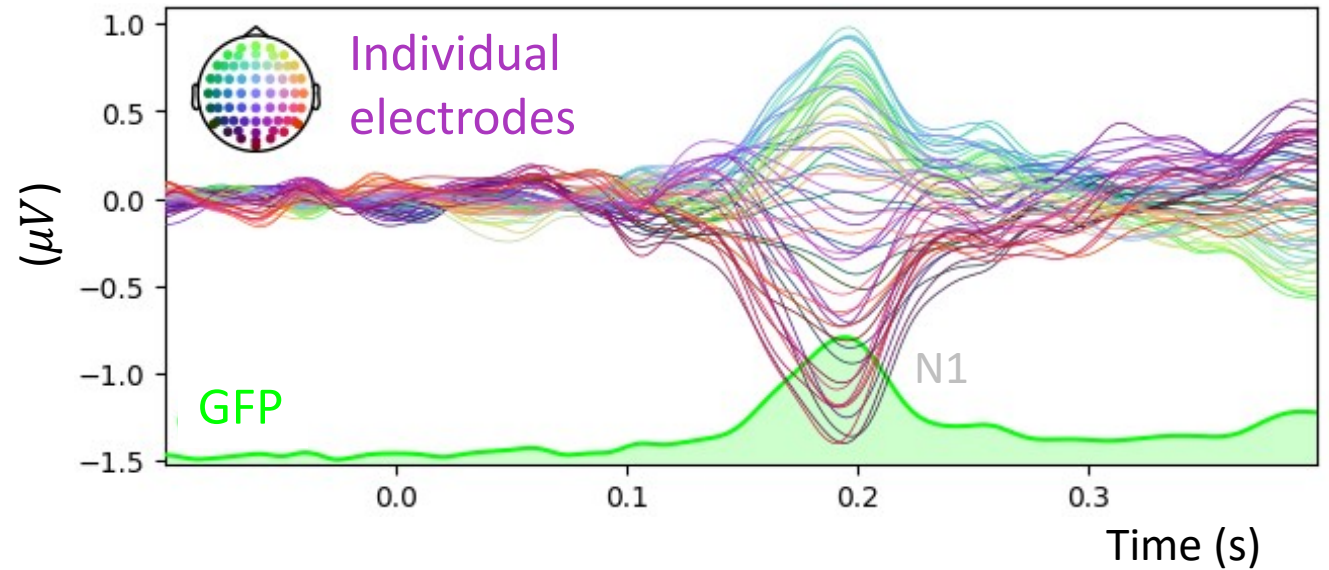
N	1st Testing			2nd Testing			3rd Testing		
	SZ	REL	CON	SZ	REL	CON	SZ	REL	CON
EEG paradigm	146	67	98	34	24	32	13	7	15



# Global Field Power (GFP)

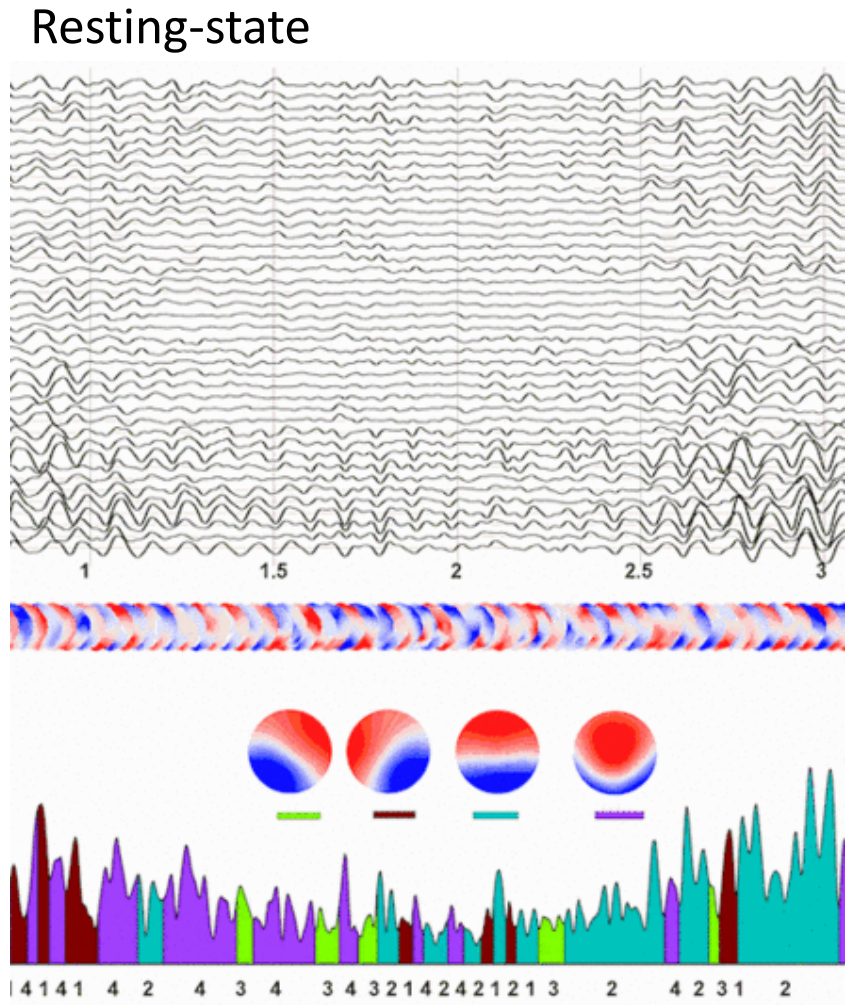
**Global field power (GFP)** quantifies the total amount of activity from all recording electrodes at each time point

$$GFP(t) = \sqrt{\sum_{i=1}^n \frac{(u_i(t) - \bar{u}(t))^2}{n}}$$



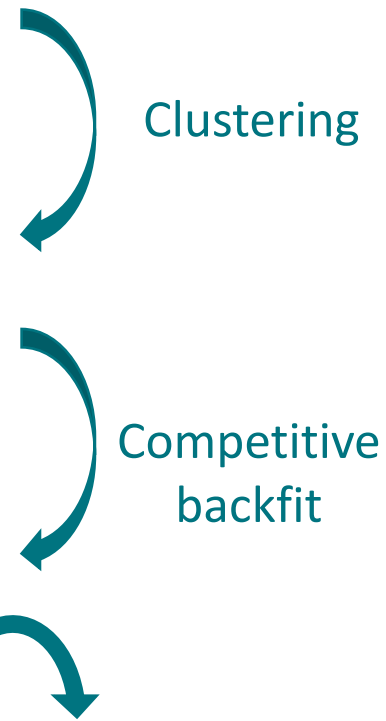
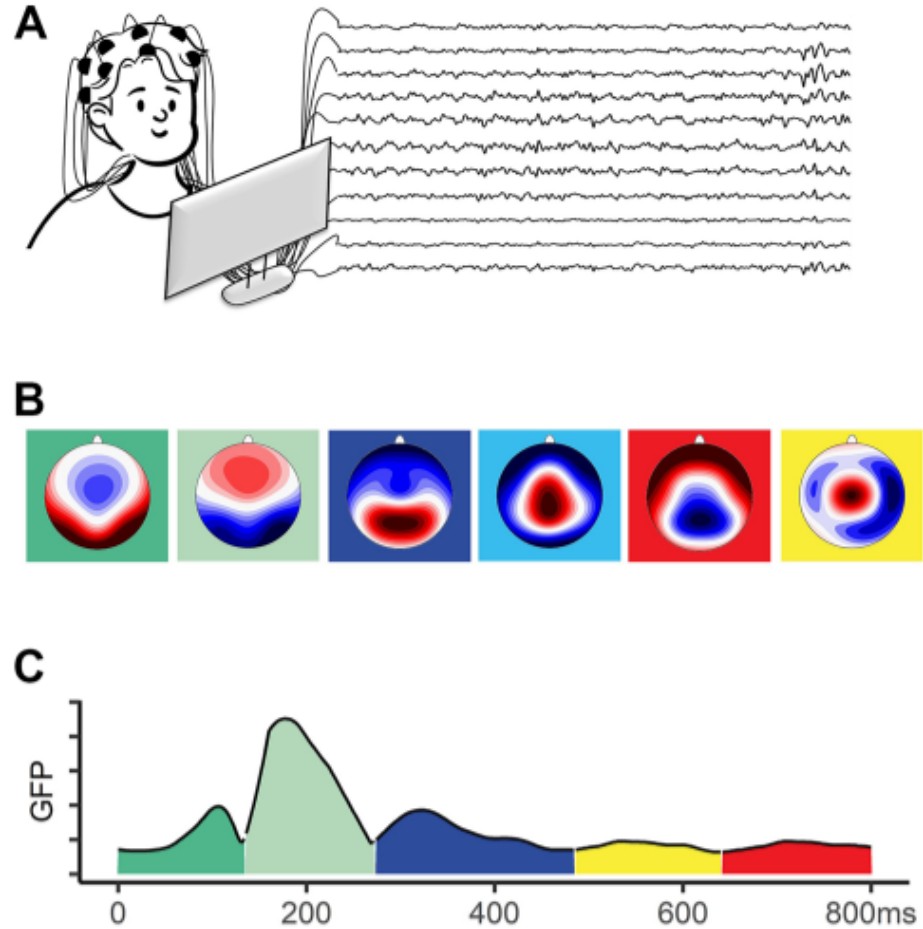


