



Tactile sensory prediction and executive attention development at preschool age: perspectives for understanding neurodevelopmental disorders

Marie Anquetil, Anne-Lise Marais, Victoria Dumont, Nadege Roche-Labarbe, S. Rossi

► To cite this version:

Marie Anquetil, Anne-Lise Marais, Victoria Dumont, Nadege Roche-Labarbe, S. Rossi. Tactile sensory prediction and executive attention development at preschool age: perspectives for understanding neurodevelopmental disorders. Journée Normande de Recherche Biomédicale, Jun 2023, Caen, France. hal-04174534

HAL Id: hal-04174534

<https://hal.science/hal-04174534>

Submitted on 1 Aug 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Tactile sensory prediction and executive attention development at preschool age: perspectives for understanding neurodevelopmental disorders

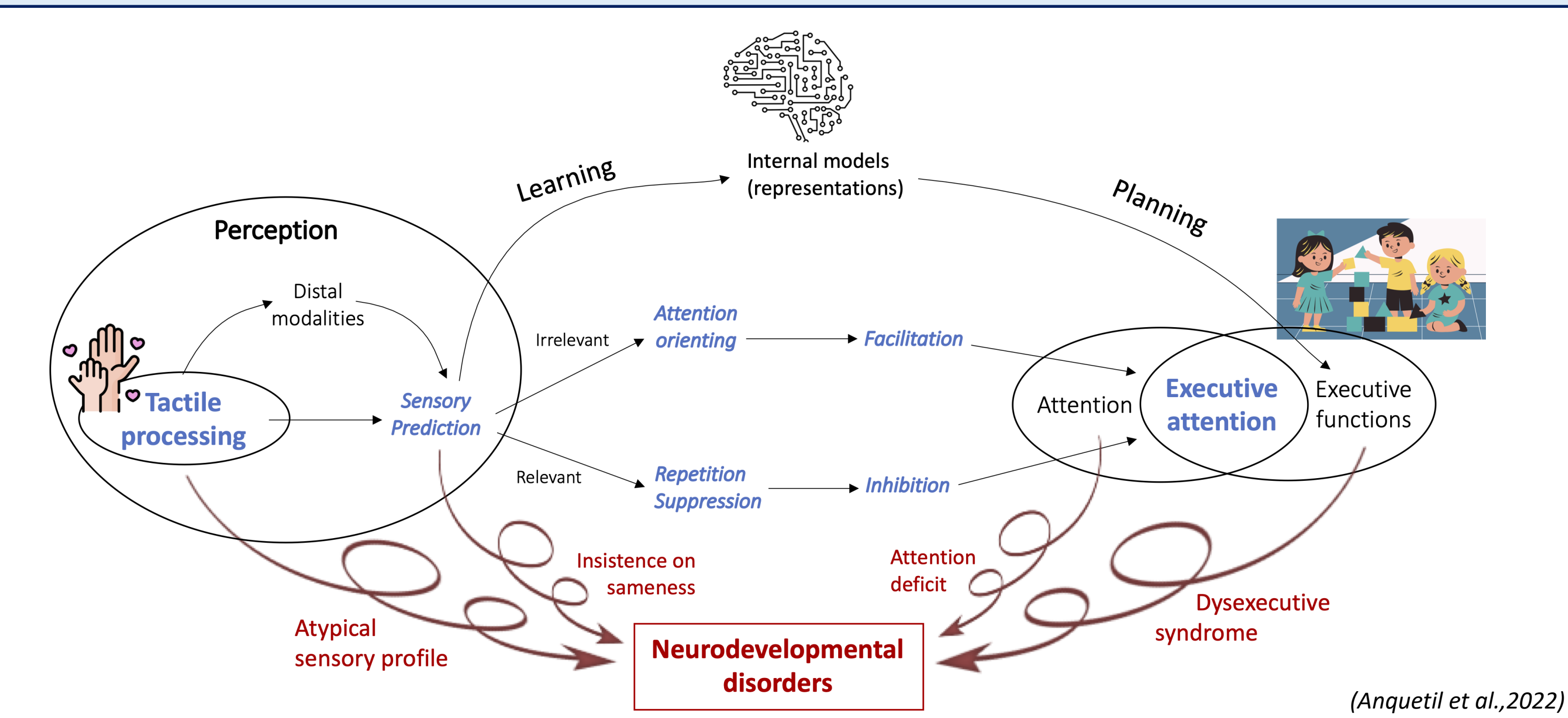
Marie Anquetil^{1*}, Anne-Lise Marais², Victoria Dumont², Nadège Roche-Labarbe², Sandrine Rossi¹¹Normandie Univ, UNICAEN, Laboratoire de Psychologie Caen Normandie (EA 7452) ; ²Normandie Univ, UNICAEN, INSERM, COMETE (U-1075)

