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## Simultaneous EEG-fNIRS explore somatosensory prediction in the premature neonate brain

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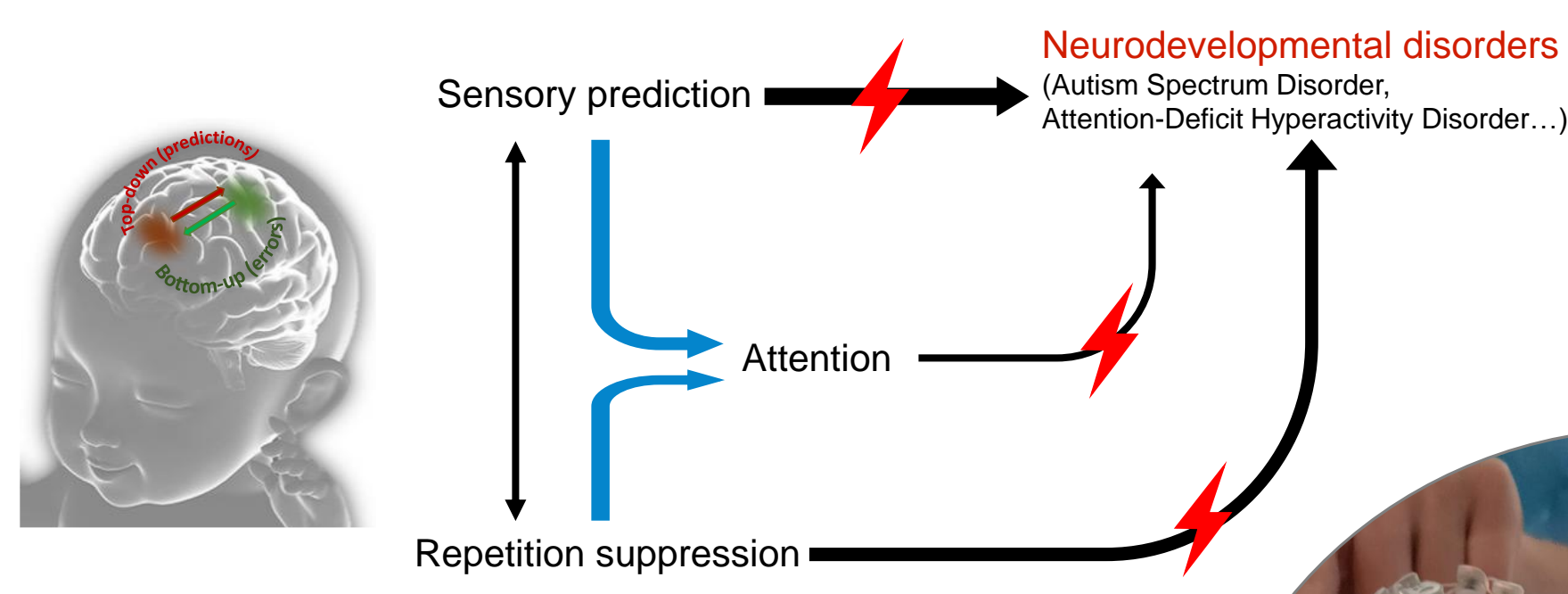
## 01 THEORETICAL BACKGROUND

### Predictive coding

- **Predictive coding** proposes that the brain is inherently predictive about the environment (Friston, 2005). These predictions can be observed through various phenomena such as:
  - **sensory prediction**, the neural anticipation of future stimulation on the basis of previous sensory inputs
  - **repetition suppression**, the decrease of cerebral activity to a repeated stimulus after a stable representation is formed, thus correctly predicted
- Predictions are **necessary to optimize** behavioral responses and the use of **attentional and energy resources**
- Sensory prediction and repetition suppression can be **altered in neurodevelopmental disorders** (NDD) like attention deficit disorders (Gonzalez-Gadea *et al.*, 2015)
- Predictive abilities were recently described in preterm infants in the tactile modality (Dumont *et al.*, 2022)

### Tactile modality

- Somatosensory inputs are numerous from birth and touch ontogenetic anteriority makes it the **foundation of neurosensory integration, and motor, cognitive and affective development** (Cascio, 2010)
- The tactile modality and the cognitive functions relying on it are often **altered in NDD** (Zoenen & Delvenne, 2018)



