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Somatosensory prediction in preschool children: a preliminary ERP study

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01 THEORETICAL BACKGROUND

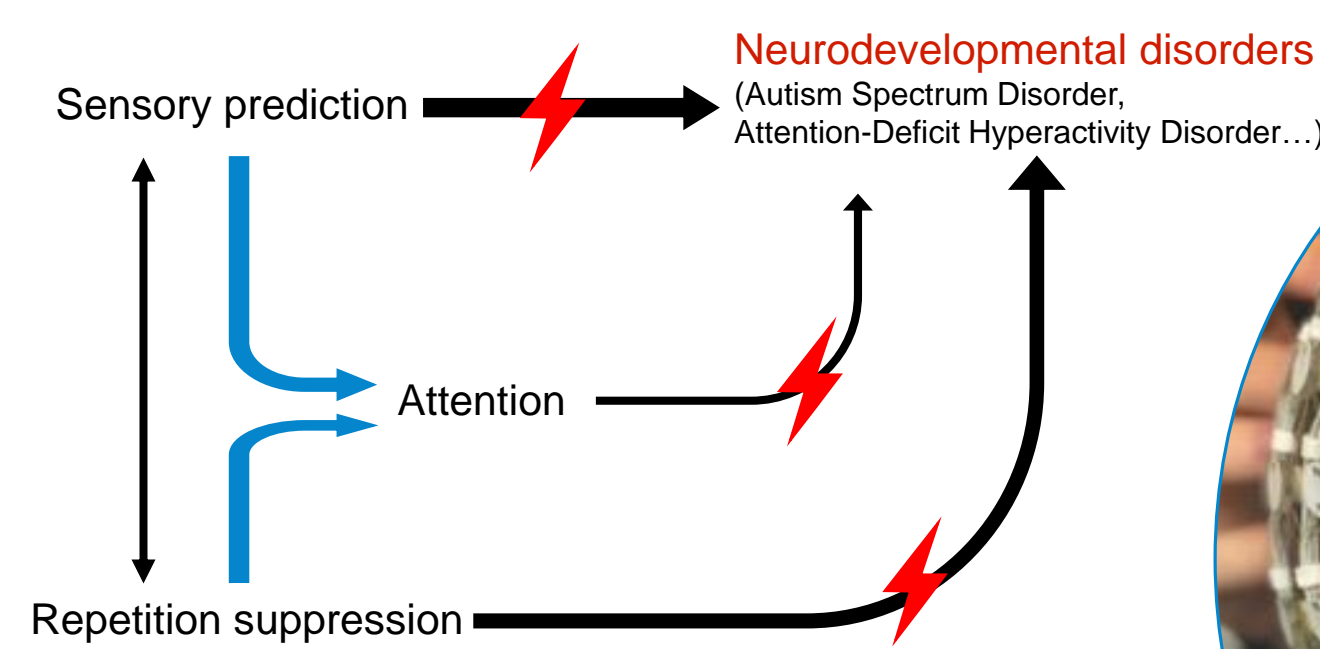
Predictive coding

- **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 when a stable representation of a repeated stimulation 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



- Touch is the **earliest** sensory modality to develop
- Somatosensory inputs are numerous from birth and touch ontogenetic anteriority makes it the **foundation of neurosensory integration, and motor, cognitive and affective development** (Casco, 2010)
- The tactile modality and the cognitive functions relying on it are often **altered in NDD** (Zoenen & Delvenne, 2018)
- Somatosensory processing does not receive the scientific attention that it should give its relevance to NDD



02 AIM & HYPOTHESIS

Investigate somatosensory prediction and repetition suppression from 2 to 6 years old in neurotypical children

Before studying its deficits in NDD

Hypothesis

- We hypothesize that children will have a **repetition suppression in the somatosensory cortex**, thus a decrease of the neuronal activation between the **familiarization** and the **control** phases.
- We hypothesize that children will have a stronger **early response to deviance** in the **somatosensory cortex** and a **late frontal response**.
- We hypothesize that children will have a recovery of activity **after an omission (PostOm)** in the **somatosensory cortex** and a **late frontal response**.