*marie.anquetil@unicaen.fr

INTRODUCTION

- The **tactile modality**, the first to develop, is the foundation of cognitive development.
- **Sensory Prediction (SP)** is a core mechanism sustained by our perceptions and allows the brain to anticipate future stimulations on the basis of previous sensory inputs (*Friston, 2005*). **Repetition Suppression (RS)** refers to the reduction of activity in the brain when a predicted stimulus is repeated or becomes irrelevant.
- **Sensory Prediction in the tactile modality** was suggested as an early precursor of cognitive development (*Dumont et al., 2022*).
- **Predictive mechanisms may form the basis of executive attention** development by sustaining self-regulation processes such as habituation or anticipation (*Bubic et al., 2010*).

The aim of this study is to investigate how tactile sensory prediction and other tactile processing phenomena are related to executive attention development at preschool age.



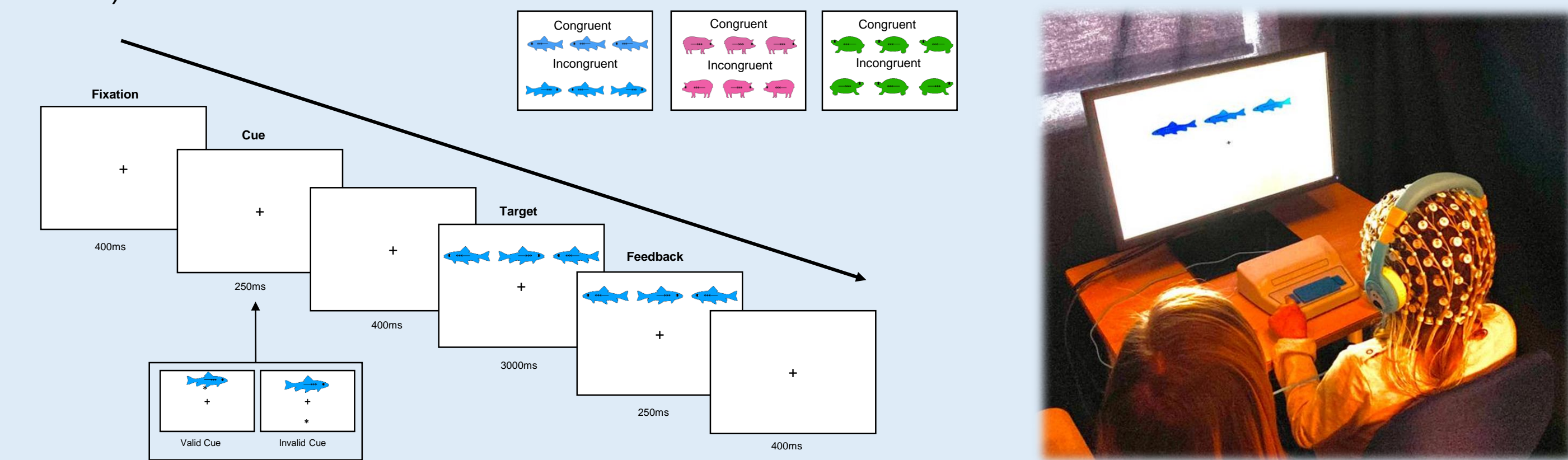
- For executive attention, we investigate the **modulation of the N2 component**, between **congruent** and **incongruent** conditions.
- For tactile sensory processing, we assess **repetition suppression**, *i.e.*, the decrease in somatosensory evoked potential (SEP) between the **familiarization** and the **control sequence** during the oddball omission-paradigm in the somatosensory cortex. We also assess potentials evoked by **deviant** stimulations.

