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Somatosensory prediction among preschool children: a cross-sectional study

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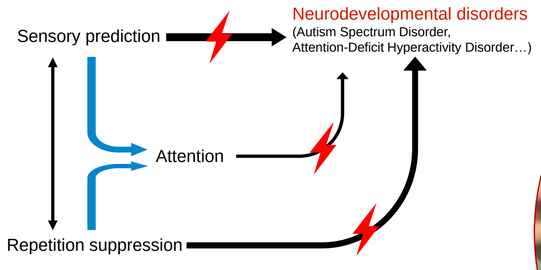
01 CONTEXT

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** (ND) like attention deficit disorders (Gonzalez-Gadea *et al.*, 2015)

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 ND** (Zoenen & Delvenne, 2018)



02 AIM & HYPOTHESES

Investigate somatosensory prediction in children 2 to 6 years old

HYPOTHESES

- **Repetition suppression of early components of SEP in the somatosensory cortex area and of late components in the frontal area**, at all ages in typical children
- **Weaker repetition suppression** in atypical children
- **Larger early response to deviance** in the somatosensory cortex area and late response in the frontal area in atypical children

03 METHODS

Current population

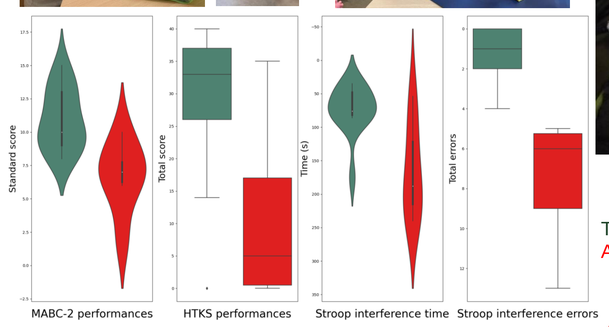
2 years old	4 years old	6 years old
N = 9 (29,56 ± 3,68 months; 2 ♀)	N = 15 (51,8 ± 3,99 months, 4 ♀)	N = 4 (72,25 ± 0,5 monhs, 3 ♀)
9 typicals	10 typicals 5 atypicals	3 typicals 1 atypical

Children were considered atypical if they were born prematurely or if they received psychological or educational follow-up or speech or occupational therapy.