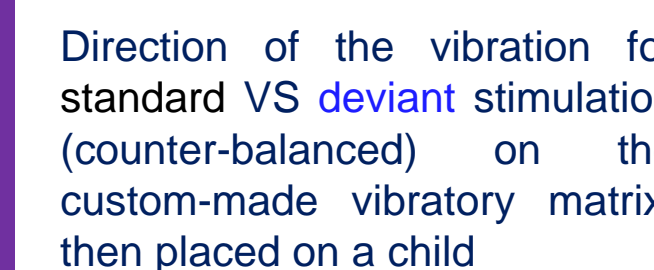
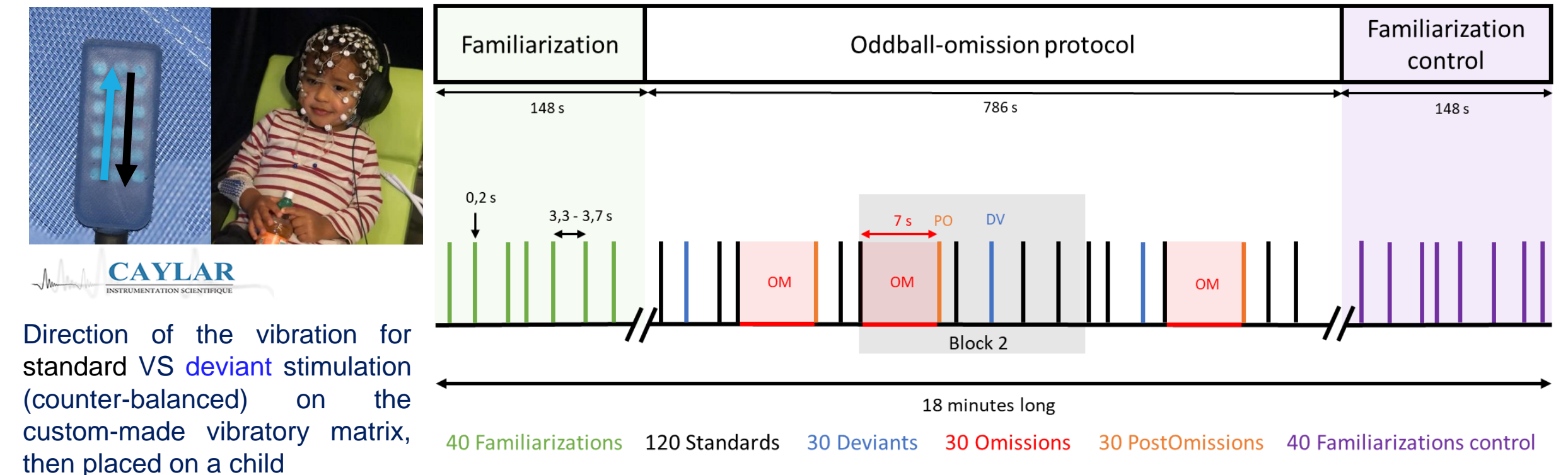
03 MATERIAL & METHODS

Aimed population

2 years old N = 20 Terms	4 years old N = 20 Terms	6 years old 20 NDD 20 Typical
2 years old N = 7 (29.14±4 months ; 1 girl)	4 years old N = 8 (52.5±4.6 months ; 4 girls)	6 years old N = 3 (72.3±0.6 months ; 3 girls)

