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AUDITORY OBJECTIVE MEASURES

Electroencephalographic measurements of auditory development in the first year of life

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Introduction

The development of hearing begins very early in life (from the 3rd trimester of gestation infants begin to perceive sounds) and continues until the end of adolescence. Already at birth, even with little linguistic experience, infants are able to differentiate speech sounds, i.e., phonemes [1].

It is therefore crucial to understand the extent to which auditory development influences language acquisition. Auditory development can be characterized using three auditory measurement recorded in electroencephalography (EEG). Auditory Brainstem Response **(ABR)** assesses auditory brainstem function in response to auditory stimuli; Frequency Following Response **(FFR)** is a neural response synchronized (e.g., phase-locked) with the oscillations of a sound and thought to reflect brainstem activity; and Auditory Steady State Response **(ASSR),** reflects the auditory brain activity following the amplitude modulation (AM) of sounds [2, 3].

The aim of this study is to explore the auditory development in the first year of life by using electroencephalographic (EEG) methods. Three recordings targeting different auditory structures from the auditory nerve up to the auditory cortex are measured in infants using a longitudinal design. A group of typically developing infants are tested both at 3 and 10-months of age **while awake**. The data collection is still ongoing (target N = 50). We present here the preliminary data from 3-months-old-infants.

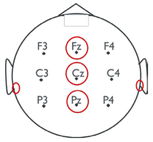
Material and methods

In the **ABR** experiment, N=26 infants hear 2000 repetitions of click sounds, played at 60 dB SPL, via an insert ear-tip placed in the right ear. We measure latency and amplitude of the neural wave V.

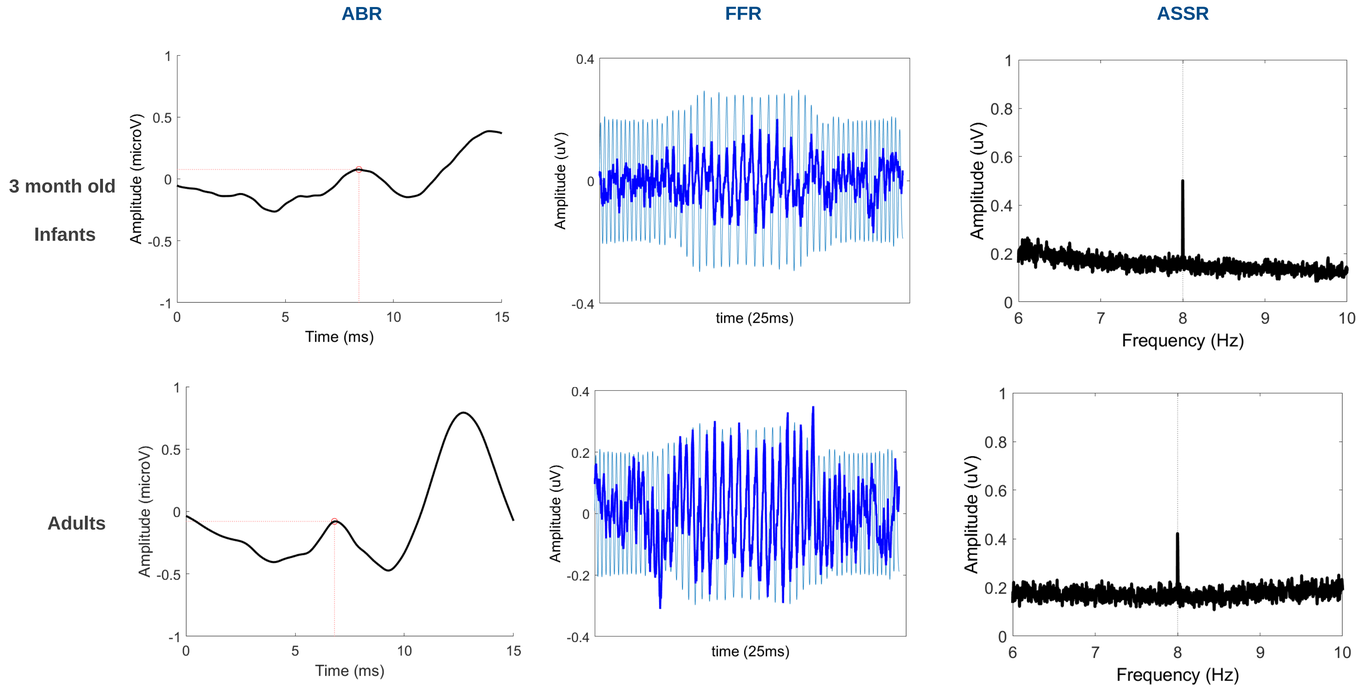
In the **FFR** experiment, N=24 infants hear 8-min-long saw-tooth wave centred at 220 Hz with frequency modulation of 4 Hz, played at 60 dB SPL, in free field.

In the **ASSR** experiment, N=21 infants hear 4-min-long pure tones (1027 Hz) sinusoidally modulated at 8 Hz, played at 75 dB SPL in free field. We measure signal-to-noise ratio (SNR) of individual ASSR at 8 Hz.

These measurements were also taken on a group of adults (N=20) acting as a control group.



Results



Average of all participants' results are presented here.

- In the **ABR** experiment, we observe Wave V. For the 3 month-old infant group and adult group respectively, the mean amplitude of this wave is **0.0764 µV** and **-0.0794 µV** and the mean latency is **8.40 ms** and **6.80 ms**.
- In the **FFR** experiment, we observe a better neural synchronisation with the frequency modulation of sound in adult than in infants. SNR values for each harmonic will be further explored.
- In the **ASSR** experiment, we observe a response at 8 Hz that reflects the brain's phase locking with the amplitude modulation of the sound. A significant ASSR is observed in **61%** of infants and **25**% of adults.

Conclusions

These preliminary results showed that it is possible to record these three auditory neural measures in awake 3-month-old infants for a total duration of 15 minutes and using a minimal EEG montage. Our results are promising for clinical assessments of auditory functions during infancy. Our longitudinal study will also provide crucial information about auditory development from early to late stages of neural sound processing, that are supposed to be highly related to speech and language development. To go further, we will look at the relationship between these objective auditory measures, the processing of speech in noise, as well as language development for the same group of normal-hearing infants.

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[1] Saffran, J. R., Werker, J. F., & Werner, L. A. (2007); The Infant's Auditory World : Hearing, Speech, and the Beginnings of Language. [2] Lorenzini, I., Labendzki, P., Hababou, M., Basire, C., Calcus, A., Cabrera, L. (2022); Human neural processing of auditory temporal modulations during the first year of life. [3] Verhulst, S., Jagadeesh A., Mauermann, M., and Ernst, F. (2016); Individual Differences in Auditory Brainstem Response Wave Characteristics: Relations to Different Aspects of Peripheral Hearing Loss

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