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# Simultaneous EEG-fNIRS to explore sensory prediction as a screening tool for neurodevelopmental disorders Marais, A-L.<sup>1\*</sup>, Dumont, V.<sup>1</sup>, Anquetil, M.<sup>2</sup>, Roche-Labarbe, N.<sup>1</sup>

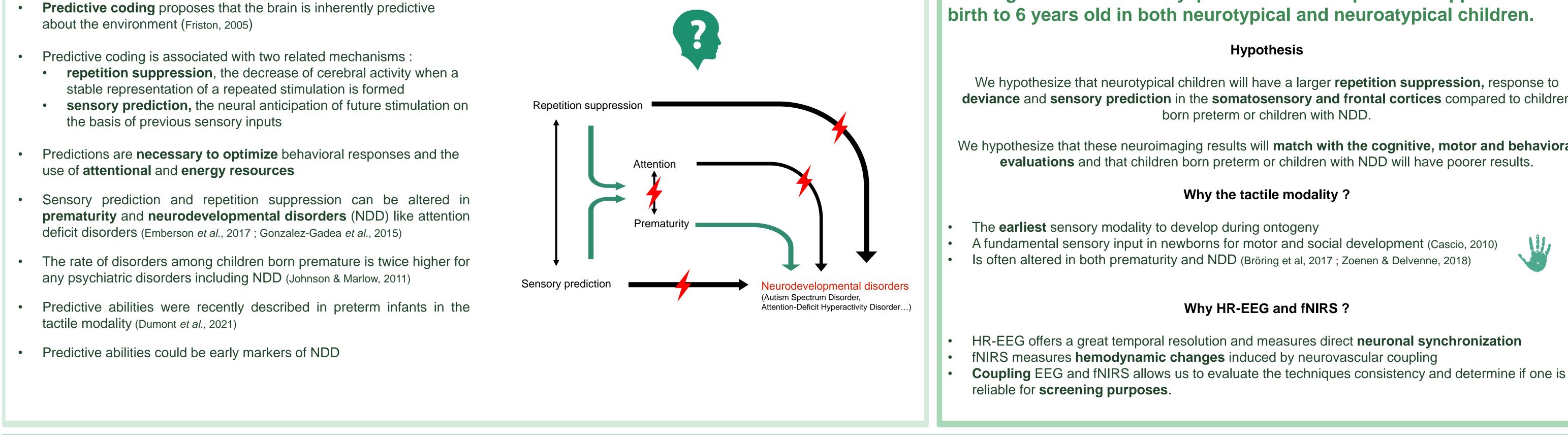


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## THEORETICAL BACKGROUND

- **Predictive coding** proposes that the brain is inherently predictive about the environment (Friston, 2005)
- - repetition suppression, the decrease of cerebral activity when a stable representation of a repeated stimulation is formed
  - sensory prediction, the neural anticipation of future stimulation on the basis of previous sensory inputs
- Predictions are **necessary to optimize** behavioral responses and the use of attentional and energy resources
- deficit disorders (Emberson *et al.*, 2017 ; Gonzalez-Gadea *et al.*, 2015)



## AIMS

Investigate somatosensory prediction and repetition suppression from

deviance and sensory prediction in the somatosensory and frontal cortices compared to children

We hypothesize that these neuroimaging results will match with the cognitive, motor and behavioral

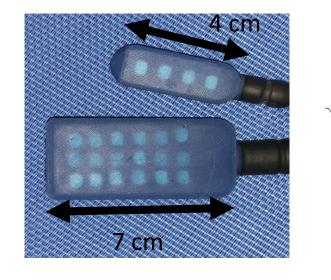
## MATERIAL & METHODS

Population			
Birth	2 yo N = 40	4 yo N = 40	6 yo N = 40
N = 40 20 Extreme preterm 20 Late preterm	20 Preterm 20 Term	20 Preterm 20 Term	20 NDD 20 Typical
EEG+fNIRS Tactile protocol at 35 weeks of gestational age	EEG Tactile protocol	EEG Tactile protocol + cognitive, behavioral and motor evaluations	EEG Tactile protocol + cognitive, behavioral and motor evaluations

### Oddball-omission protocol

	Familiarization	Oddball-omission protocol	Familiarization control
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Newborn-size matrix and children-size matrix



Direction of the vibration for standard VS deviant stimulation (counterbalanced)

### EEG and fNIRS acquisition

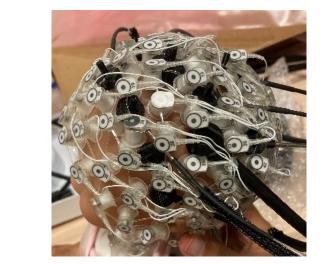
- 128 channels EEG (Magstim EGI, Eugene OR, USA), sampling rate : 1000 Hz
- 8 channels fNIRS (Imagent, ISS, Champaign IL, USA), sampling rate : 12.5 Hz