We hypothesize a relation between brain evoked potentials at tactile sensory oddball paradigm and brain evoked potentials at Child-ANT : the modulation of N2 component is associated with repetition suppression. We also hypothesize that SEP are associated with behavioral measurements and parental questionnaires of executive attention and executive functions.

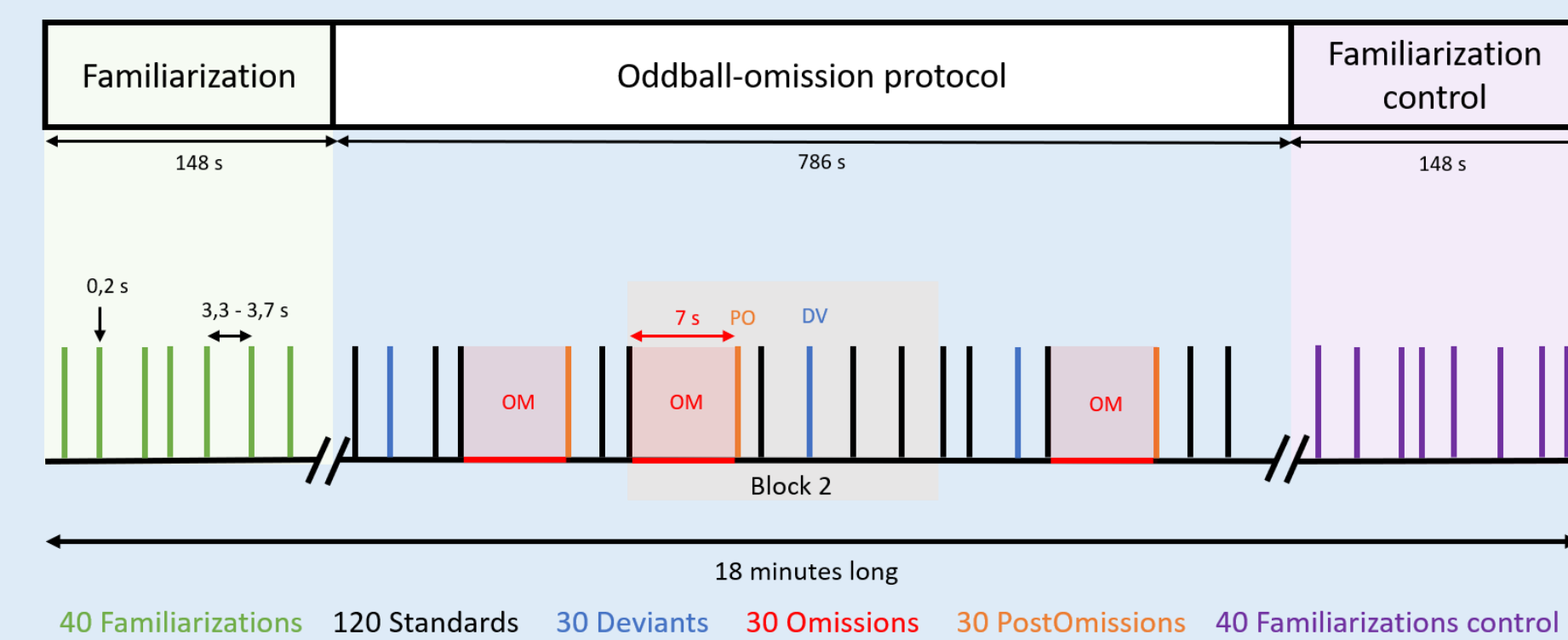
METHODS

28 children between 48 and 60 months perform the following tasks in random order while 128-electrodes electroencephalography (Magstim EGI) is being acquired:

- an adapted version of the **Child-Attention Network Task (ANT)**, a measure of executive attention) (*Rueda et al., 2004*)



- a **tactile oddball-omission paradigm** (vibrotactile stimuli are presented on the forearm randomly interspersed with deviant and omitted stimuli).