# Microstates analysis



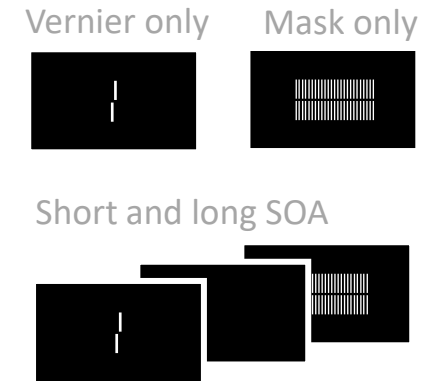
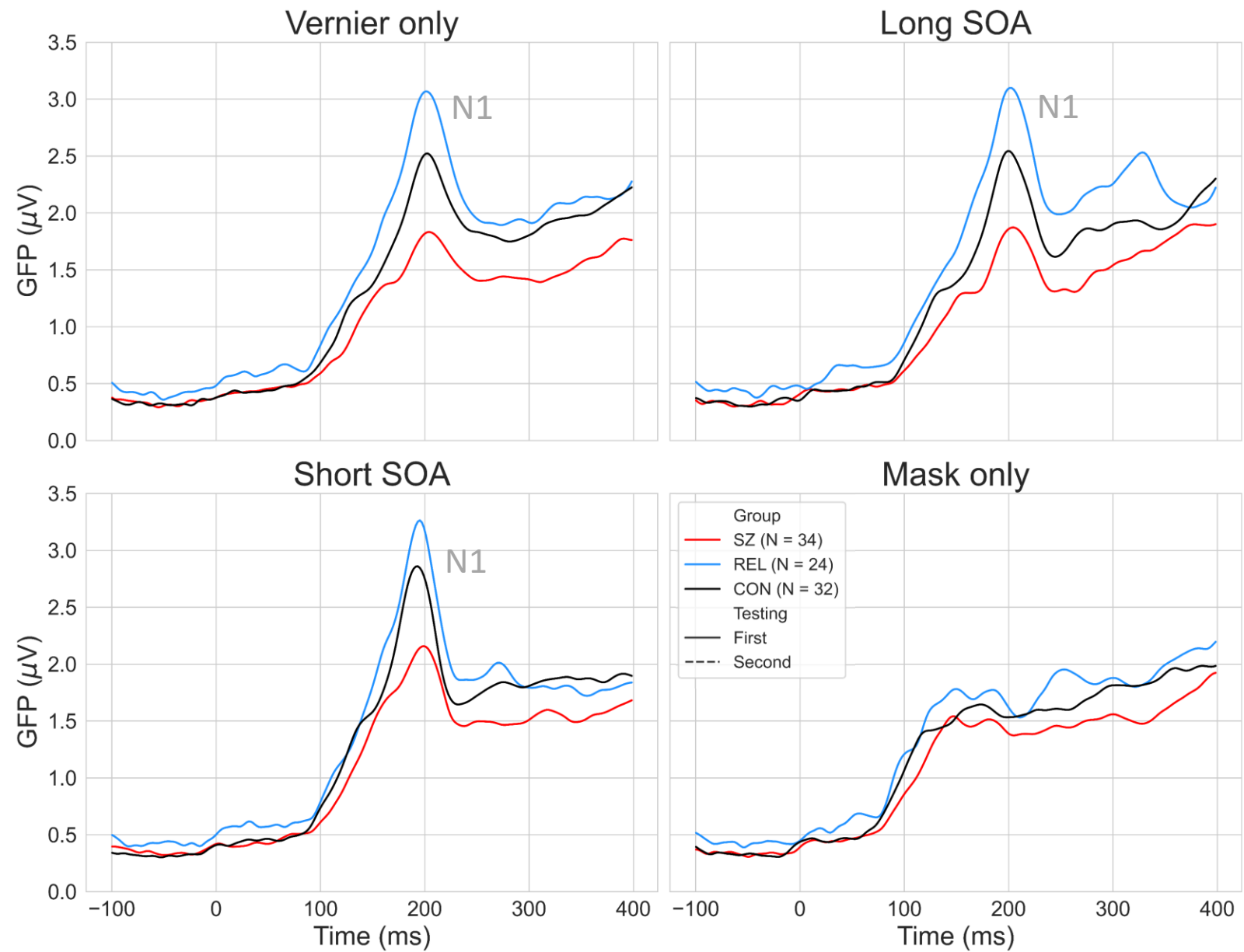
**Microstate:** brief, semi-stable EEG pattern that lasts few tens of ms

## Event-related potential



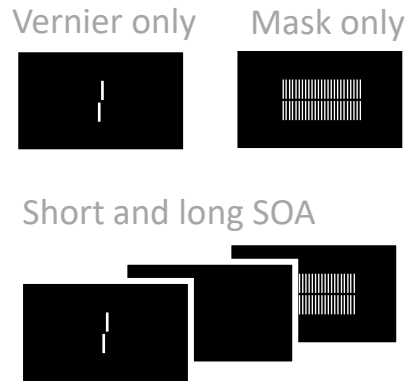
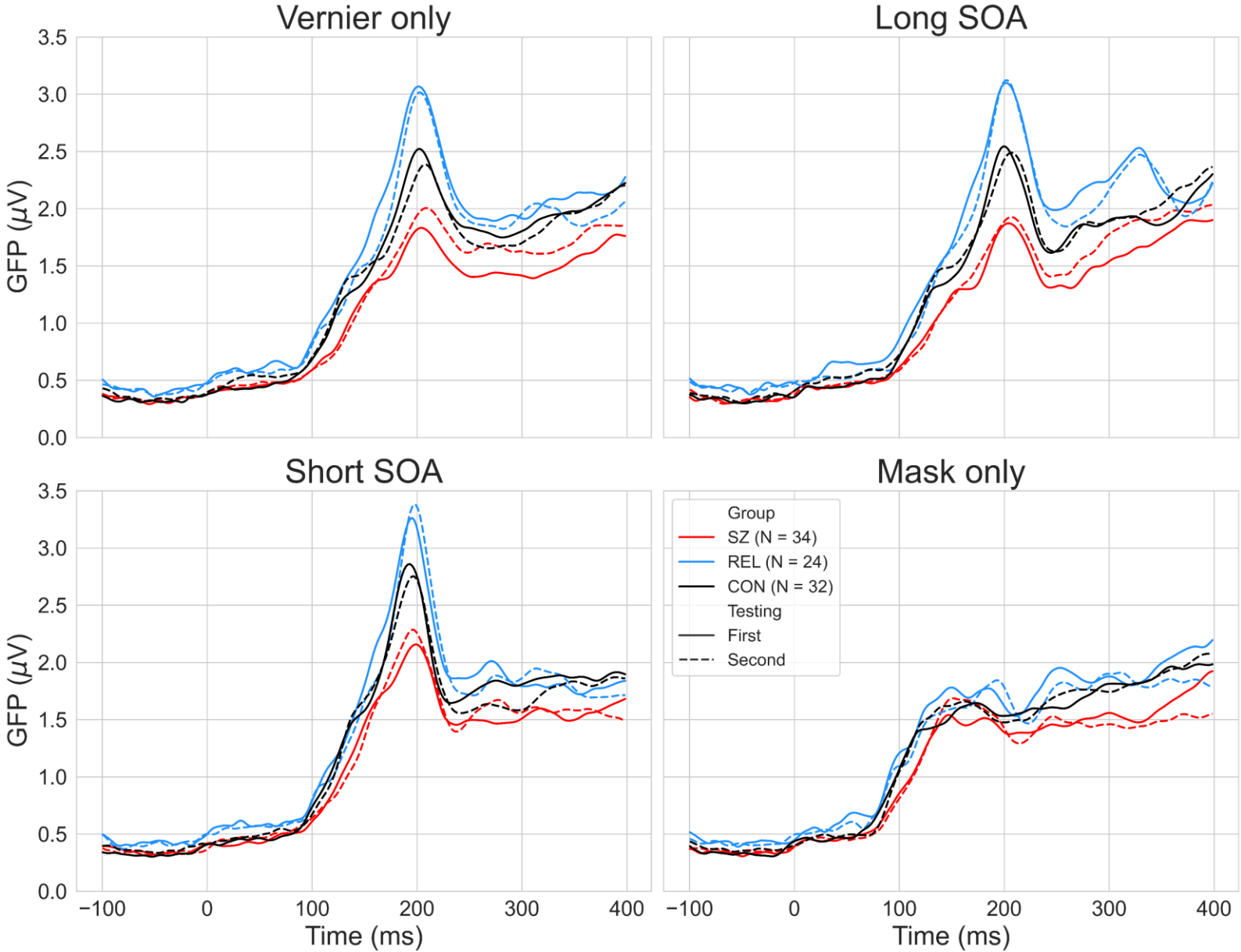
Dietrich Lehmann et al. (2009) EEG microstates. Scholarpedia, 4(3):7632.  
 Schiller, B., Sperl, M. F., Kleinert, T., Nash, K., & Gianotti, L. R. (2023). EEG microstates in social and affective neuroscience. Brain topography, 1-17.