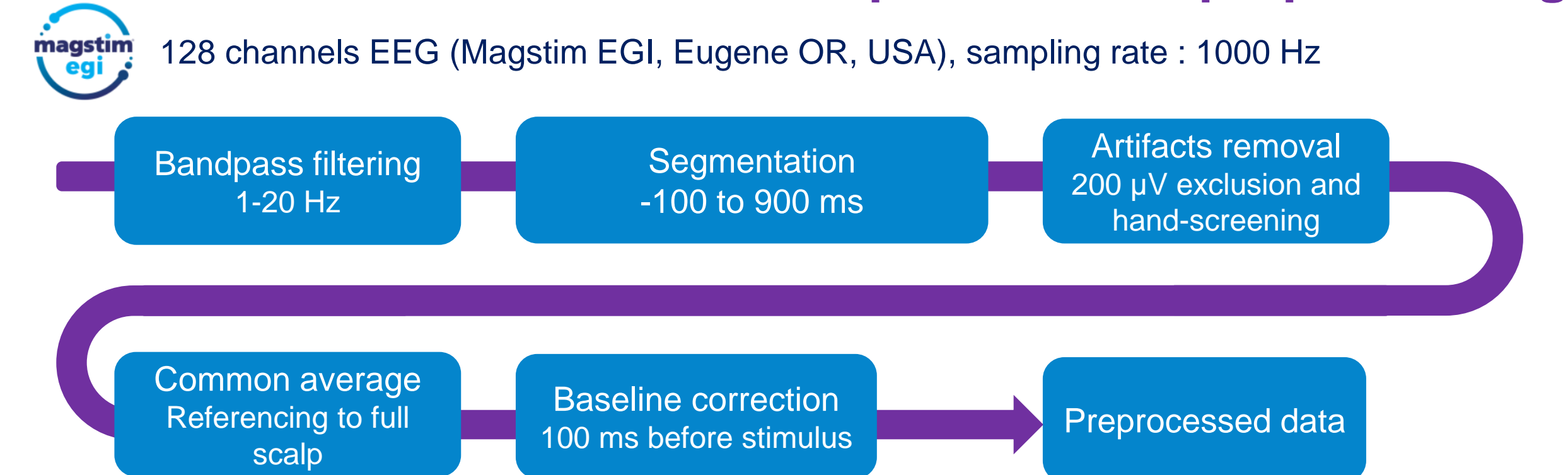
Current population

Oddball-omission protocol



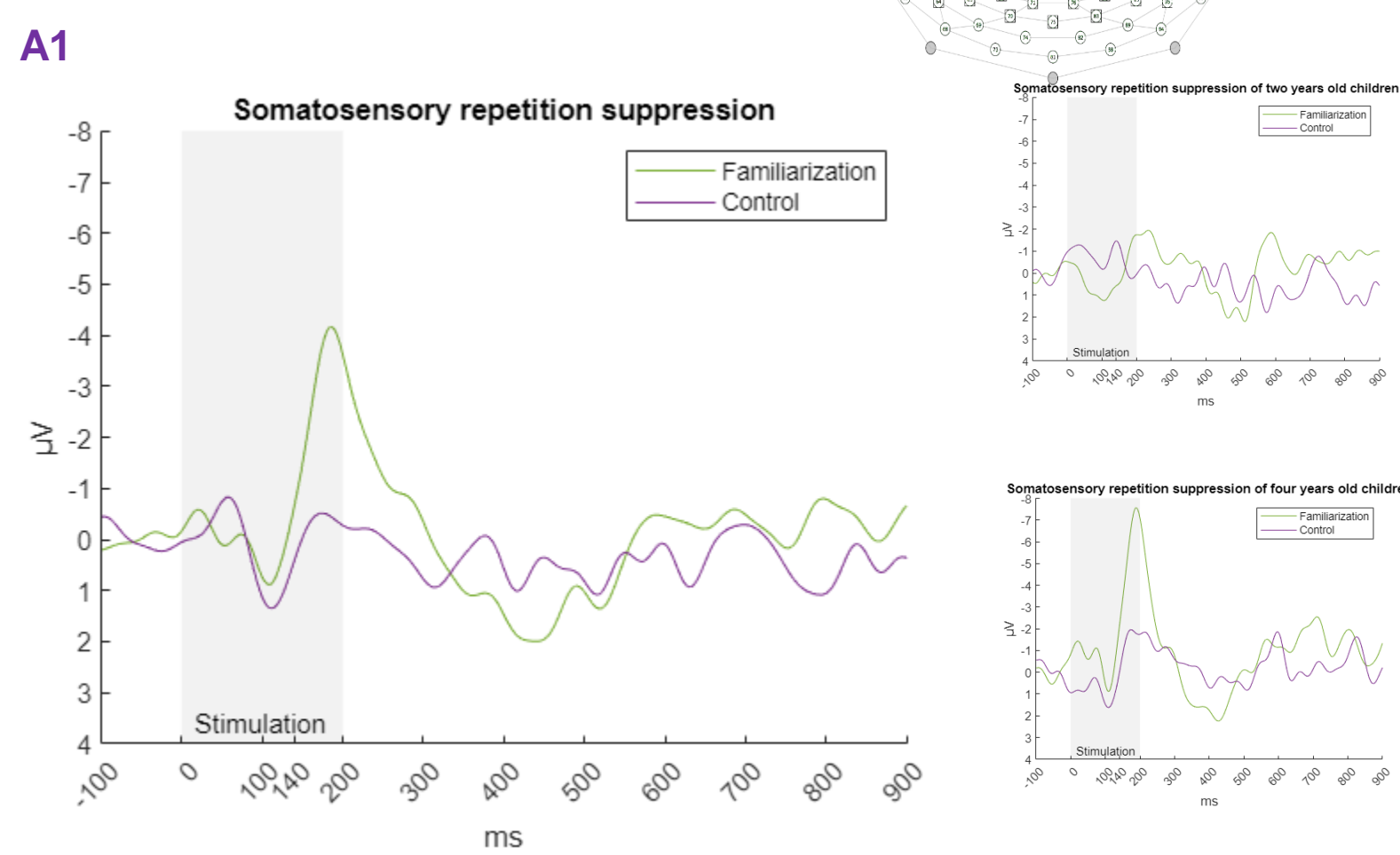
Direction of the vibration for standard VS deviant stimulation (counter-balanced) on the custom-made vibratory matrix, then placed on a child