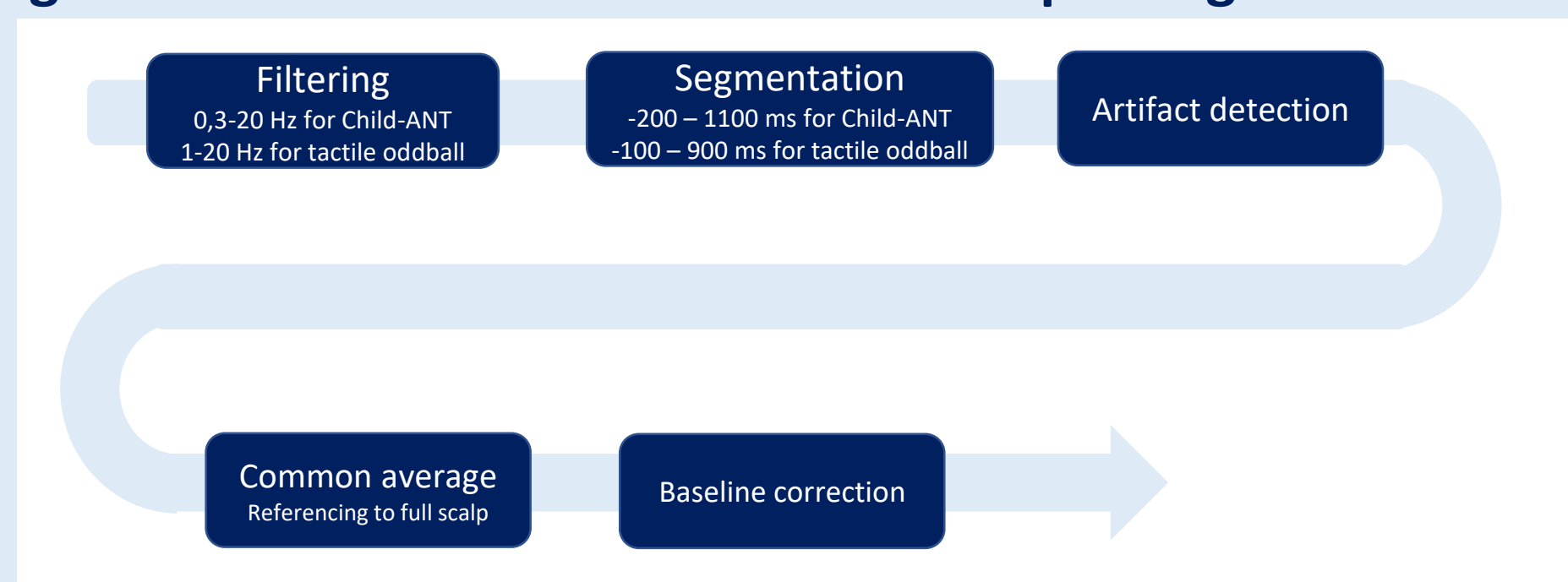


Children also perform the following behavioral tasks in random order :

- **Movement Assessment Battery for Children 2nd edition (MABC-2)**
- **Stroop task** adapted for non-reading children (*Wright et al., 2003*)
- **Head-Toes-Knees-Shoulders (HTKS)** task (*McClelland et al., 2014*)

Parents are also invited to complete 3 questionnaires : **Dunn's Full Sensory Profile**, **BRIEF-P** and **ESSENCE 2-5**.

- **EEG preprocessing for Child-ANT and for Tactile oddball paradigm**



- **Statistical analysis**

We computed the mismatch between the different conditions for each subject in order to determine the peak amplitude of interest for the analyses. We then carried out Student or Wilcoxon comparison tests depending on the normality of the sample.

To quantify the link between brain activity in the tactile oddball paradigm and during the Child-ANT, we used the generalized linear model. We used the same method to compare tactile repetition suppression and executive functions.