### EEG preprocessing

• In Netstation, data are bandpass-filtered (1-20 Hz) and segmented (100 ms before to 900 ms after stimulation and 7000 ms for the omissions). Segments are



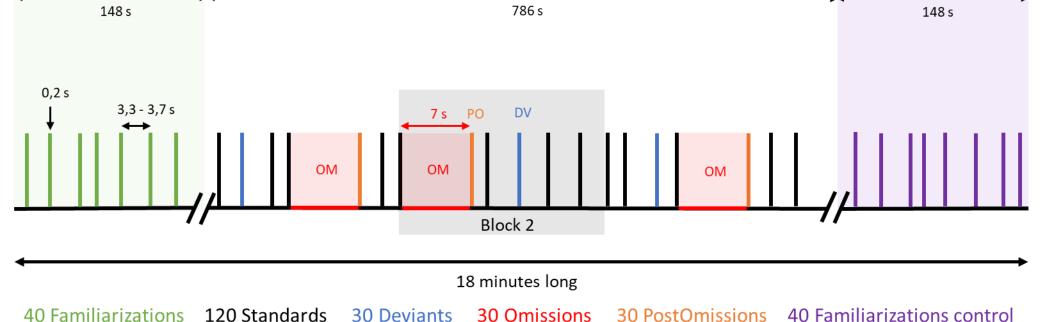
### A 12 months old child wearing the EEG net





### EEG net and fNIRS placed on a preterm doll head

A 5 years old child ready to get the tactile protocol



visually inspected to remove artifacts before averaging. We apply baseline correction to all the segments at 100ms before stimulus onset. Tha data are averaged and analized with MATLAB.

### fNIRS preprocessing

• Homer 3 (https://github.com/BUNPC/Homer3) is used to preprocess the data. After converting the data to hemoglobin concentration, they are bandpass filtered (0.02-0,3 Hz) and segmented per condition. Segments containing movements artifacts are discard. Data are block-averaged to obtain the mean responses per condition.





A child taking the psychomotor evaluation

04 ADULT PR	RETESTS RESULTS				05 DISCUSSION
Participants' characteristics					Preliminary observations :
We recorderd simultaneous	our protocol during a pretest on 5 EEG and fNIRS	adults			<ul> <li>Repeated stimulations elicit weaker event-related activity in both EEG and fNIRS : we observe repetition suppression in adults with this protocol.</li> </ul>
Event-related analysis     EEG pretest results			fNIRS pretest results		<ul> <li>Omission elicits a frontal hemodynamic response and a somatosensory post-omission response in EEG</li> </ul>
A -3 -2 -2 -2	B -3 -2 -2	C -3 -2 Deviant Standard	D 2 ×10 <sup>-5</sup> HbO Familiarization 1.5 HbO Control	2 × 10 <sup>-5</sup>	<ul> <li>Responses are dissociated in location : somatosensory area for the EEG and frontal area for the fNIRS</li> </ul>
$\geq$ 0 $\wedge$	= 1 $\geq 0$ $AAAAAA$				<ul> <li>EEG might be more relevant for the study of response to deviance.</li> </ul>
			-0.5		Conclusion :
َةِ مَدَيْهُ عَ مَدَ عَ مَدَةً مَعَ مَدَةً عَ مَدَةً مَدَةً مَدَةً مَدَةً مَدَةً مَدَّةً مَدَّةً مَدَّةً مَدَّ ms Somatosensory repetition suppression	<sup>الج</sup> المحمد ال	َةِ <sup>ح</sup> مَّ <sup>ال</sup> اللَّهُ اللَّعُمَّ اللَّهُ اللَّالِي اللَّهُ اللَّالِي اللَّالِي اللَّالِي اللَّالَ اللَّالِي مُعَالِي مُوالللَّالِي مُعَالِي مُعَالِي مُعَالِي مُواللَّالِي مُوالِي مُواللِي مُواللِي مُواللِي مُوالِي مُواللِي مُوالِي مُواللَّالُ مُولِي مُولِي مُولِي مُولِي مُوالللِ	Frontal repetition suppression	Frontal omission	The aim of this study is to investigate early mechanisms

Gray areas represent stimuli, red areas represent omissions.

A. The amplitude of the electrical response is weaker during the control phase compared to the familiarization for the N140 and the P200 in the somatosensory cortex. **B.** The amplitude of the electrical response during the postomission is greater at P200 in the somatosensory cortex. **C.** The amplitude of the electrical response is greater at P100, N140 and P200 during the deviance in the somatosensory cortex. **D.** There is an weaker increase of HbO and decrease of HbR during the control phase compare to the familiarization in the frontal cortex. E. There is an increase of HbR and a decrease of HbO during the omission in the frontal cortex.

necessary for the development, sensory prediction and repetition suppression, using the tactile modality in children from birth to 6 years old to understand early developmental trajectories of children born preterm and children with NDD.



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