EEG acquisition and preprocessing



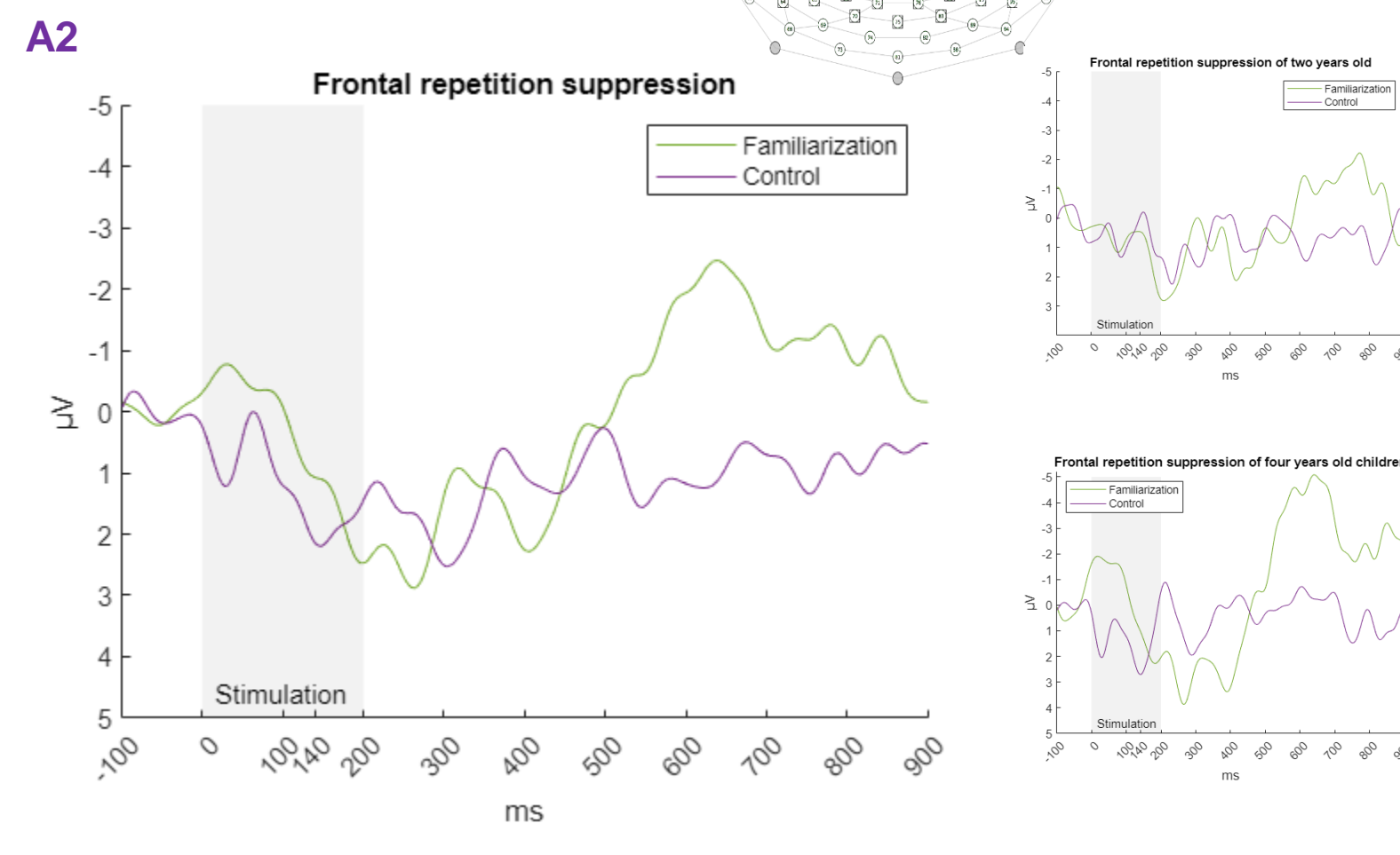
04 DESCRIPTIVE RESULTS

Somatosensory analysis

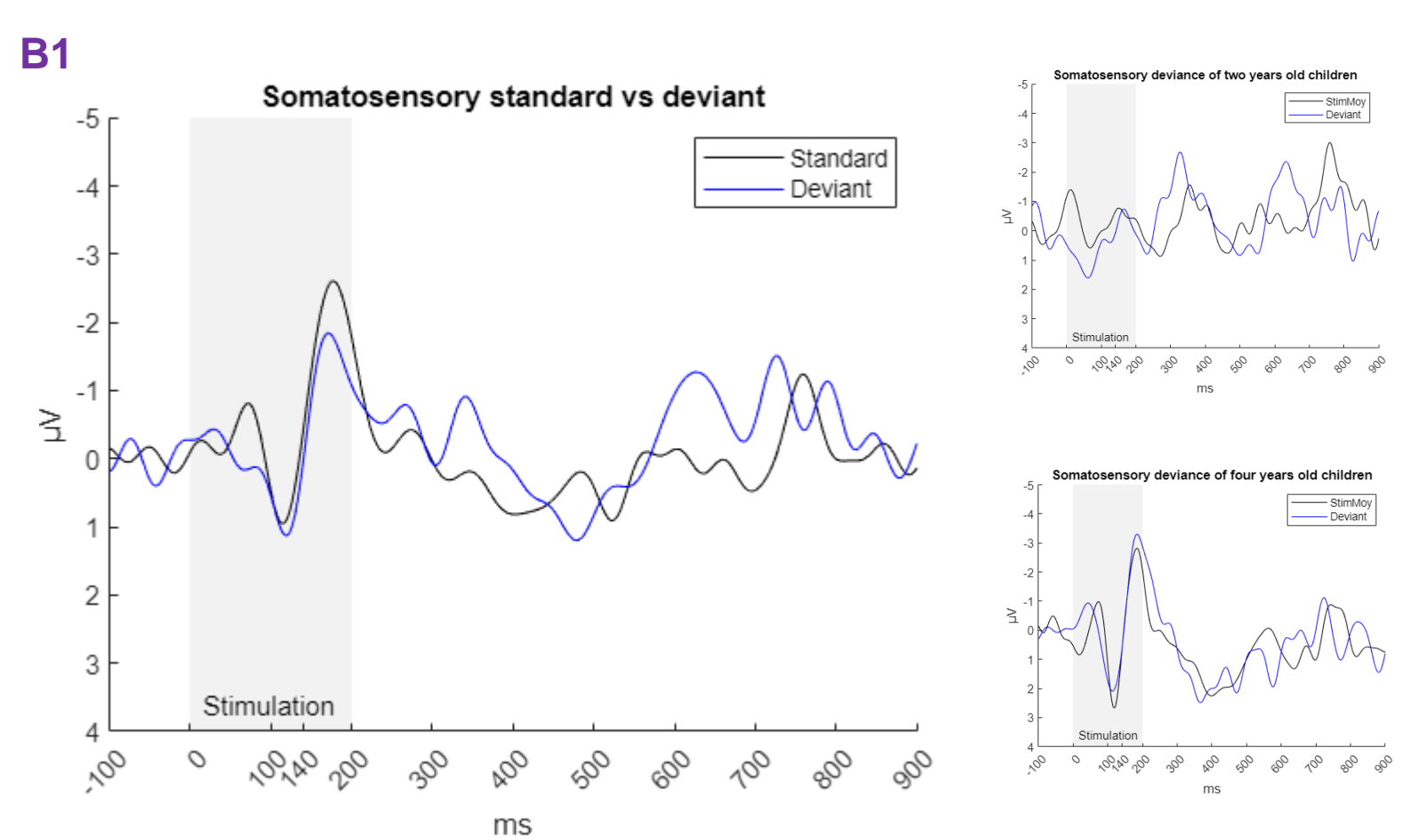


The amplitude of the electrical activity decreases at N140 and P400 for the last 40 stimulations (Control) compared to the first 40 stimulations (Familiarization) in the somatosensory cortex.