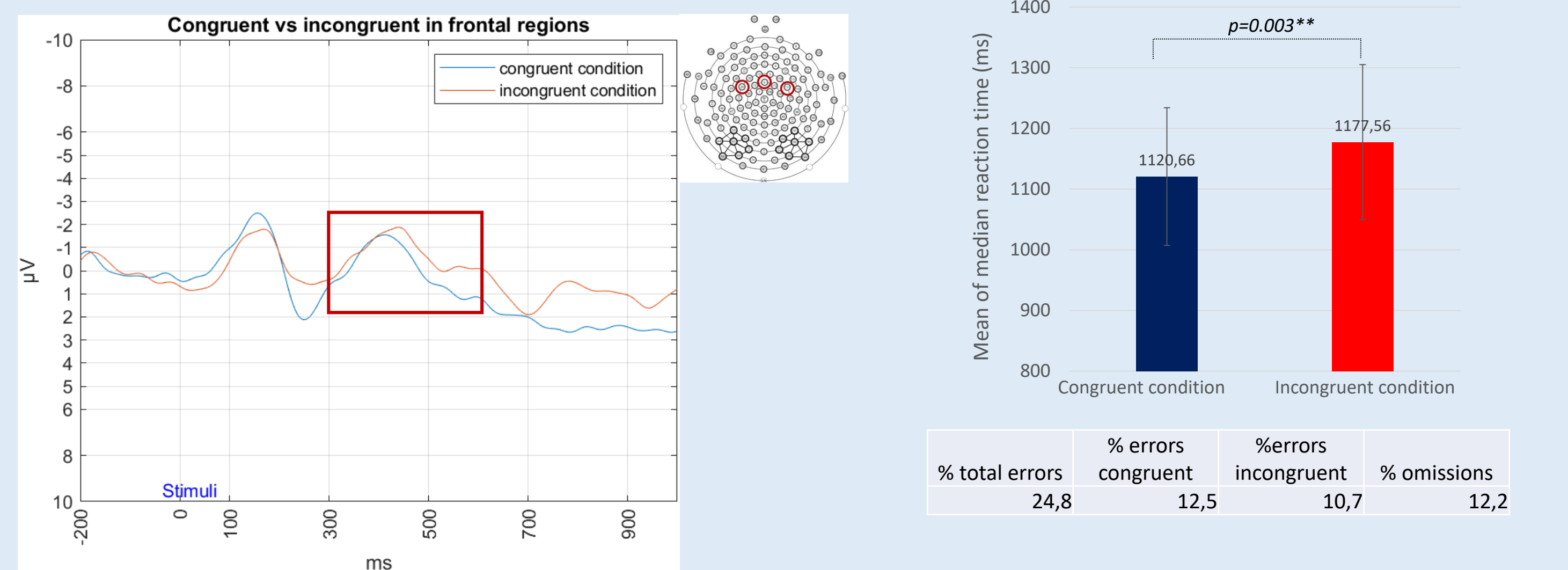
REFERENCES

- Anquetil, M., Roche-Labarbe, N. & Rossi, S. (2022). Tactile sensory processing as a precursor of executive attention : towards early detection of attention impairments and neurodevelopmental disorders. *Wires Cognitive Science*.
- Bubic, A., Von Cramon, D. Y., & Schubotz, R. I. (2010). Prediction, cognition and the brain. *Frontiers in Human Neuroscience*, 4.
- Dumont V., Giovannella M., Zuba D., Clouard R., Durduran T., Guillois B. and Roche-Labarbe N. (2022). Somatosensory prediction in the premature neonate brain. *Developmental Cognitive Neuroscience*.
- Friston, K. (2005). A theory of cortical responses. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360(1456), 815-836.
- McClelland, M. M., Cameron, C. E., Duncan, R., Bowles, R. P., Acock, A. C., Miao, A., & Pratt, M. E. (2014). Predictors of early growth in academic achievement : The head-toes-knees-shoulders task. *Frontiers in Psychology*, 5.
- Rueda, M. R., Fan, J., McCandliss, B. D., Halparin, J. D., Gruber, D. B., Lercari, L. P., & Posner, M. I. (2004). Development of attentional networks in childhood. *Neuropsychologia*, 42(8), 1029-1040.
- Wright, I., Waterman, M., Prescott, H., & Murdoch-Eaton, D. (2003). A new Stroop-like measure of inhibitory function development. Typical developmental trends. *Journal of Child Psychology and Psychiatry*, 44(4), 561-575.