# Cross-sectional Group-level Global Field Power



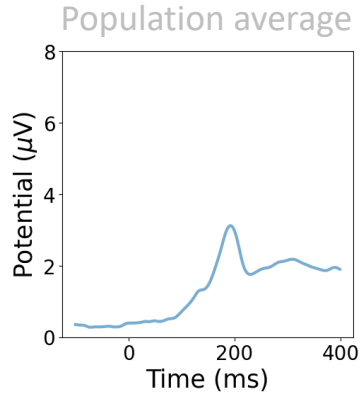
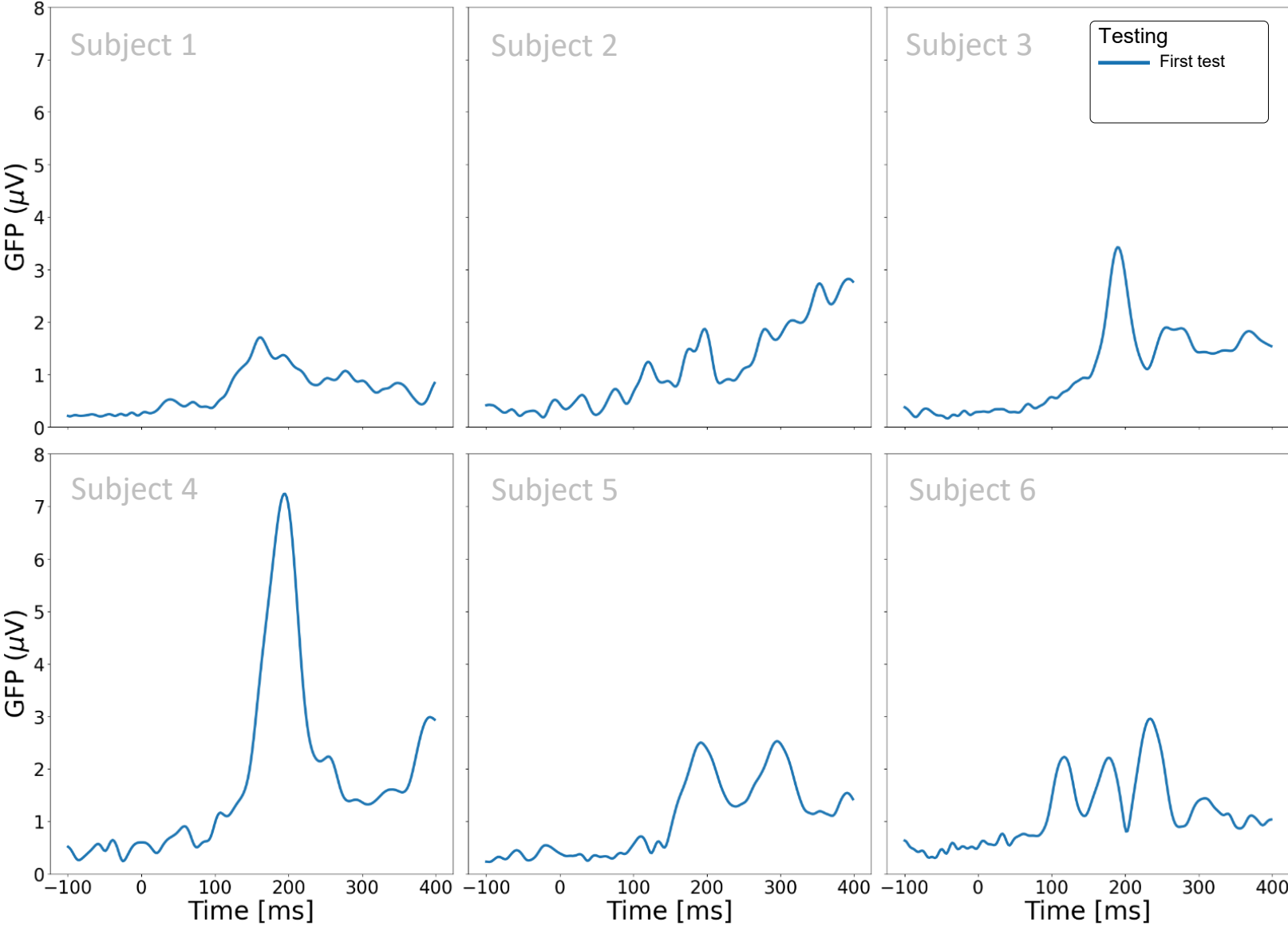
# Longitudinal Group-level Global Field Power

First & second testings  
 $\Delta t_1 = 5.1$  years



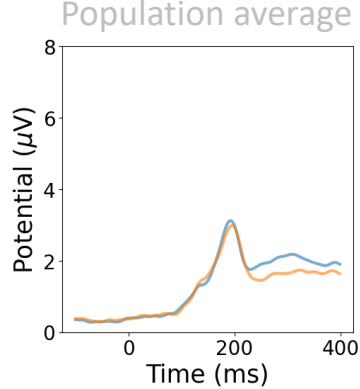
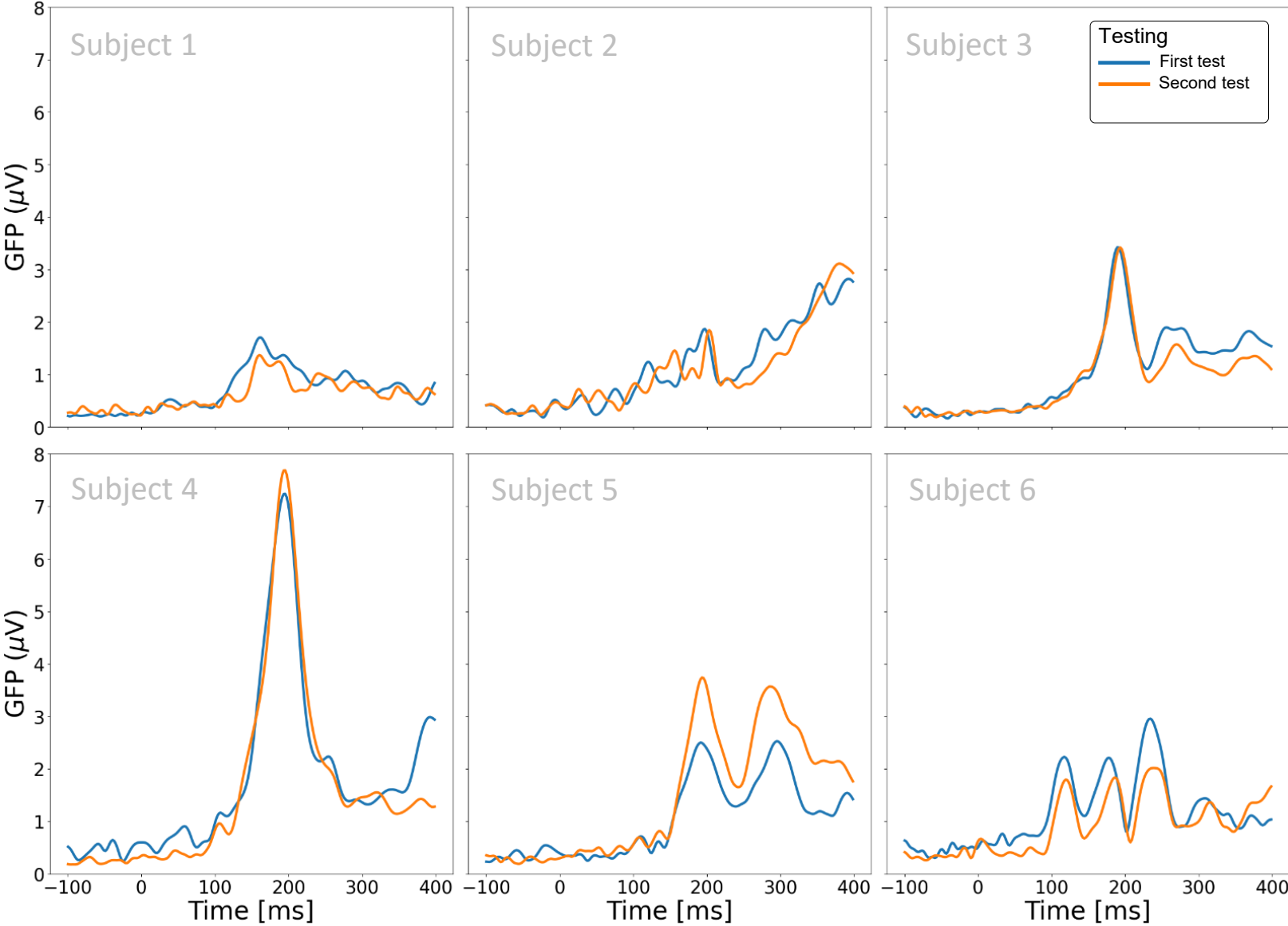
# High inter-individual variability