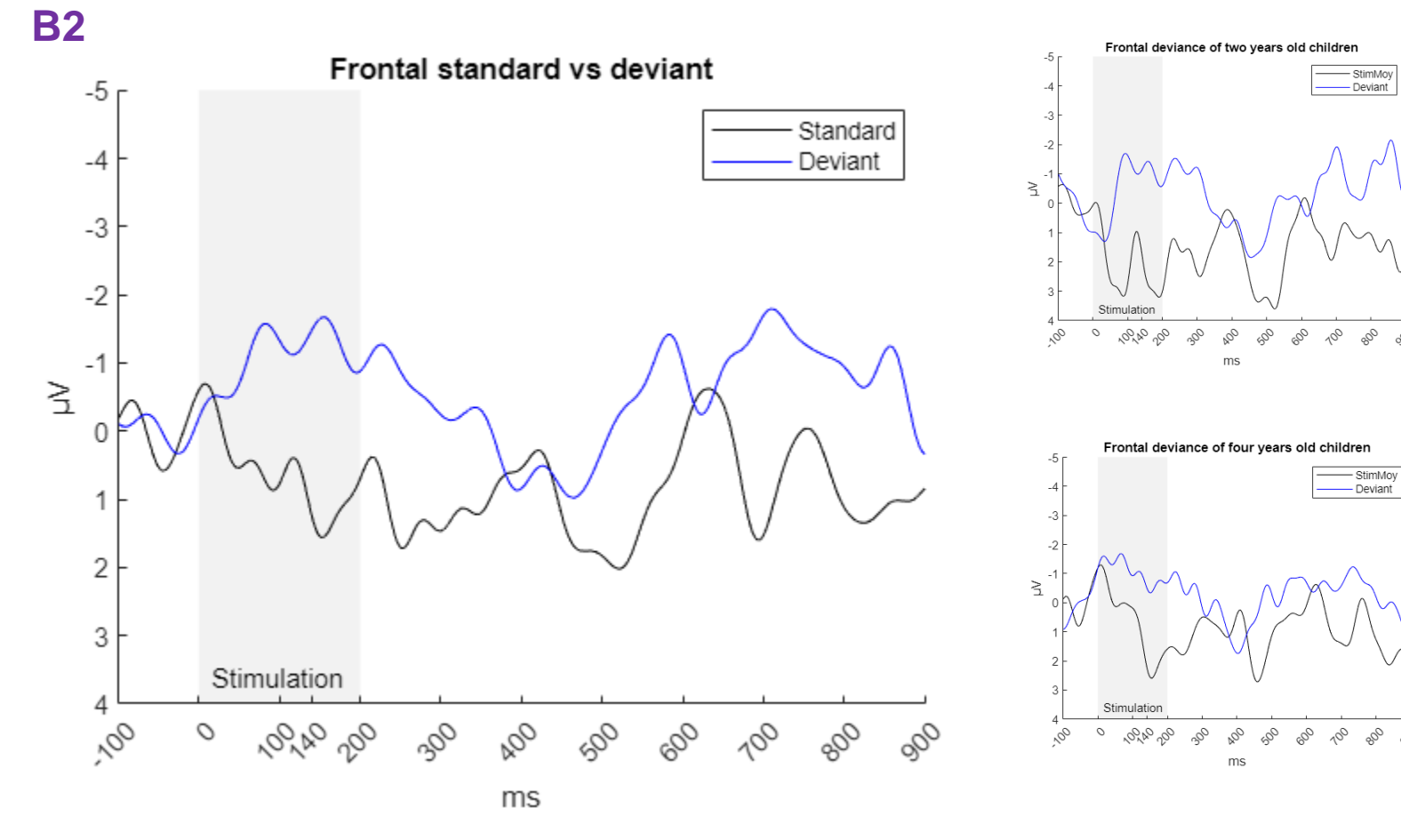
Frontal analysis



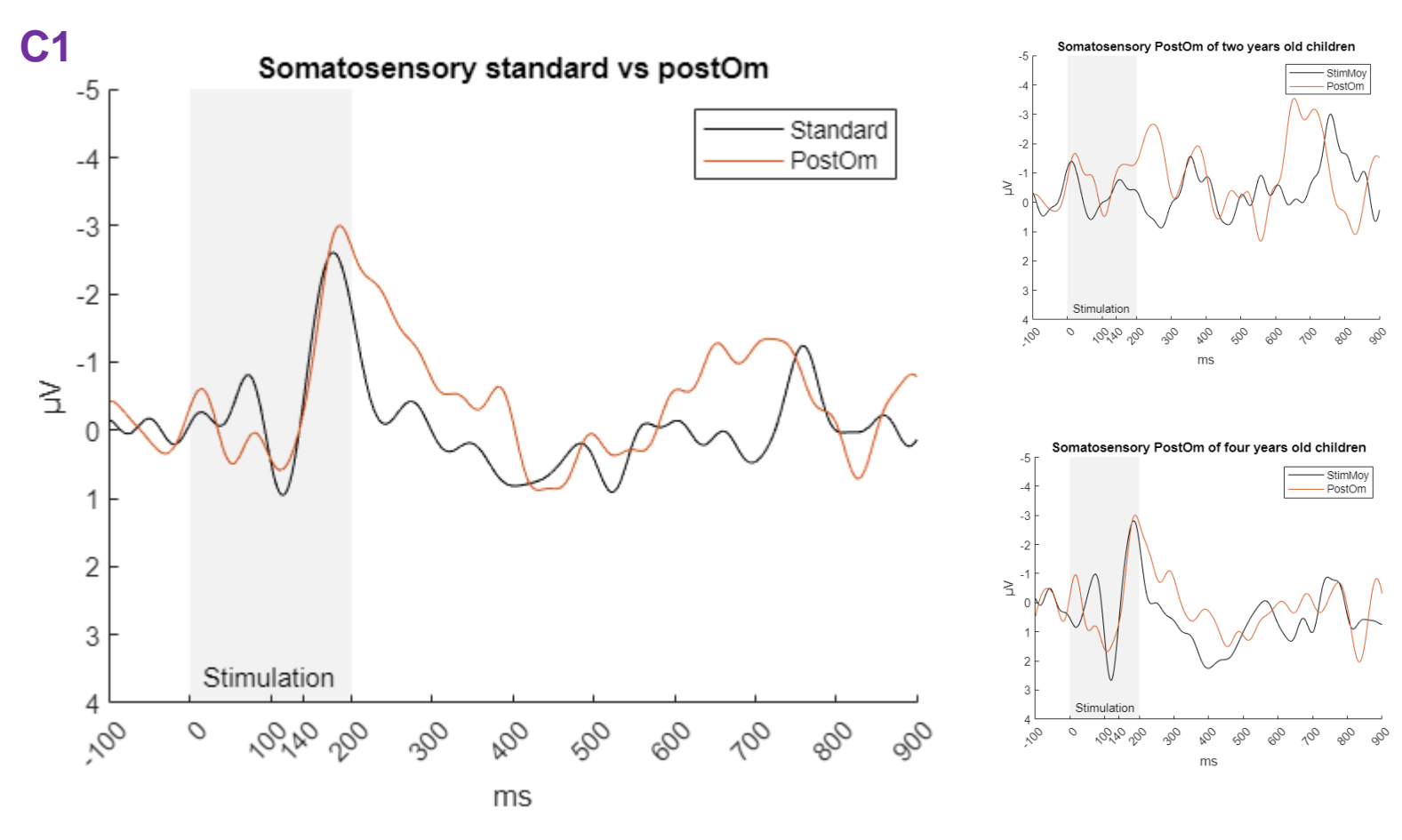
The amplitude of the electrical activity decreases at the late negative components for the last 40 stimulations (Control) compared to the first 40 stimulations (Familiarization) in the frontal cortex.