RESULTS

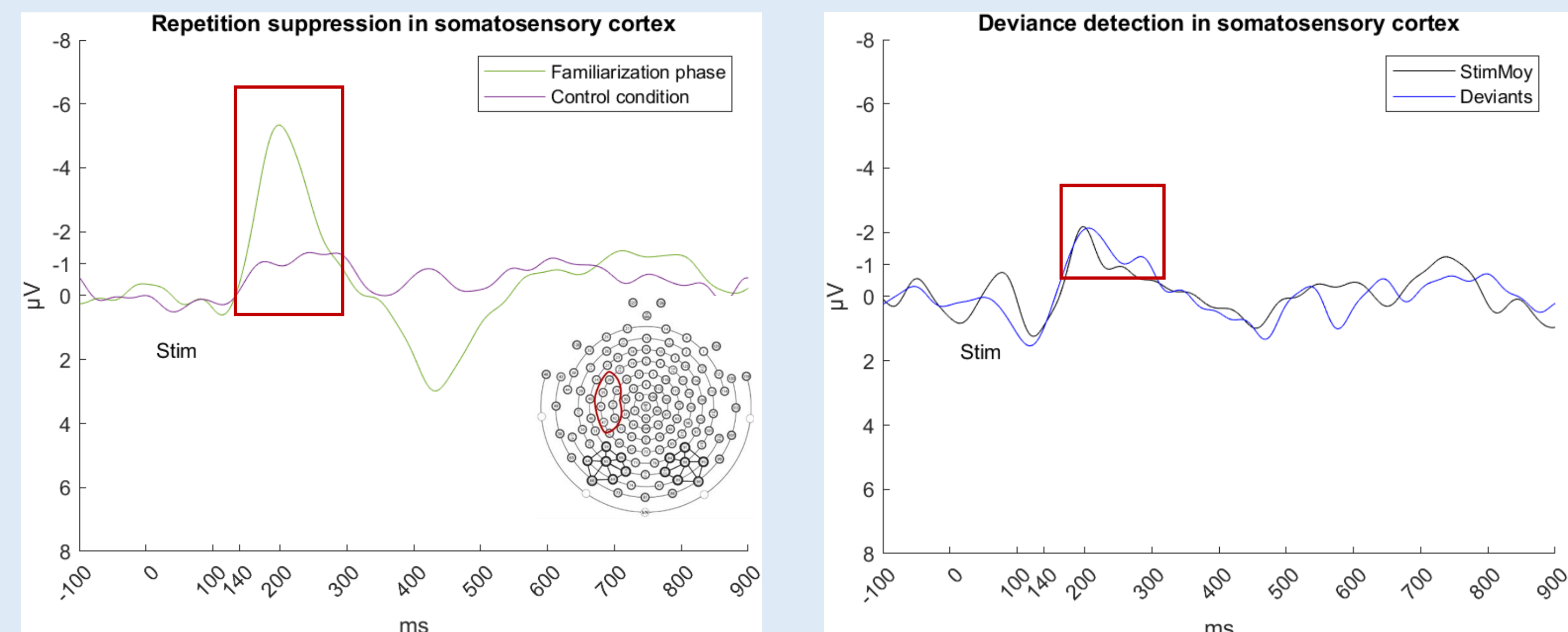
N = 28 (4 children were removed after EEG analysis)
(11 ♀ , 17 ♂ ; m= 53 months ± 3 months)

- **Frontal activity and behavioral performance at the executive attention task of the Child-ANT (all participants)**