Short SOA condition  
First testing



# High intra-individual stability

Short SOA condition  
 $\Delta t_1 = 5.1$  years

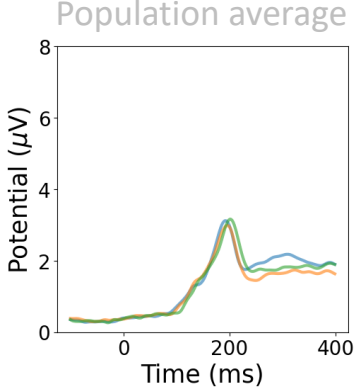
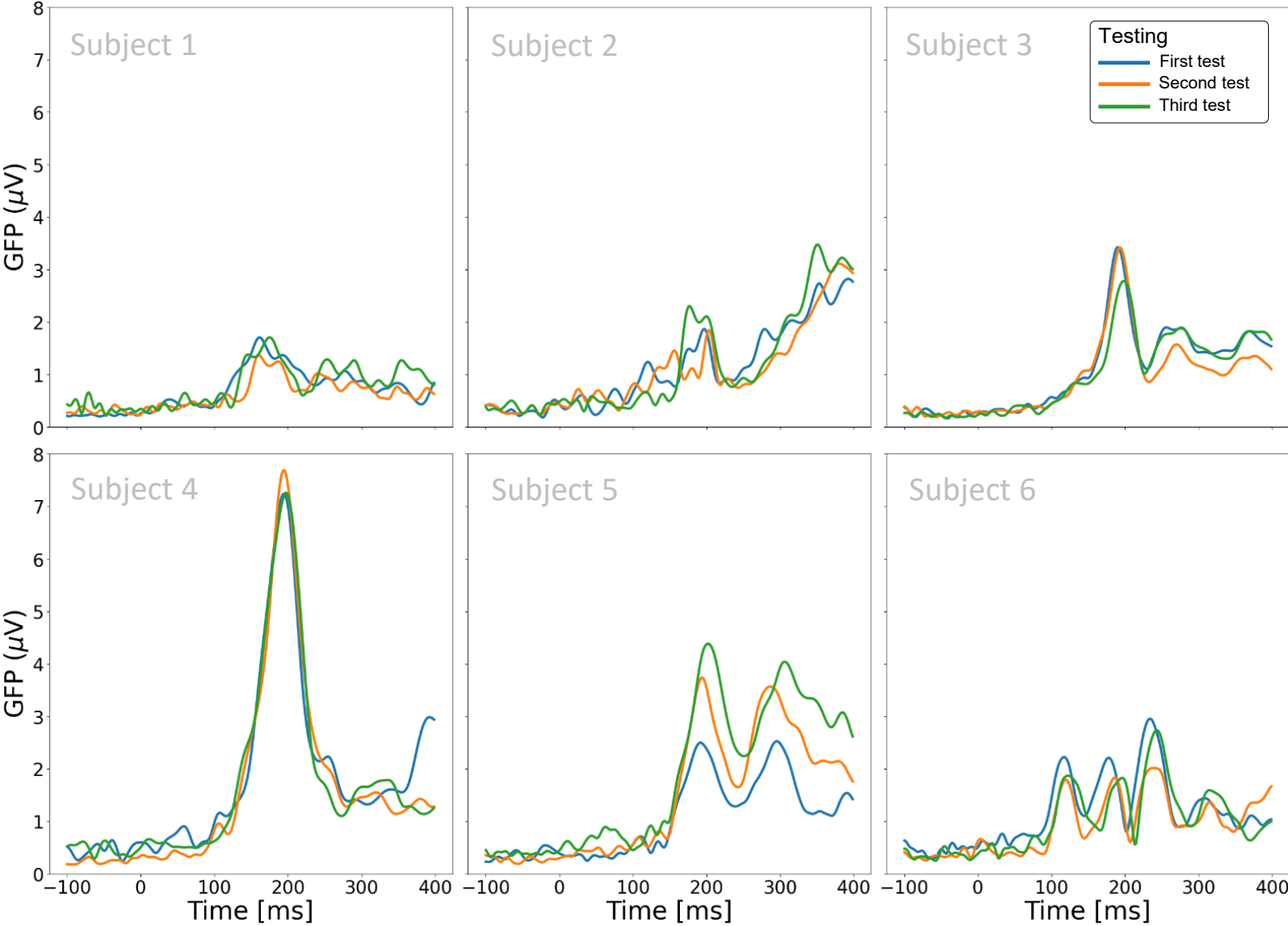


# High intra-individual stability

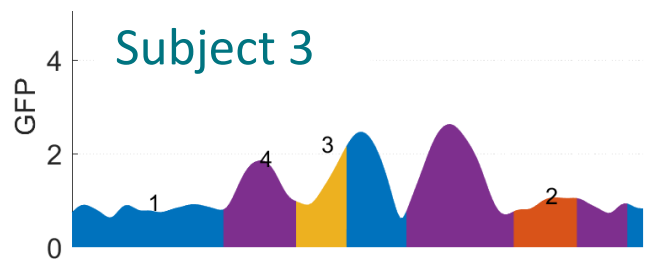
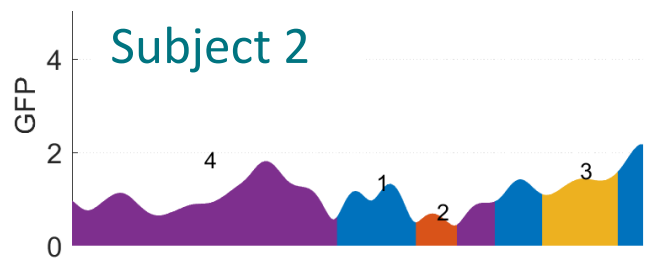
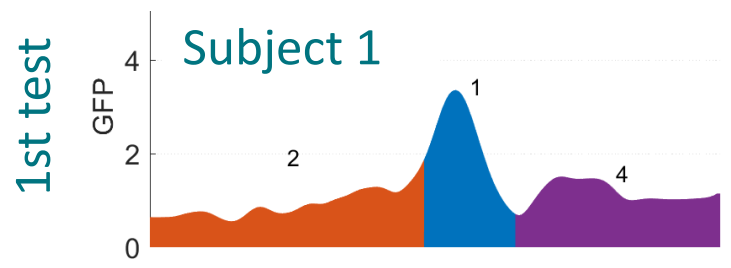
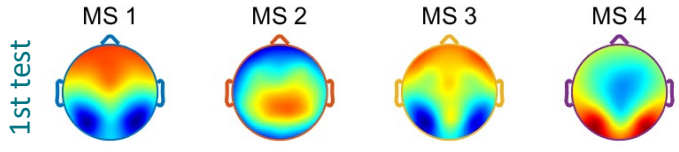
Short SOA condition

$\Delta t_1 = 5.1$  years

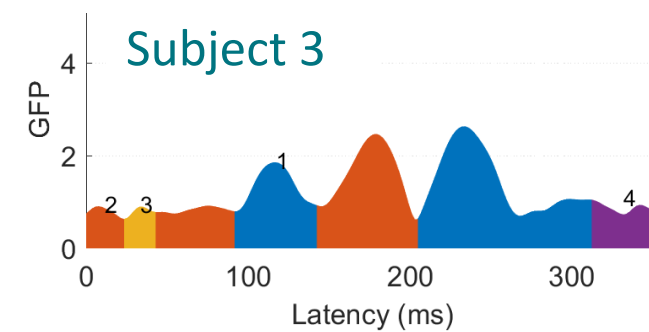
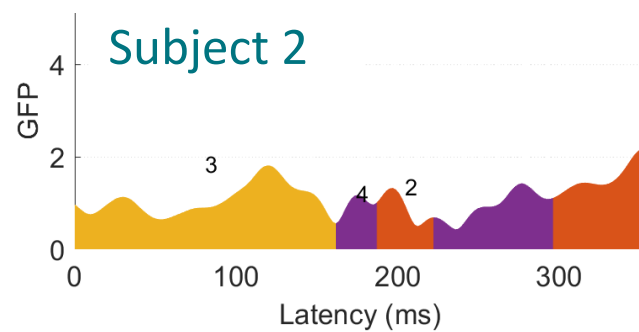
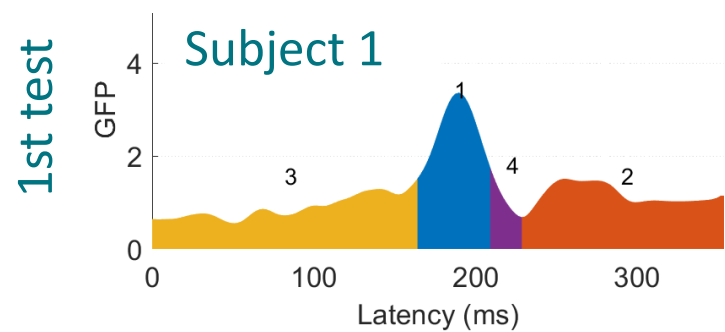
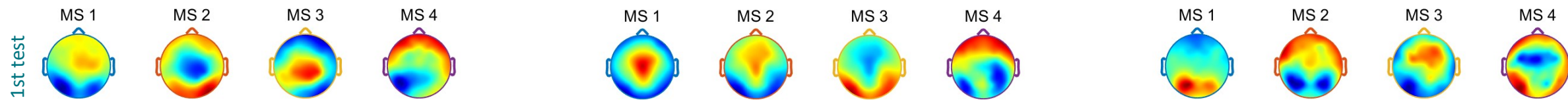
$\Delta t_2 = 5.3$  years