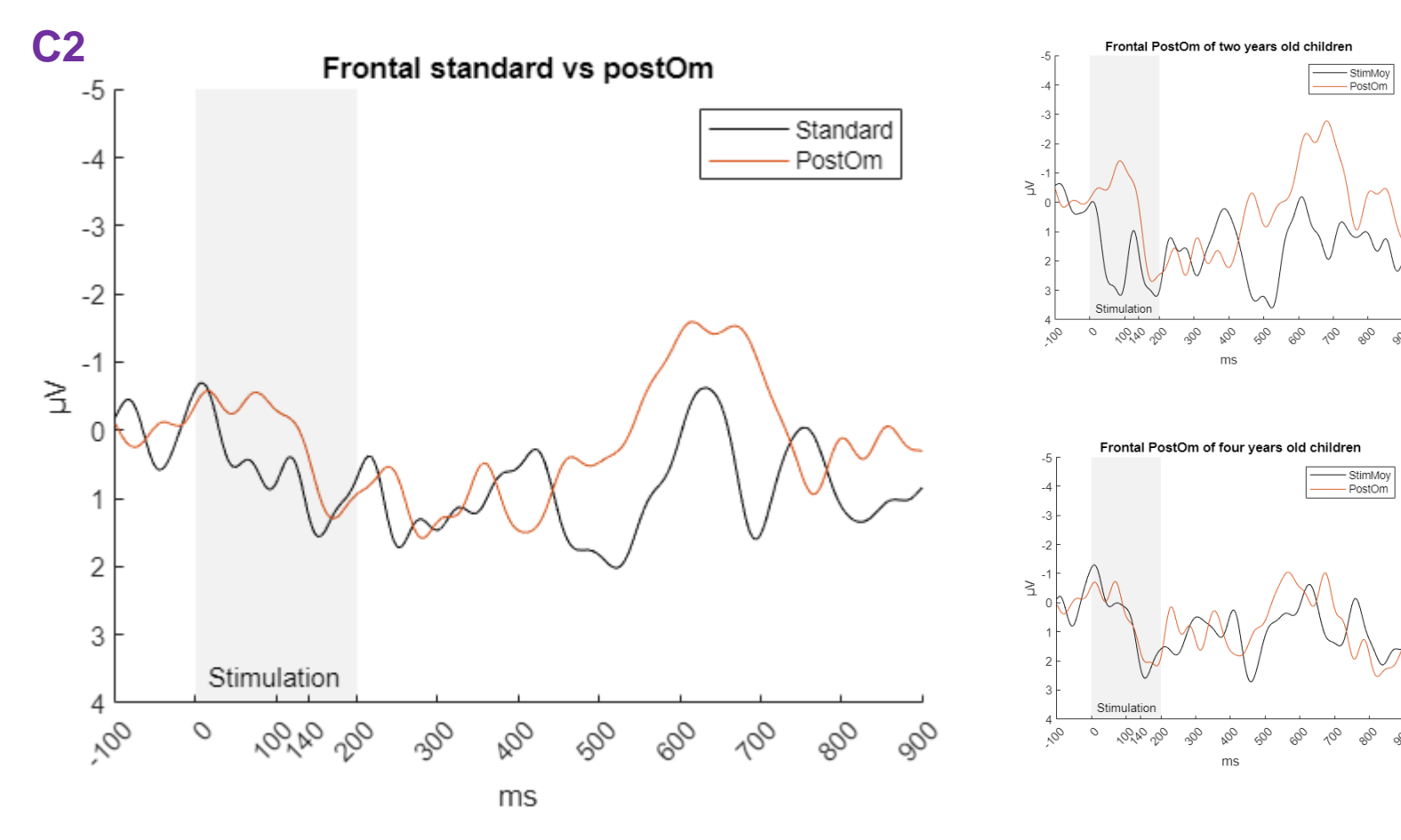
The amplitude of the electrical activity decreases at N140 for the deviant stimulations compared to the standard stimulations in the somatosensory cortex.



The amplitude of the electrical activity increases at early components from 50 to 400 ms and late components from 500 ms after stimulus onset for the deviant stimulations compared to the standard stimulations in the frontal cortex.



The amplitude of the electrical activity increases at N140 for the post omissions stimulations compared to the standard stimulations in the somatosensory cortex.



The amplitude of the electrical activity increases at the late negative components from 500 ms after stimulation for the post omissions stimulations compared to the standard stimulation in the frontal cortex.

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05 DISCUSSION

- **Repeated stimulations** elicit weaker event-related activity in both somatosensory and frontal cortices: we observe **repetition suppression** in children from 2 years old
- We do not observe a strong difference in ERPs evoked by **deviant** stimuli in the somatosensory cortex compared to standards. In the frontal cortex, there is a mismatch negativity: the early negative component is also found in the auditory modality in babies (Dehaene-Lambertz & Dehaene, 1994) and explained as a consequence of the prediction error. The late negative component during the **deviance** was also found in the auditory modality in babies and in the somatosensory modality in children and was argued as an attentional process (Basirat, Dehaene & Dehaene-Lambertz, 2014 ; Spackman *et al.*, 2010)
- During the **post omission**, there is a slight increase of electrical activity at N140 in the somatosensory cortex suggesting a prediction error during the omission. In the frontal cortex, as for the deviance there is a late negative component during the **post omission** whereas Nelson *et al.* (1990) observed a frontal positive slow wave in the frontal cortex during a visual auditory oddball protocol in children.

Conclusion

Typically developing preschool children from 2 years of age are able to form predictions and detect an error in the environment using the somatosensory modality. The late negative components found during the **deviance** and the **post omission** in the frontal cortex suggest that these prediction mechanisms could rely on a common frontal process as suggested by the predictive coding theory

07 ABOUT US

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