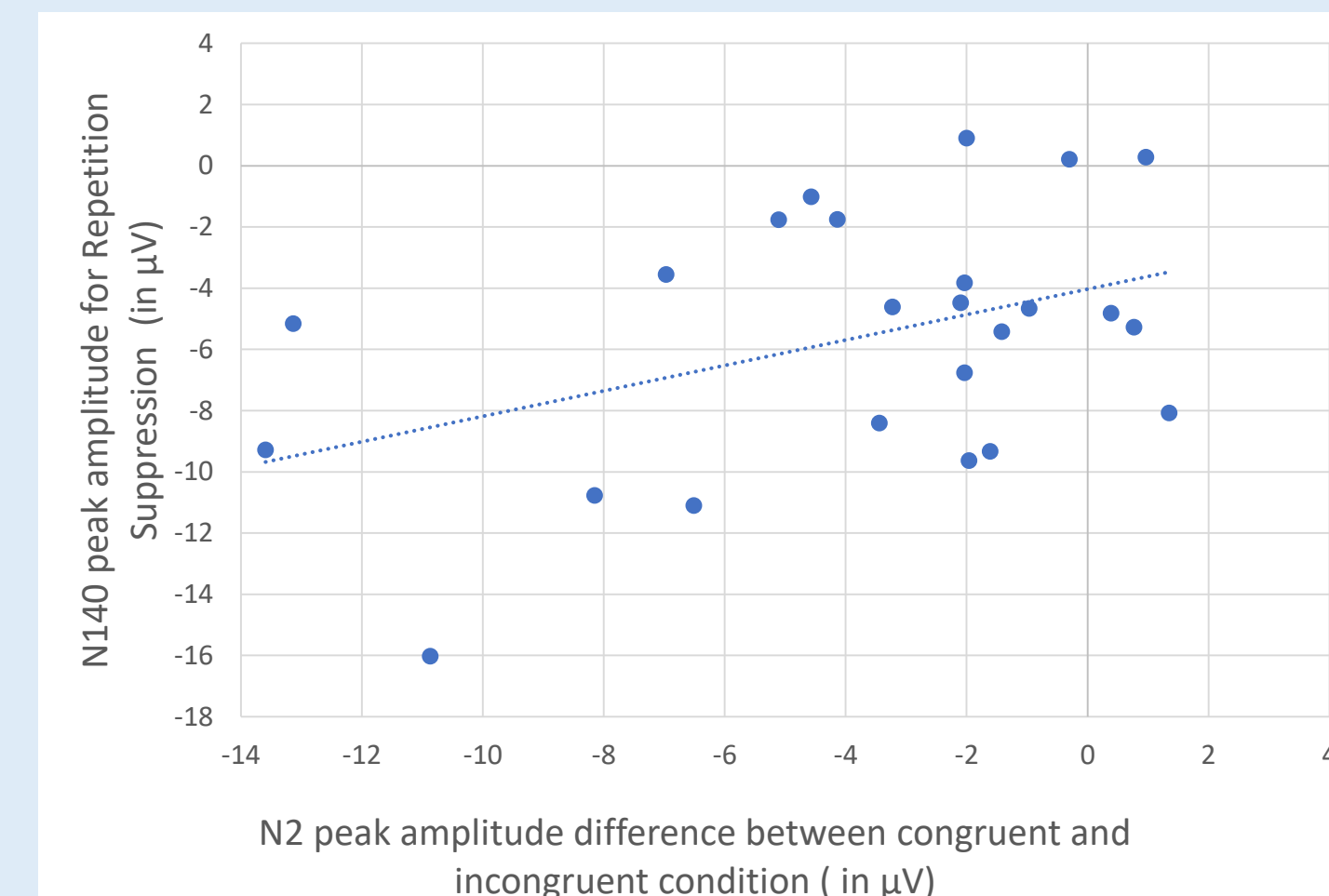
- There is a significant difference between **congruent** and **incongruent** conditions in terms of reaction time (p<0.001).
- This difference is also significant for N2 peak amplitude between conditions (p<0.001) : **children are sensitive to cognitive conflict**.

- **Tactile sensory processing (all participants)**



- **Repetition suppression** : the amplitude of SEP at N140 decreases across the sequence. There is a significant difference between **familiarization phase** and **control condition** (p<0.001).
- **Deviance detection** : the amplitude of SEP at N140 during **deviant** stimulations is higher compared to an equal number of standard stimulations (p<0.001).