## 02 AIM & HYPOTHESIS

### Describe somatosensory prediction and repetition suppression in preterm neonates

#### Hypotheses

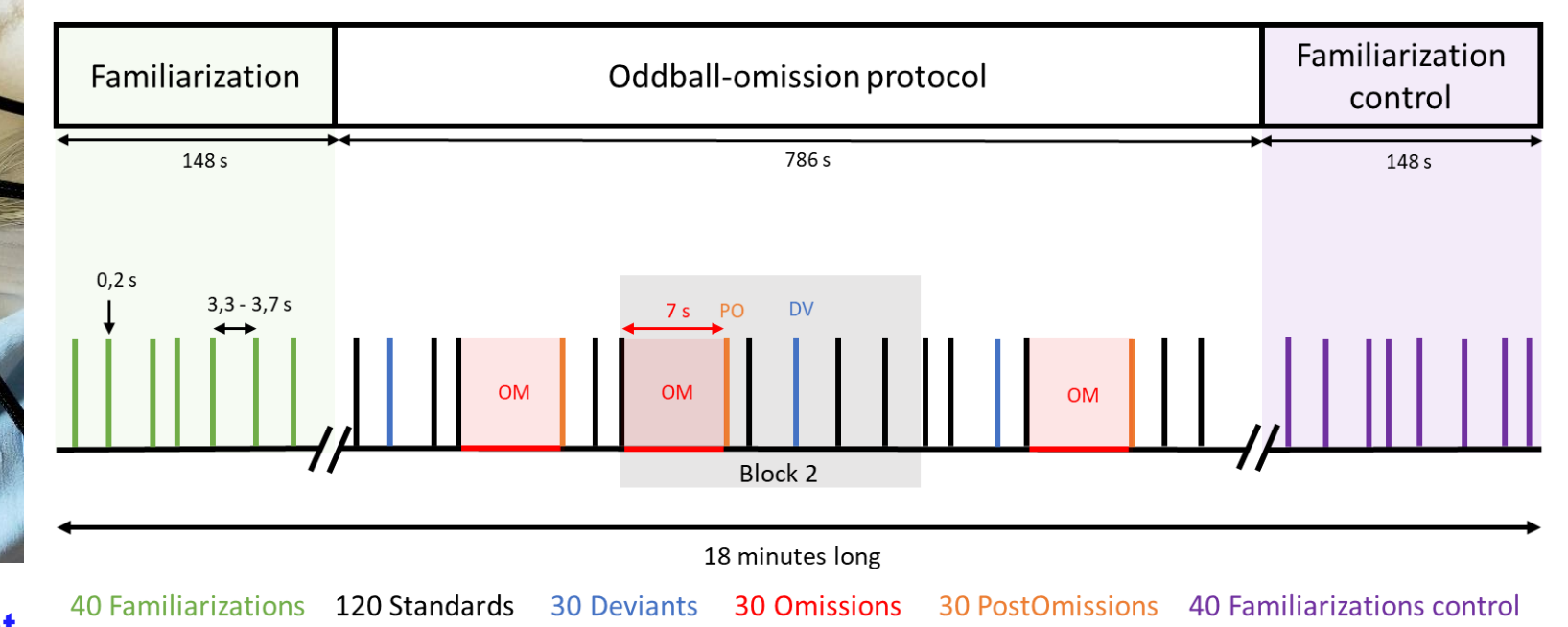
- Neonates will show **repetition suppression in the somatosensory and frontal cortices**: decrease of the neuronal activation between the **familiarization** and the **control** phases of the tactile stimulation sequence.
- Neonates will show a larger **early response** in the **somatosensory cortex** and a **late frontal response** to **deviance** (rare stimuli in the sequence).
- Neonates will have an **increase of HbO** during the **omission** in the somatosensory cortex, and a **late frontal response on EEG**.