# Group-level ERP microstates



# Individual-level ERP microstates



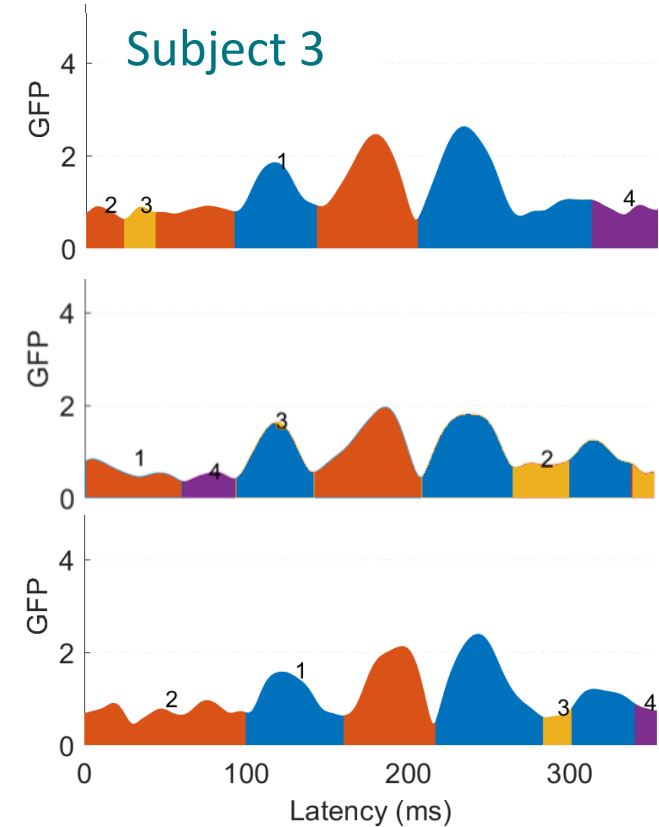
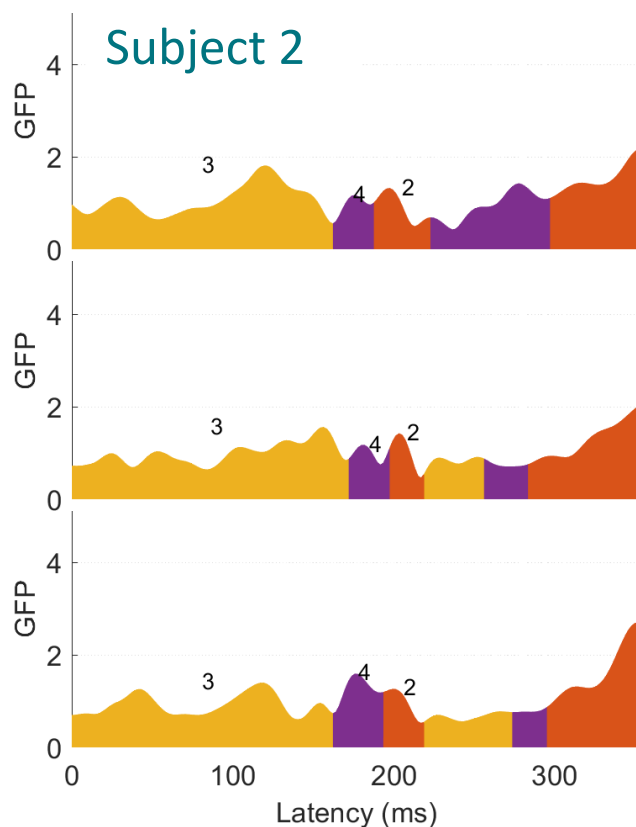
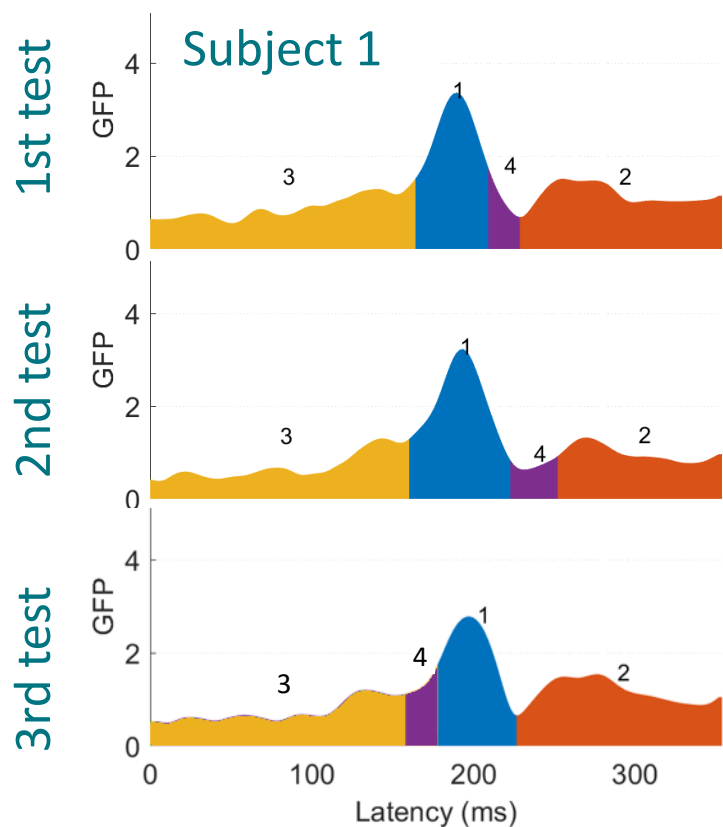
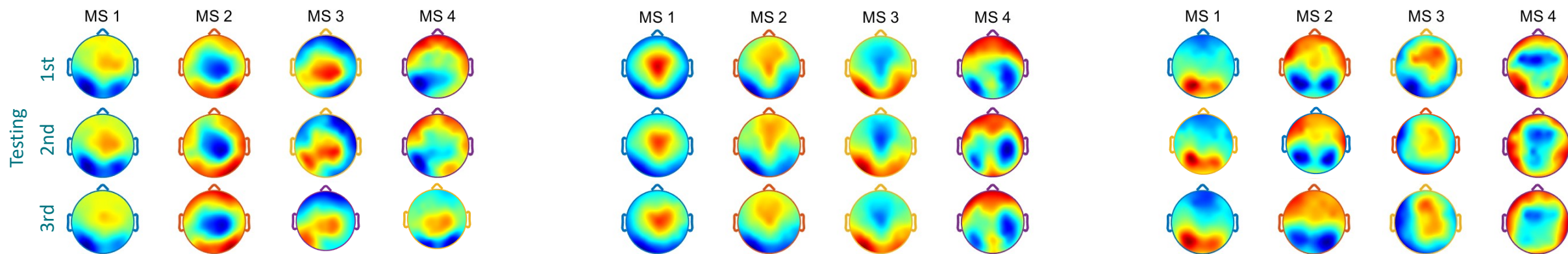


