fNIRS in child and infant studies

1. INTRO

Several neuroimaging techniques are available for the study of the infant brain, designed either to detect direct activation related to electrical activity in the brain (e.g. EEG or MEG) or the coupled hemodynamic response (e.g. PET, fMRI and fNIRS). While being very well established for adults, many of these techniques have limitations making their application to infants hard or even impossible. While some of them require the use of radioisotopes (PET), others, like MRI or MEG require the infant to remain very still. EEG allows for relatively fast setup time and is well tolerated by infants, however, the signal is subject to motion or environment artefacts.

Because of that, the application of most of these brain imaging techniques has been restricted to studies of sleeping or sedated infants. The field lacked a safe, fully non-invasive and participant friendly modality with which to probe the infant brain. fNIRS has filled this gap, opening up the way for new discoveries.

NIRx flat tip NIRS optode, ideal for use on neonates and infants.

Flat probes sit directly in NIRScaps to maximize comfort.

2. ADVANTAGE OF FNIRS IN INFANT AND CHILD STUDIES:

- Fast setup time
- No gel required
- Completely non-invasive (no tracer needed)
- Good penetration into cortex
- Robustness to motion and noise

3. CONSIDERATIONS

fNIRS has become a reliable, easy-to-use, and efficient tool to explore the infant brain. The degree of infant tolerance needed is extremely low, considering the noninvasive and light weight setup and fast preparation times. Since the pioneer studies in functional brain activation in infants, the number of published NIRS infant and child studies has rapidly increased. fNIRS has been used to address topics such as speech perception and language development, social communication and social interaction, object processing, human action processing and developmental disorders.

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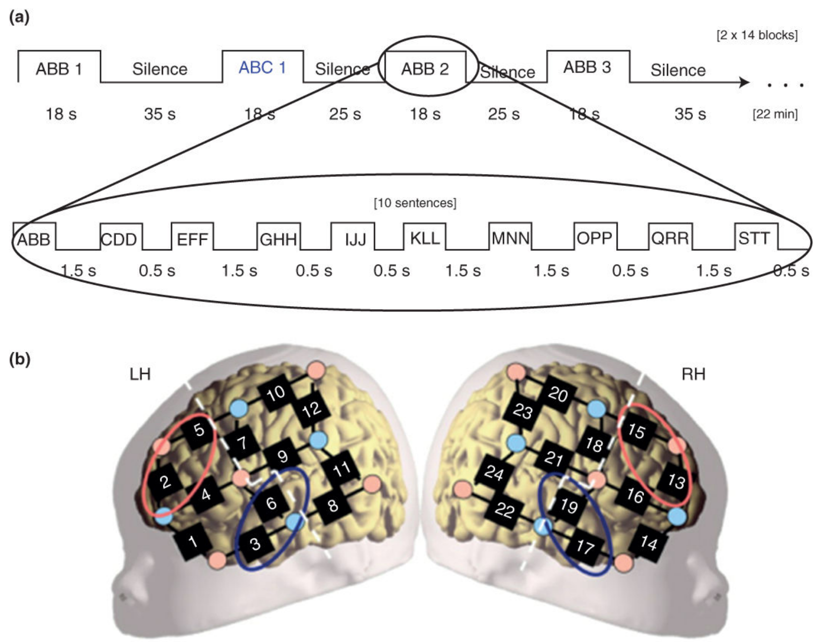
4. FNIRS USE CASE 1: SPEECH PERCEPTION, LANGUAGE DEVELOPMENT

Probe placement and experiment design as in [1]. "Newborns can discriminate speech sequences that follow a regularity, such as the repetition-based ABB rule (e.g. 'mubaba', 'penana', among others), from otherwise similar random sequences (ABC: 'mubage', 'penaku', among others)."

Although individual variation can never be excluded, this placement should ensure recording from perisylvian and anterior brain regions. The dashed white lines separate anterior and posterior ROIs. The red ellipses indicate the channels included in the frontal area of interest. The blue ellipses indicate channels included in the temporal area of interest.

The results indicted greater hemodynamic responses to ABB sequences rather than ABC sequences in the bilateral temporal and left frontal areas.

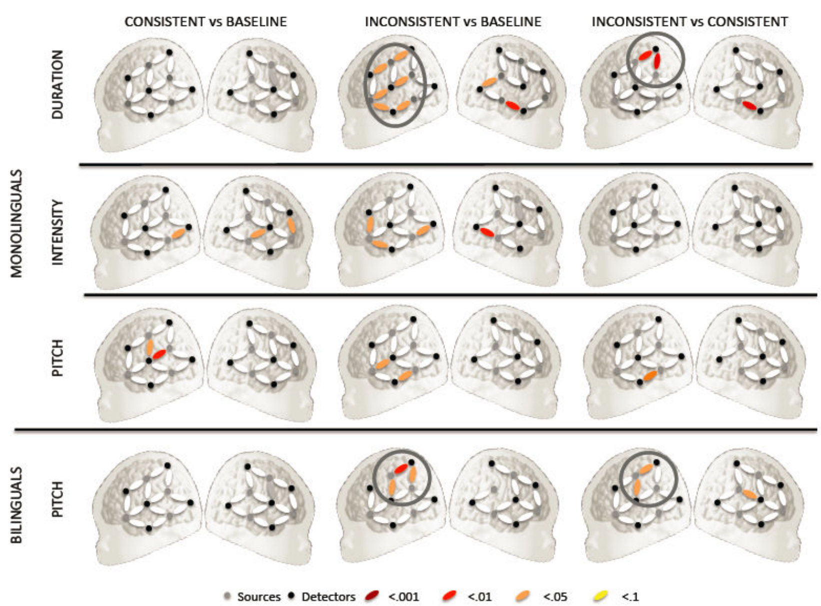


5. FNIRS CASE 2: MULTILINGUAL BRAIN

Prosody perception at birth [2]. Study of the effect of variations in pitch, duration and intensity in the speech signal in monolingual and bilingual newborns.

Prosodic cues are implemented in each language differently in such a way that there is always a dominant cue. NIRS has been used to understand whether newborns are already able to discriminate prosodic variations.

It is also very interesting to understand how bilingual newborns react to variations in prosodic cues which are dominant in one of their native languages but not in the other.



[1] Gervain, Judit. "Plasticity in early language acquisition: the effects of prenatal and early childhood experience." *Current opinion in neurobiology* 35 (2015): 13-20.
[2] Abboub, Nazzi, Gervain, 2015 (under revision)
[3] Bouchon, C., Nazzi, T., & Gervain, J. (2015). Hemispheric asymmetries in repetition enhancement and suppression effects in the newborn brain. PlosOne, in press.