## 03 MATERIAL & METHODS

### Current population

N = 30 of 90 (32,64 ± 2,24 SA at birth, 13 ♀), 13 had simultaneous EEG/fNIRS

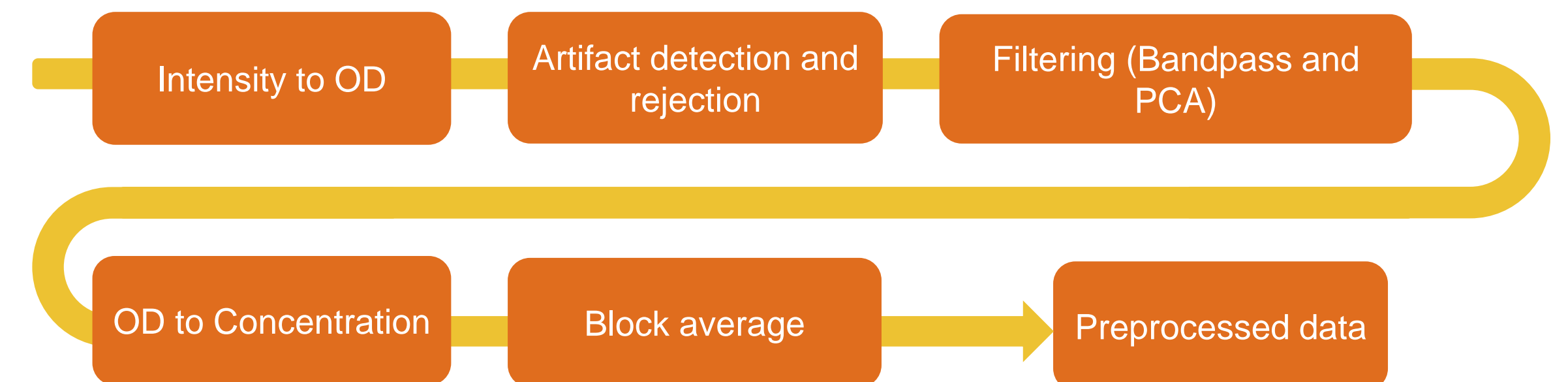
### Oddball-omission protocol



Counter-balanced **standard vs. deviant** stimulation on the custom-made vibratory matrix, then placed on a fully-equipped preterm neonate

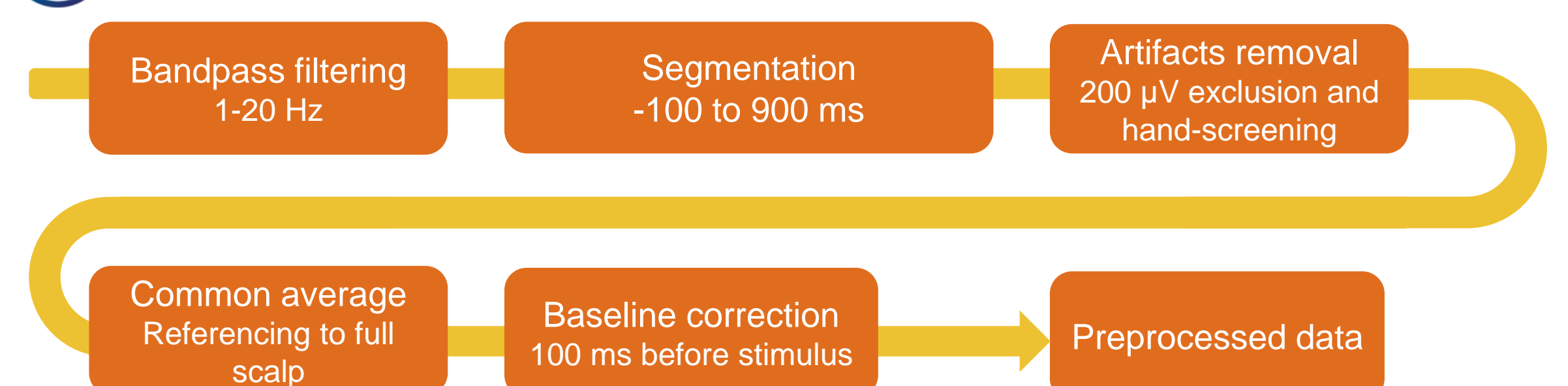
### fNIRS acquisition and preprocessing

fNIRS at 690 & 830 nm (Imagent, ISS, Champaign IL, USA), 1 detector, 4 sources over fronto central areas