Psychomotor evaluations

Executive functions: Stroop & HTKS

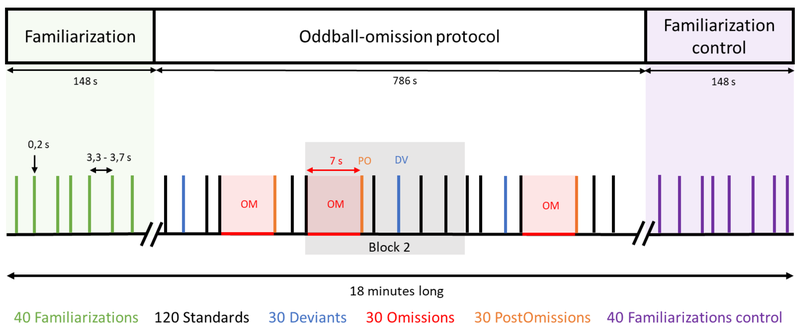
Motor evaluation: MABC-2



Vibroactile stimulation

CAYLAR

Oddball-omission protocol



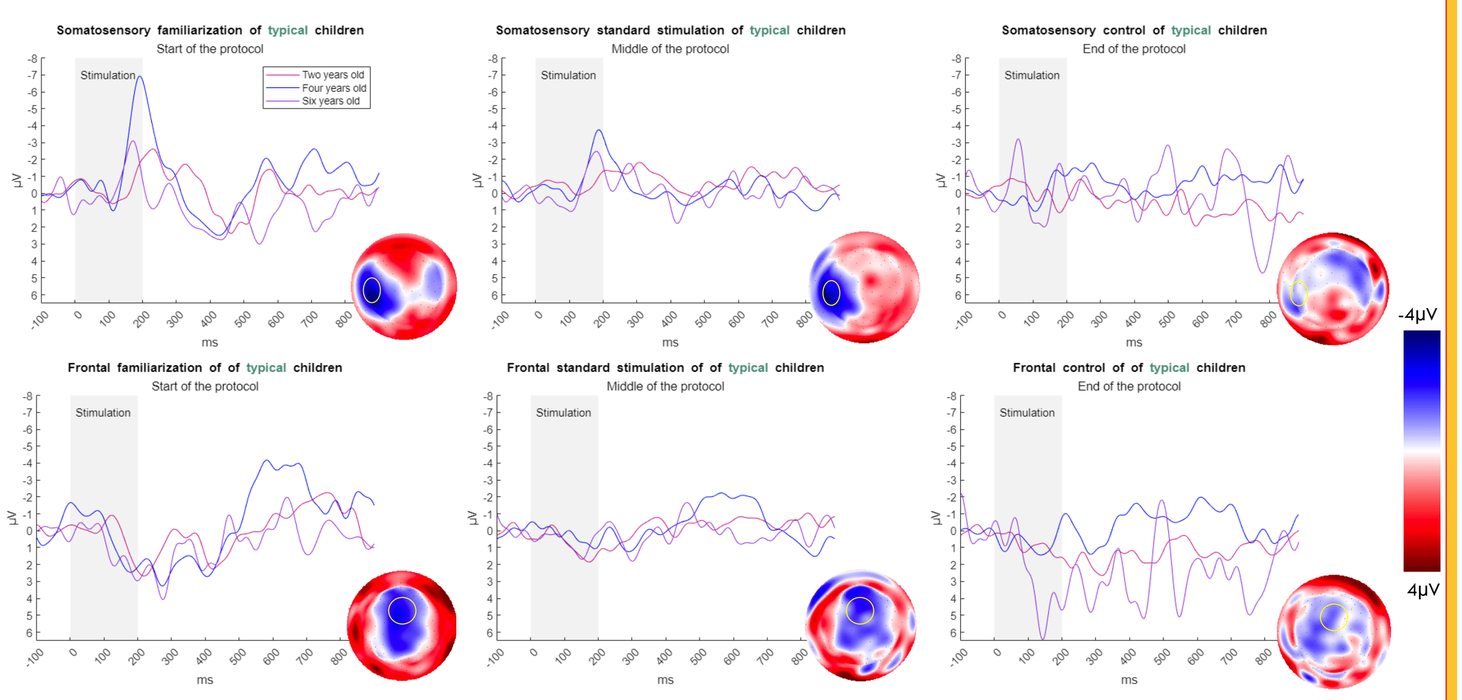
EEG acquisition and preprocessing

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

Bandpass filtering 1-20 Hz → Segmentation -100 to 900 ms → Artifacts removal 200 µV exclusion and hand-screening → Common average Referencing to full scalp → Baseline correction 100 ms before stimulus → Preprocessed data