# Individual-level ERP microstates

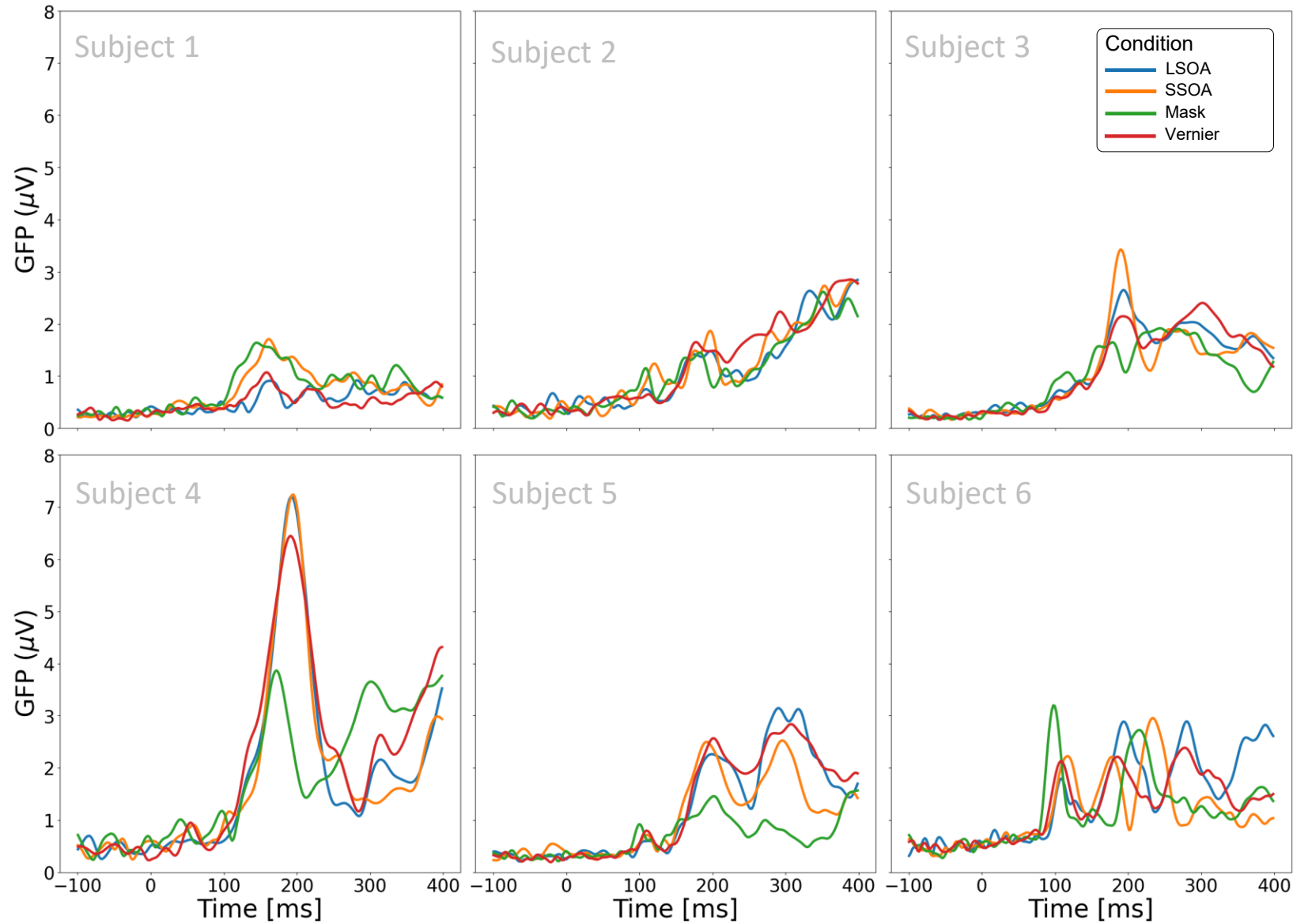
Short SOA condition

$\Delta t_1 = 5.1$  years

$\Delta t_2 = 5.3$  years



# Consistency accross conditions



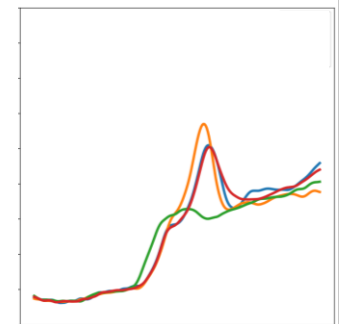
Vernier only      Mask only



Short SOA & Long SOA

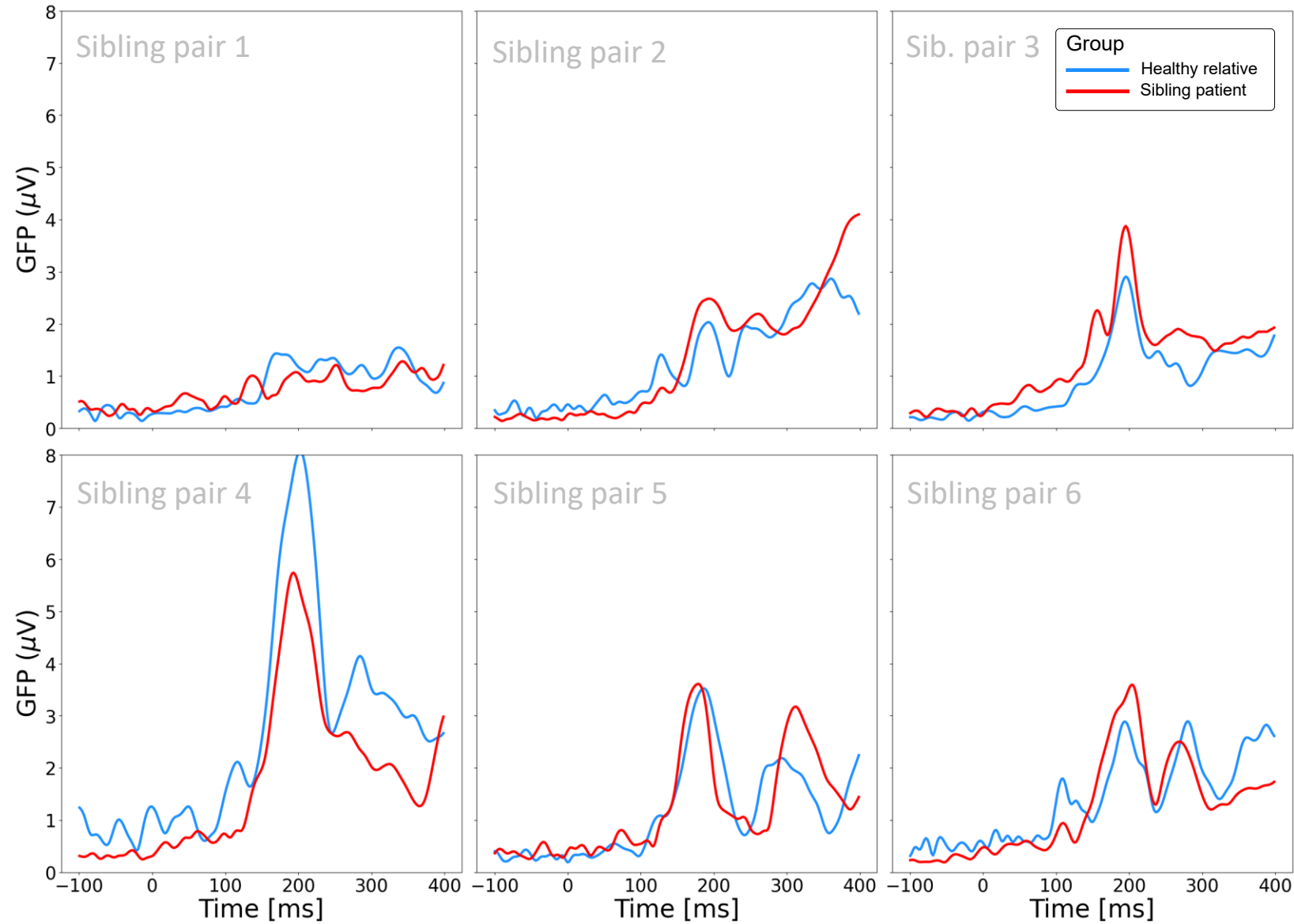


Group-average



# Consistency accross siblings

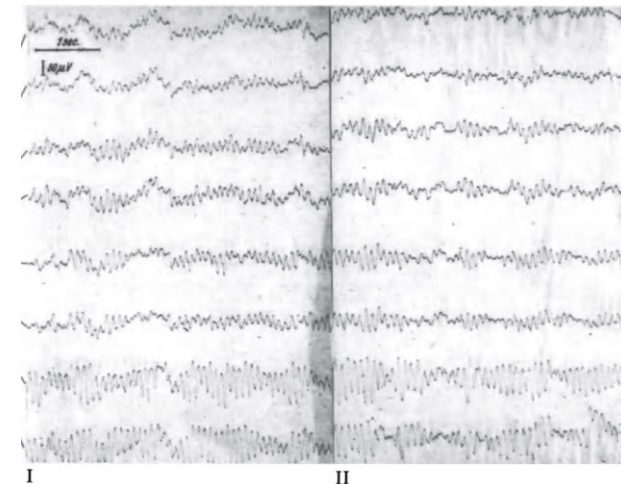
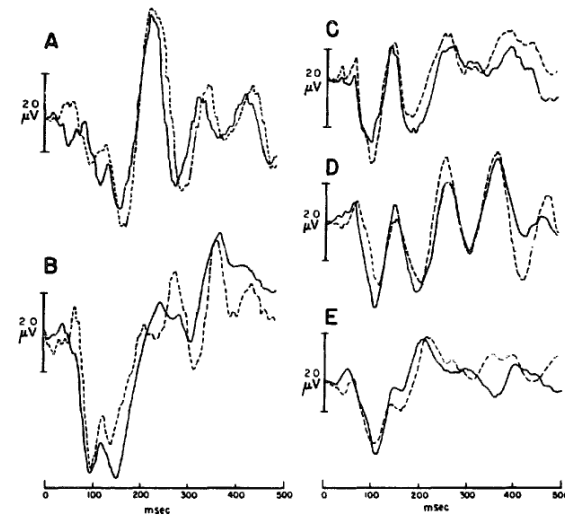
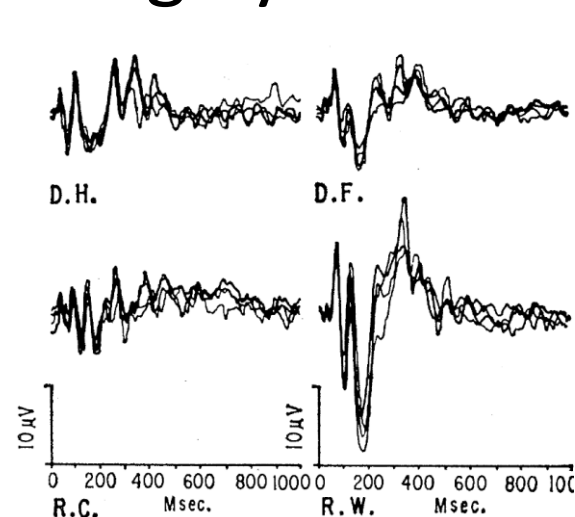
First testing  
Long SOA condition