### EEG acquisition and preprocessing

128 channels EEG (Magstim EGI, Eugene OR, USA), sampling rate : 1000 Hz

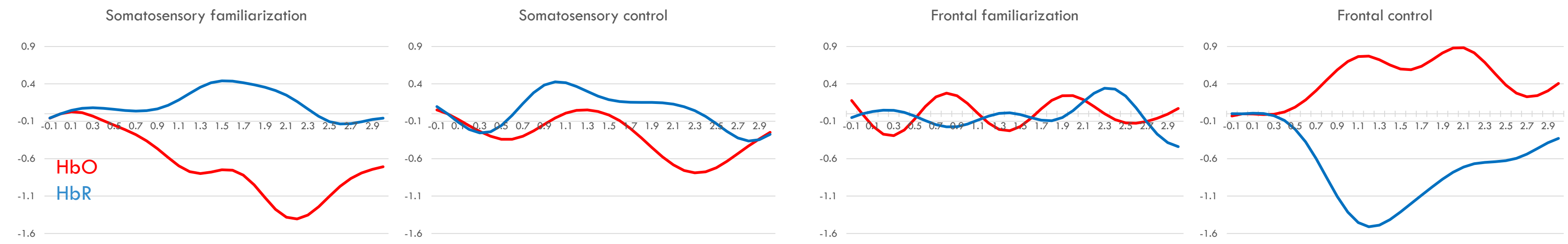
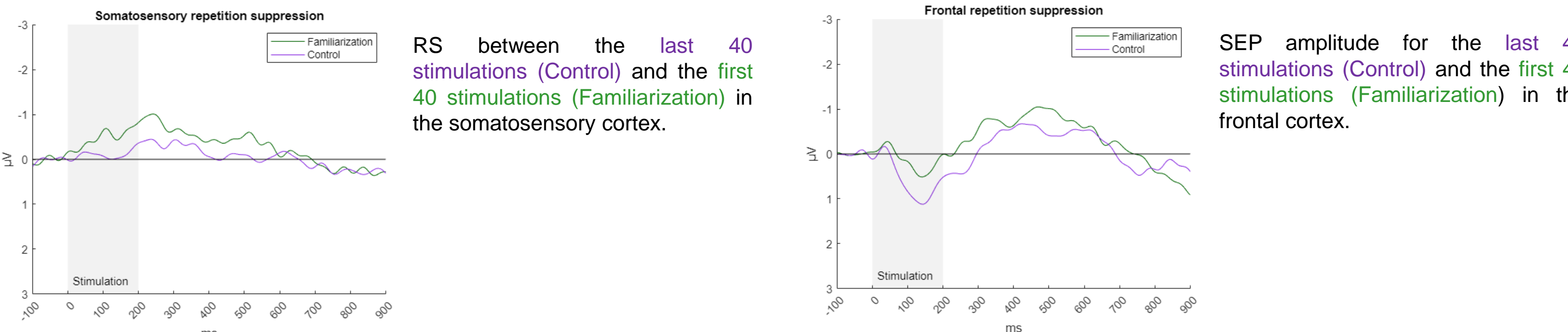


## 04 PRELIMINARY RESULTS (N<sub>EEG</sub>=30, N<sub>fNIRS</sub>=13)

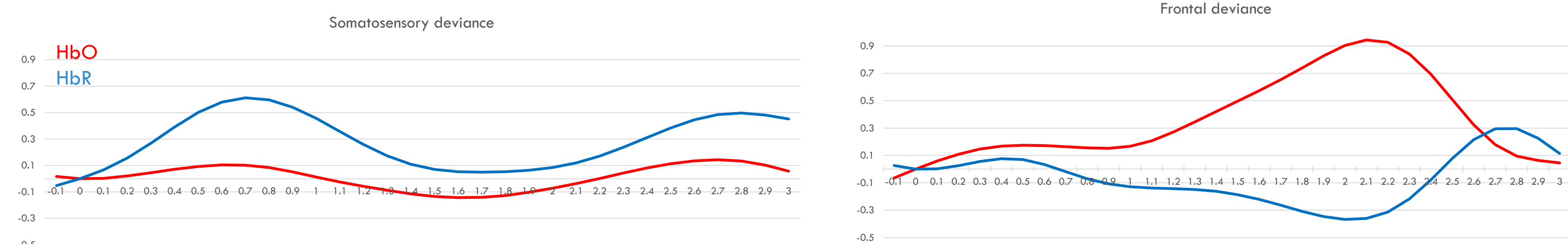
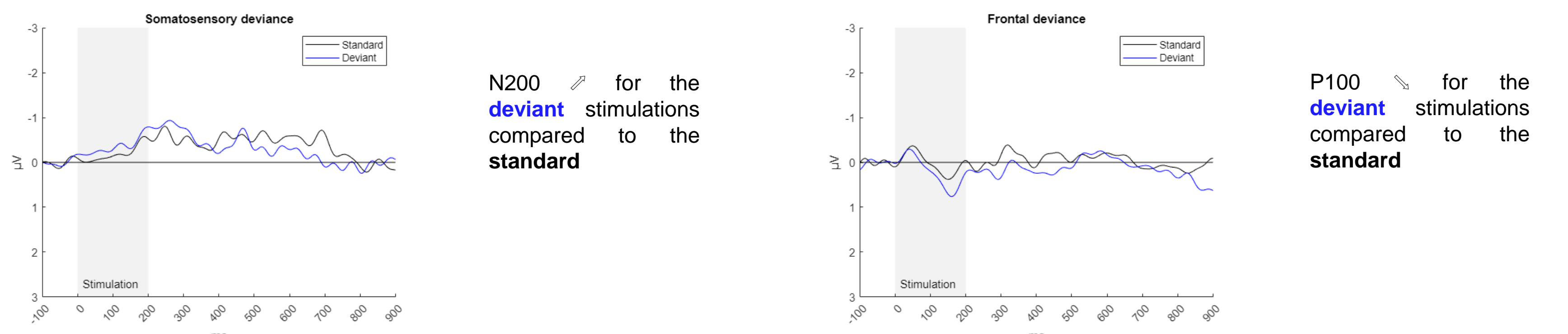
### Somatosensory cortex