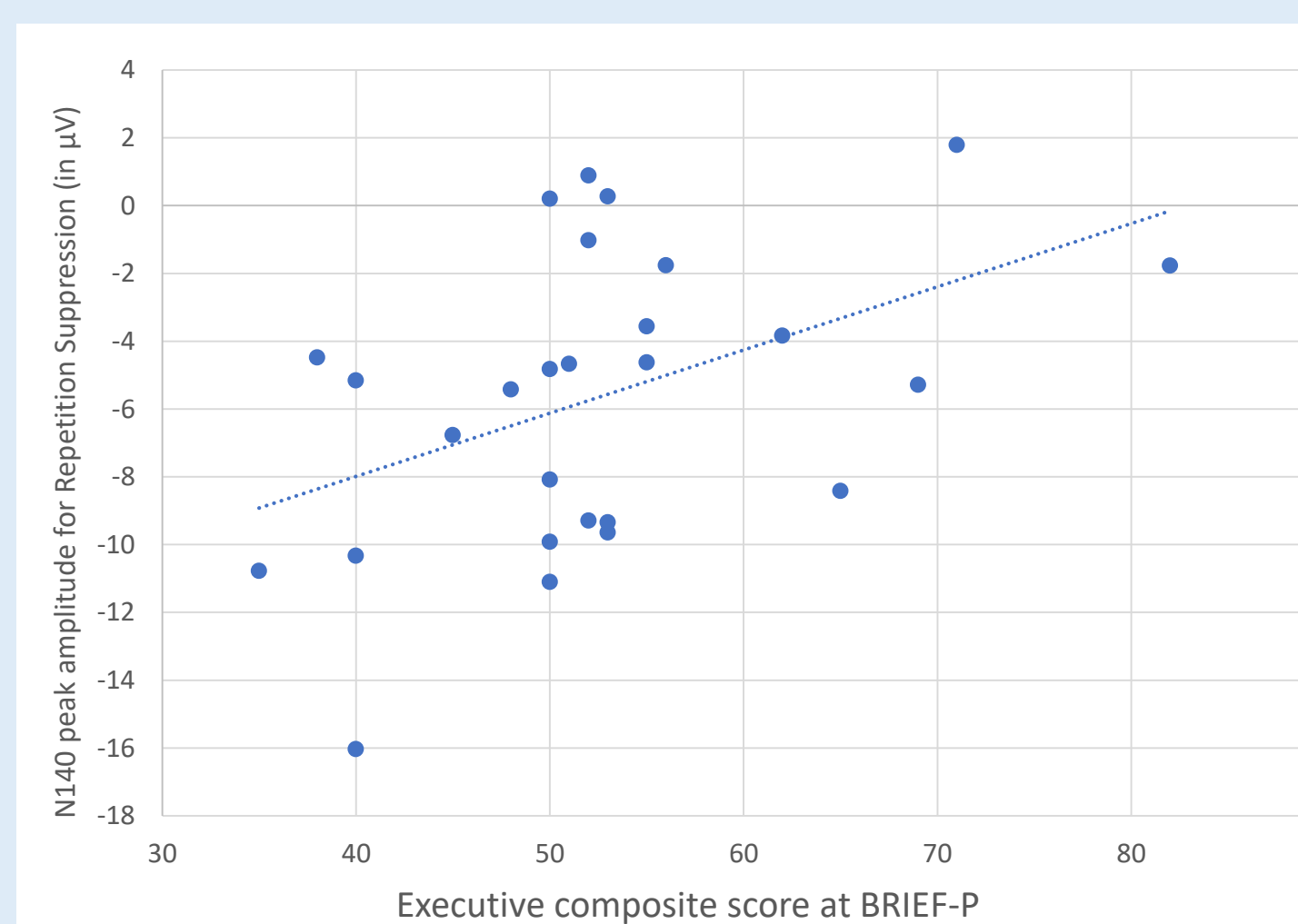
- **Tactile repetition suppression as a function of executive attention**



- **Tactile deviance detection as a function of executive attention**



- **Tactile repetition suppression as a function of executive functions**



- Repetition suppression of the tactile N140 is associated with BRIEF-P executive composite score (p=0.019) : **children who do not suppress tactile information across the sequence have higher BRIEF-P composite scores**, reflecting impaired executive functioning.

CONCLUSION

- **We found a relationship between the quality of tactile sensory processing and executive attention at preschool age** : brain activity in the tactile oddball paradigm is associated with brain activity at the Child-ANT.
- **Our results highlight the importance of tactile sensory processing in early development and also during preschool period when executive attention develops rapidly.**
- **Such findings could help for early attention disorders diagnosis.**