# Stable individual differences in EEG

## Event-related potentials (across time, space and stimuli) and the properties of resting-state EEG are:

- Highly stable in time within individuals
- Highly variable across individuals
- Largely heritable

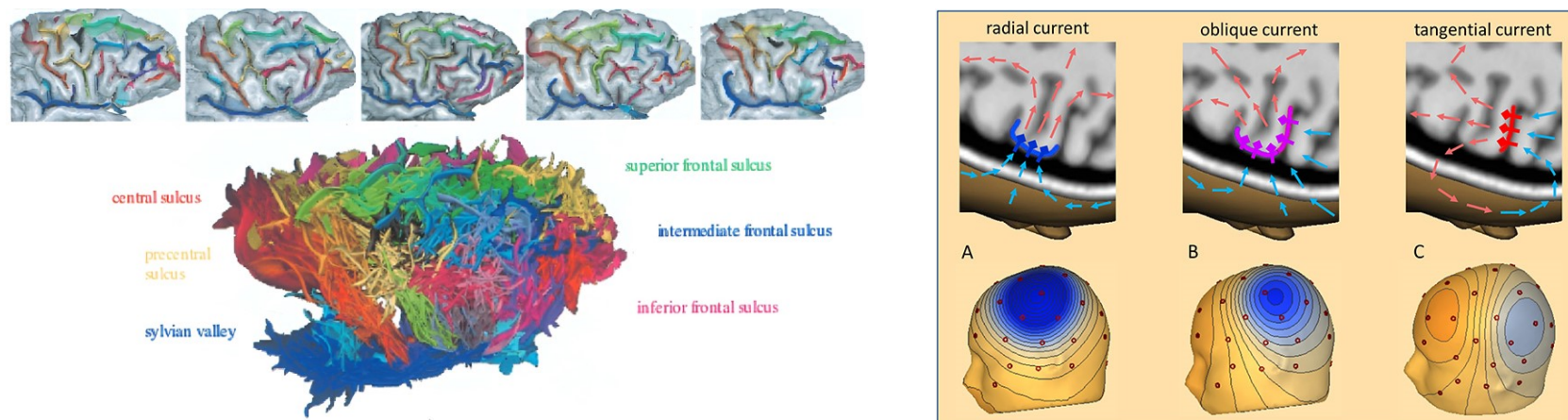


# Anatomical hypothesis

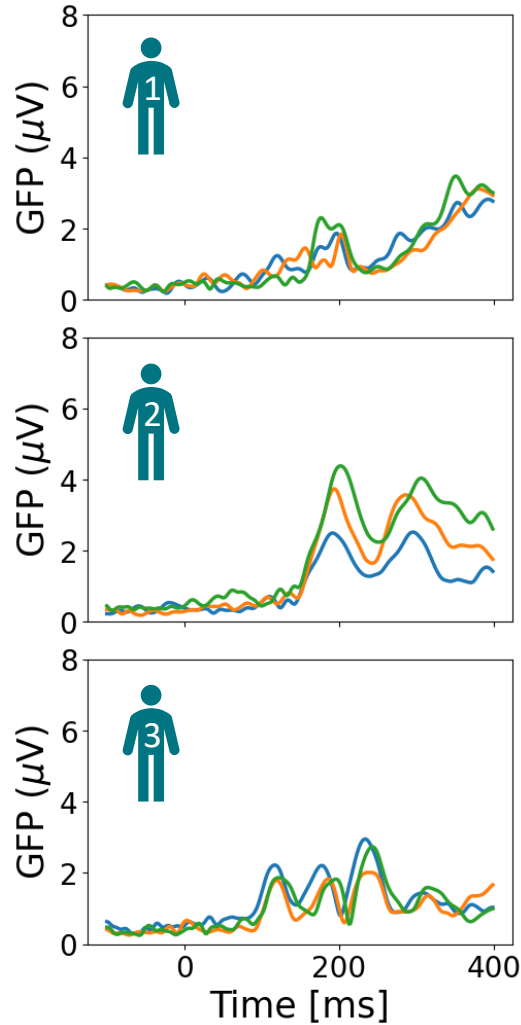
**Individual differences in event-related potential might arise from individual differences in anatomy e.g. in cortical folding patterns**

**The EEG signal is influenced by distance and orientation of the source**

- Signal amplitude decrease sharply with distance from the source
- Tangential sources are underrepresented relatively to perpendicular sources
- Sulcal sources are underrepresented relatively to gyral sources



# Take-home messages



Individual differences in event-related potentials are stable across:

- Time
- Pairs of siblings

They might contain relevant information about the subjects' anatomy

Group averaging might lead to spurious conclusions



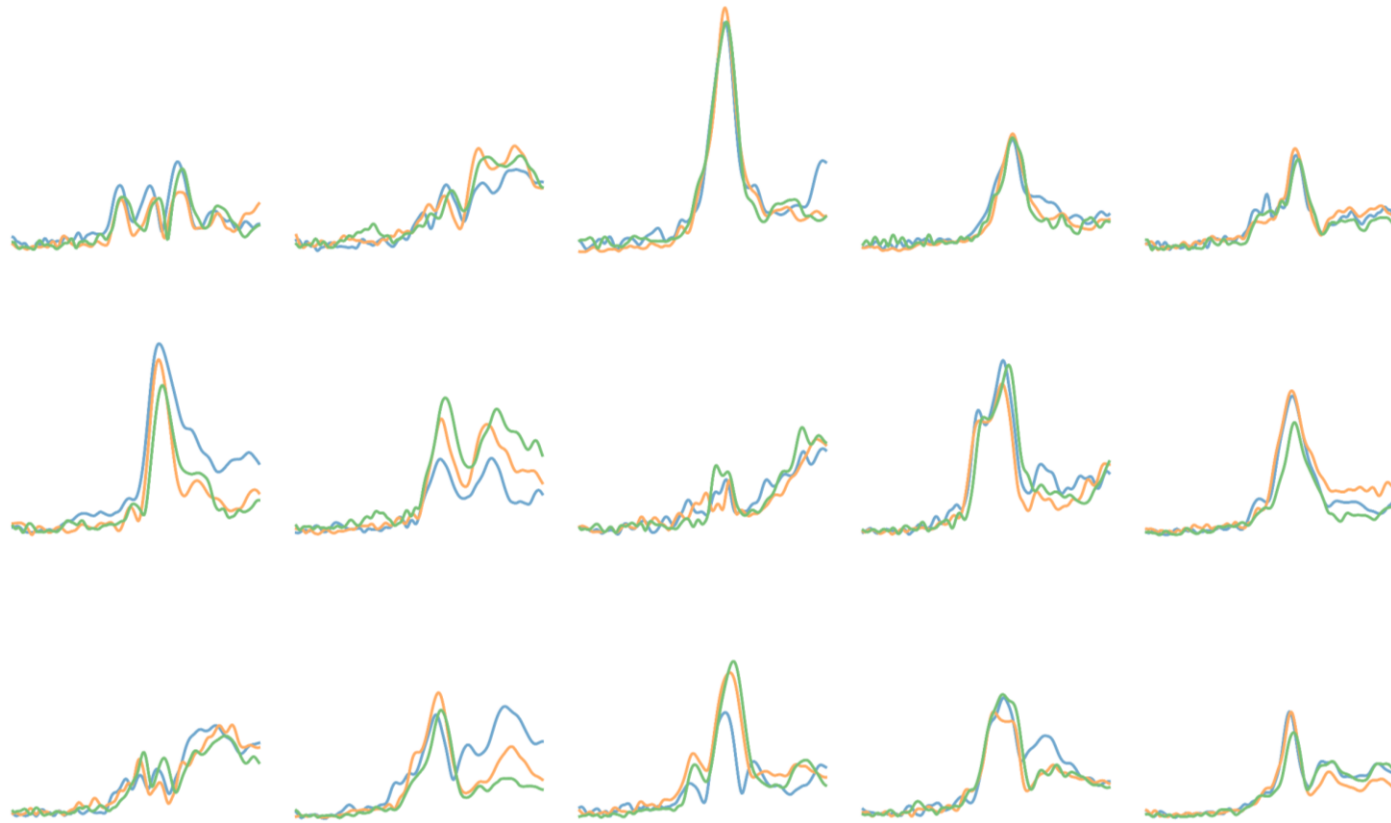
# Thank you for your attention !