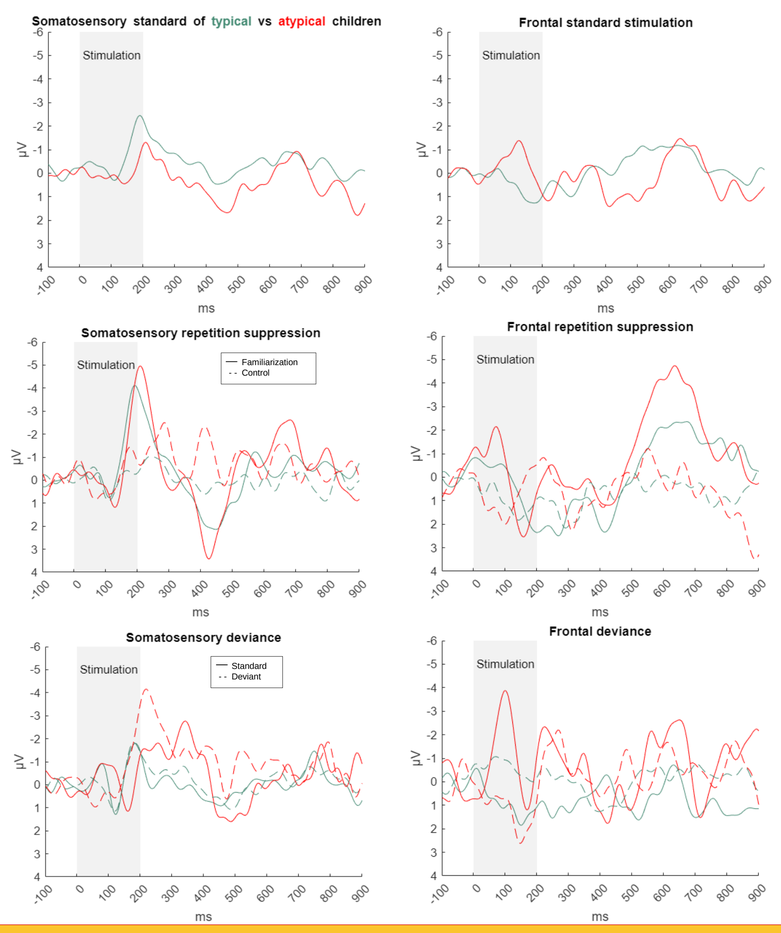
04 PRELIMINARY RESULTS

Evolution of the neuronal response of typical children across the protocol



Evolution of the neuronal responses across the stimulation sequence as function of age in typically developing children.
From left to right: Figures in the first row show the time course of the somatosensory stimulation, with mean scalp distribution of the N2 peak above (averaged electrodes are circled in yellow). Figures in the second row display the same time course in the frontal cortex, with mean scalp distribution of the N600 peak below. In the three age groups there was a **suppression of both N2 in the somatosensory cortex and N600 in the frontal cortex**. There were wider amplitude responses of four years old children compared to the others mostly at the beginning of the protocol.

Oddball neuronal responses of typical vs atypical children



Standard stimulation of typical vs atypical children
The amplitude of the electrical activity during standard stimulations at N2 was weaker for atypical children, but greater at P300 in the somatosensory cortex. In the frontal cortex, atypical children showed an inverted pattern compared to typical children at 100 and 500ms after stimulus onset.

Repetition suppression of typical vs atypical children
The amplitude of the electrical activity decreased at N2 and P300 for the last 40 stimulations (Control) compared to the first 40 stimulations (Familiarization) in the somatosensory cortex in both groups, albeit wider in atypical children. Same results were found in the frontal cortex a N600.

Deviance of typical vs atypical children
The amplitude of the N2 increased during the deviance compared to standard stimuli, for atypical children in the somatosensory cortex, whereas for typical children, it was at N1. In the frontal cortex, there was a wide N1 peak during standard stimulations only in atypical children whereas later activity did not change for deviance compared to standard stimulations. In typical children however, standard stimulations elicited more positive activity while deviance elicited more negative activity along the course of the stimulation.

05 DISCUSSION & CONCLUSION

- **Repetition suppression in typical children from 2 years old**. Wider ERP amplitude found in 4 years old might be due to a developmental shift.
- **Wider amplitudes in atypical children** : tactile sensitivity could be increased.
- Early response to **deviance delayed in atypical children** : they could take longer to evaluate the deviance as an error.
- **Atypical children could have a somatosensory to frontal shift** of early components for error detection whereas typical children exhibited late frontal responses to deviance, commonly argued as a the recruitement of higher-order processes (Dehaene-Lambertz & Dehaene, 1994, Spackman et al., 2010).

Further analyses will be conducted on the response to omissions and the association of EEG measures and behavioral assessements.

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