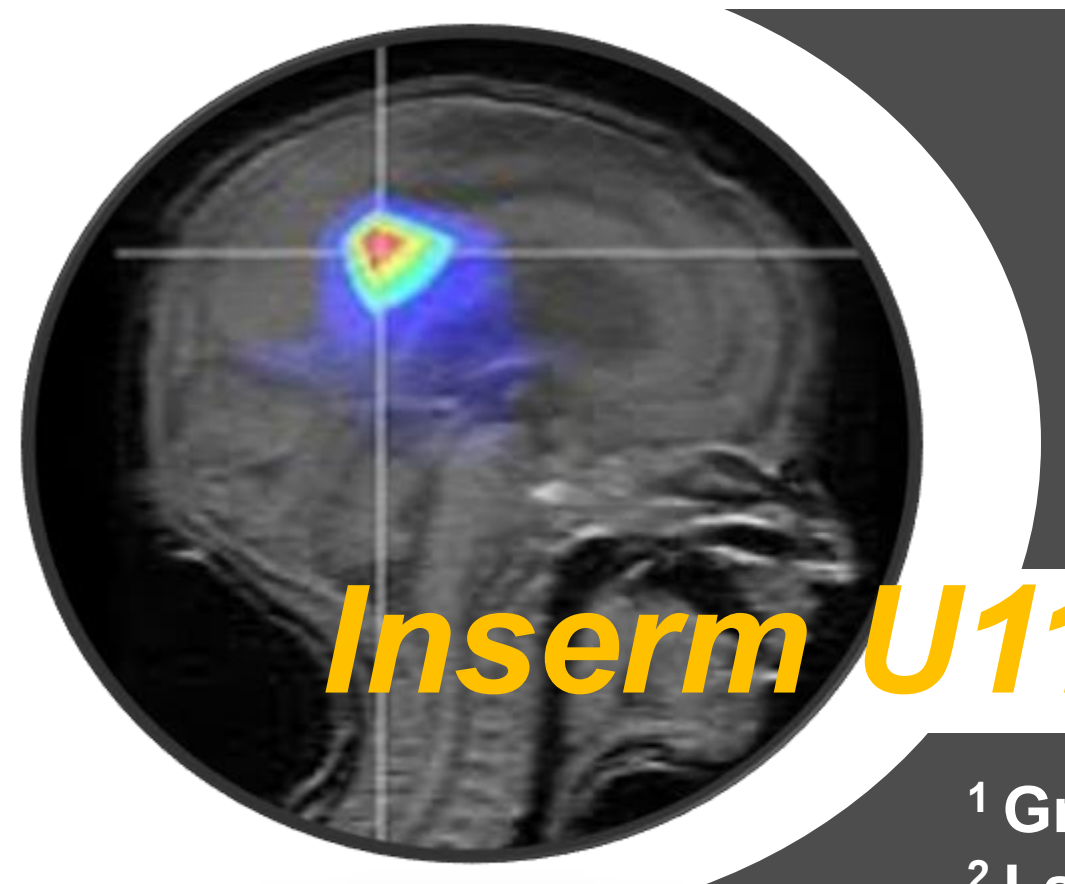




Exploring the impact of tactile stimulation on rhythm perception in newborns

Monica S Hegde¹, Mohammadreza Edalati¹, Anne Kosem³, Arthur Foulon¹, Barbara Tillmann², Sahar Moghimi¹

¹ Groupe de Recherches sur l'Analyse Multimodale de la Fonction Cérébrale (GRAMFC, Inserm UMR1105), Université de Picardie, 80054 Amiens, France

² Laboratory for Research on Learning and Development, CNRS-UMR 5022, Université Bourgogne Europe, 21000 Dijon, France

³ Lyon Neuroscience Research Center (CRNL), INSERM U1028, 69500 Bron, France

1 Introduction

From the womb, infants are immersed in a **rhythmic world** (maternal heartbeat, voice melodies). These early sensory experiences are fundamental for **cognitive and social development**. After birth, rhythmic interactions continue through **patting, rocking, lullabies, and infant-directed speech**, facilitating **attention, learning, and early communication**.

Tactile stimulation and **singing** are natural, pervasive forms of stimulation critical for infants' **rhythm perception**. Understanding how the combination of these stimuli influences **rhythm perception and multisensory integration** from birth is essential.

This study explores how newborns process complex rhythmic structures, a process key to **language development [1]**, **musical behaviors**, and **social interactions [2]**. We aim to understand the impact of rhythmic tactile stimulation on rhythm perception and its role in early cognitive development.