### Frontal cortex

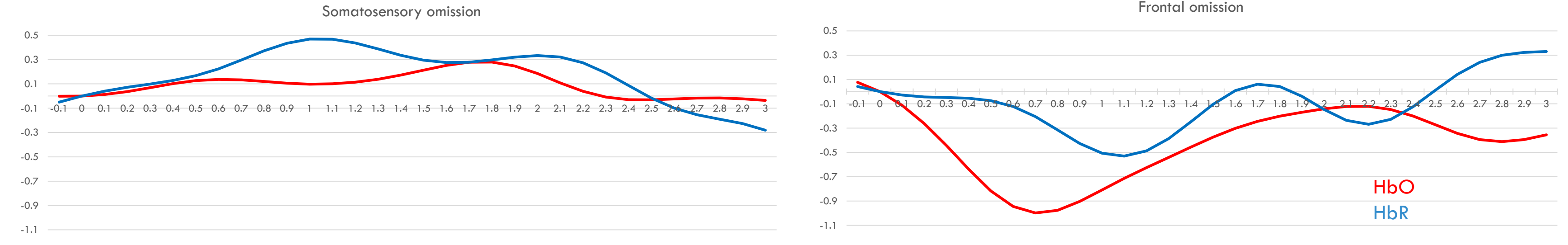
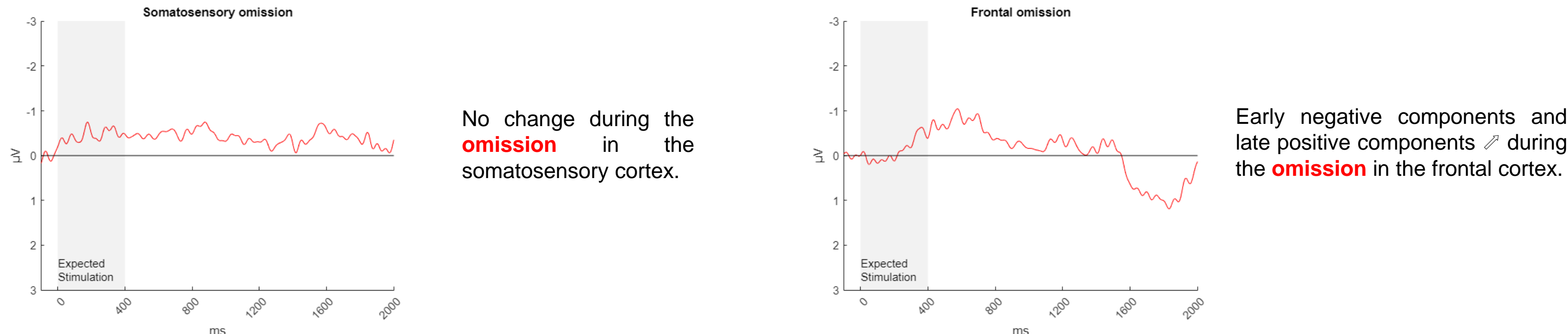
### Repetition suppression



### Deviance



### Omission



## 05 DISCUSSION

- **Repeated stimulations** elicit weaker HbO changes in the somatosensory cortex but increased HbO changes in the frontal cortex. We expected activation and not deactivation in the somatosensory cortex. In the frontal cortex, fNIRS and EEG show RS and are consistent with hypotheses.
- **Deviance** elicited a strong increase in HbO as well as an increased early electrical response in the frontal cortex. An increase in neuronal activity was observed only on EEG in the somatosensory cortex. Future measurements are needed to interpret fNIRS data.
- **Omission** elicited no change in the somatosensory cortex but elicited a decrease in HbO in the frontal cortex coupled with neuronal activity on EEG.

### Conclusion

Preterm neonates form predictions and detect an error in the tactile environment.

The late negative components found on EEG during the deviance and the omission in the frontal cortex suggest that these prediction mechanisms could rely on a common frontal process as suggested by the predictive coding theory.

fNIRS measurement provide complementary information on tactile processing but more participants are needed to interpret fNIRS data further.

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