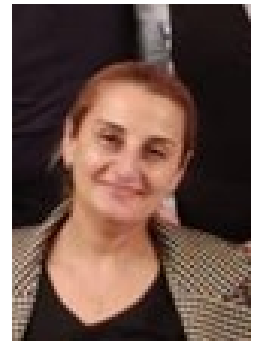
Prof. Michael Herzog



Dr. Dario Gordillo



Prof. Eka Chkonia



Maya Roinshvili

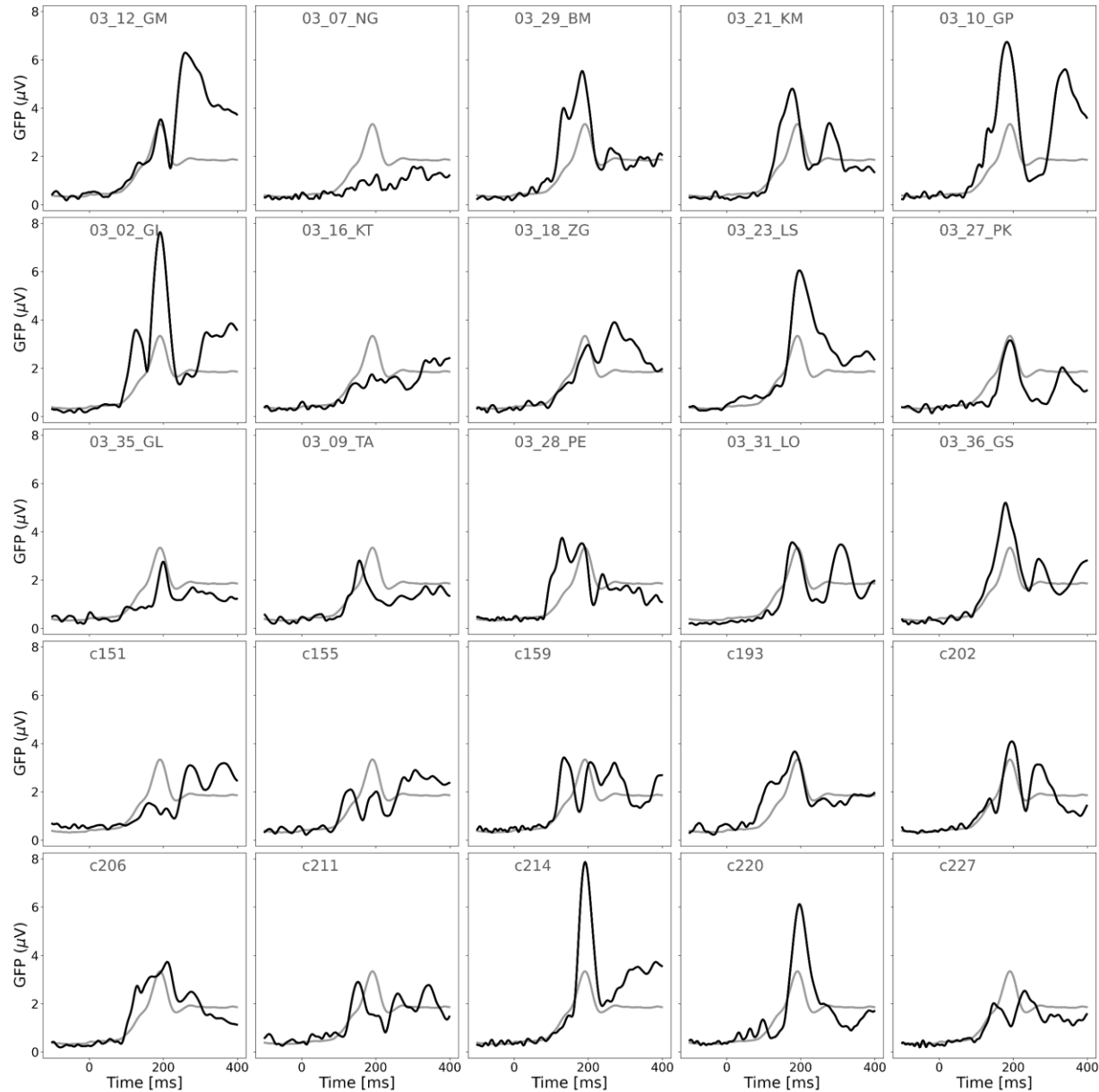
Supplementary slides



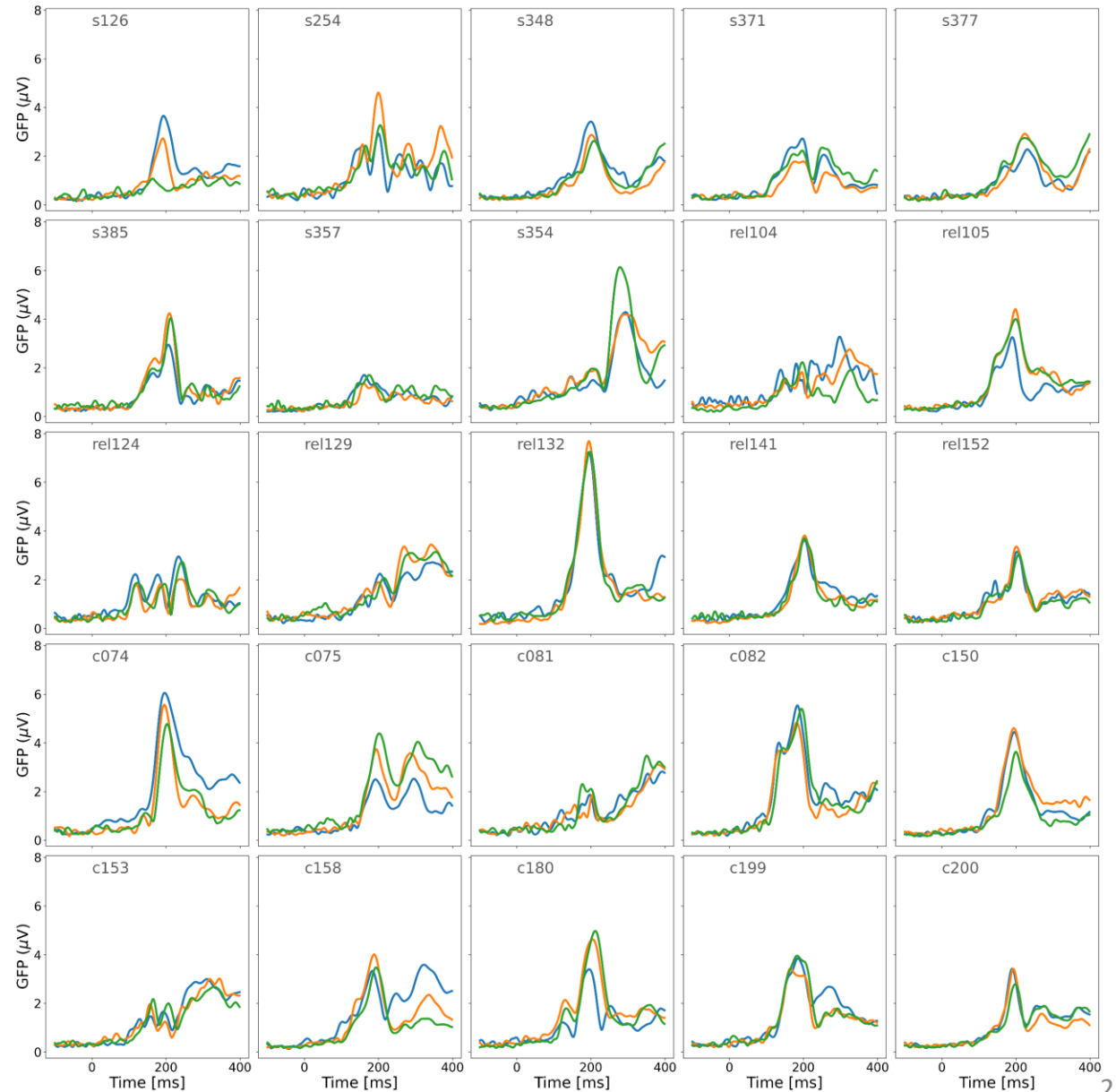
# Inter-individual variability

Level of analysis  
— Individual-level  
— Group-level

Testing  
— First test  
— Second test  
— Third test



# Intra-individual stability



# Across siblings

Level of analysis  
— Individual-level  
— Group-level

Testing  
— First test  
— Second test  
— Third test

# Across conditions