2 Materials & Methods

Participants

Full-term newborns (target N = 40, tested so far: 28; 22 with analyzable data)

Age: within 4 days of birth

Recruited at Amiens University Hospital (CHU Amiens-Picardie)

Stimuli

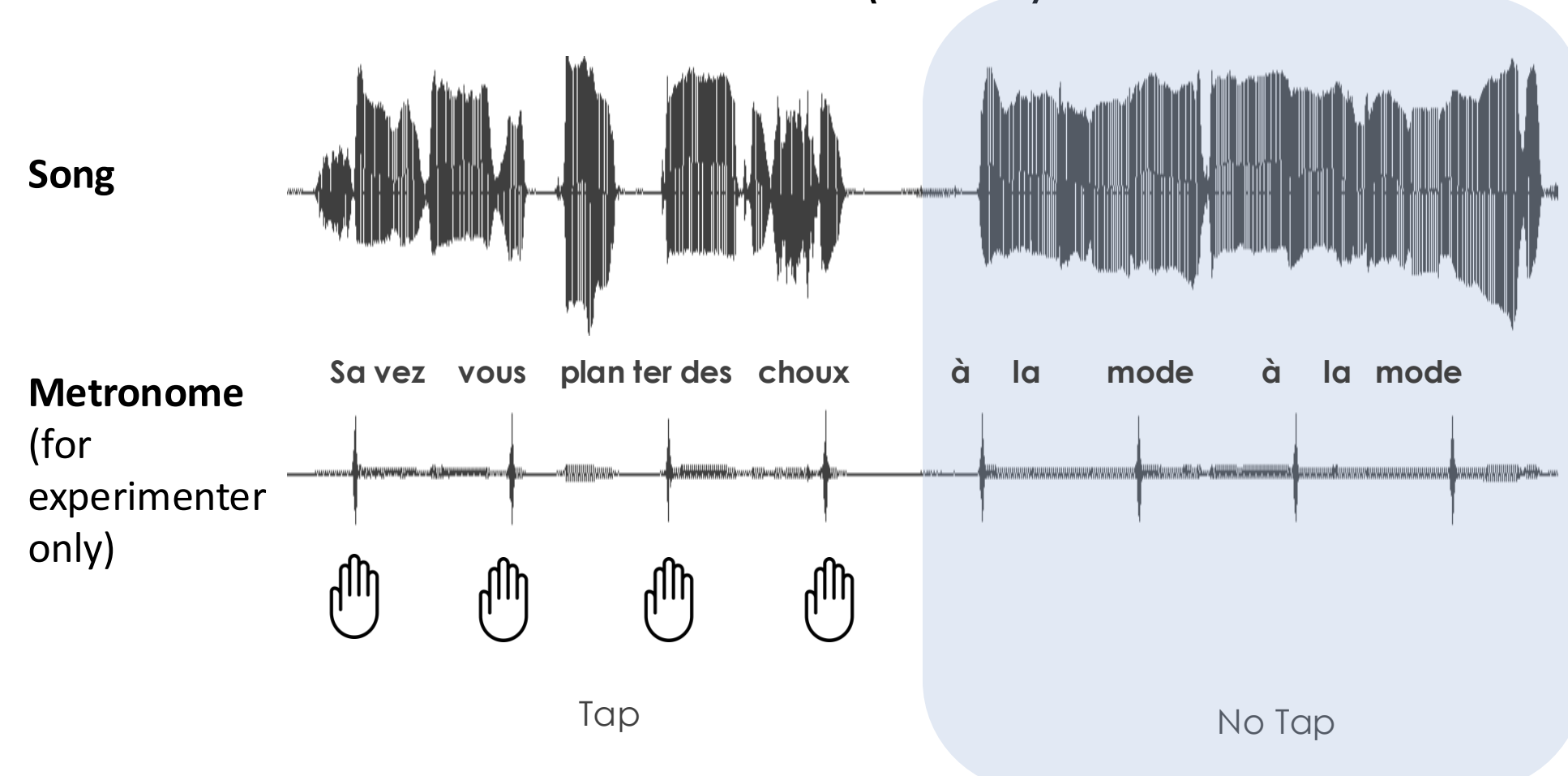
Conditions:

(1) **Auditory-only (A)** → lullabies at musical 2 Hz (beat level; 120bpm)

(2) **Auditory-tactile (AT)** → lullabies (2 Hz) + patted tactile input at 1 Hz (strong beat; 60 bpm)

Structure: Repeating blocks of 4 beats

tactile / 4 beats no tactile (AT-A)



Stimulus Design

Songs and Repetitions

Ten Pseudorandomized Blocks: Each song contributes Tap/NoTap trials across both conditions

All infants hear the same songs (i.e., same number of trials) in both conditions.

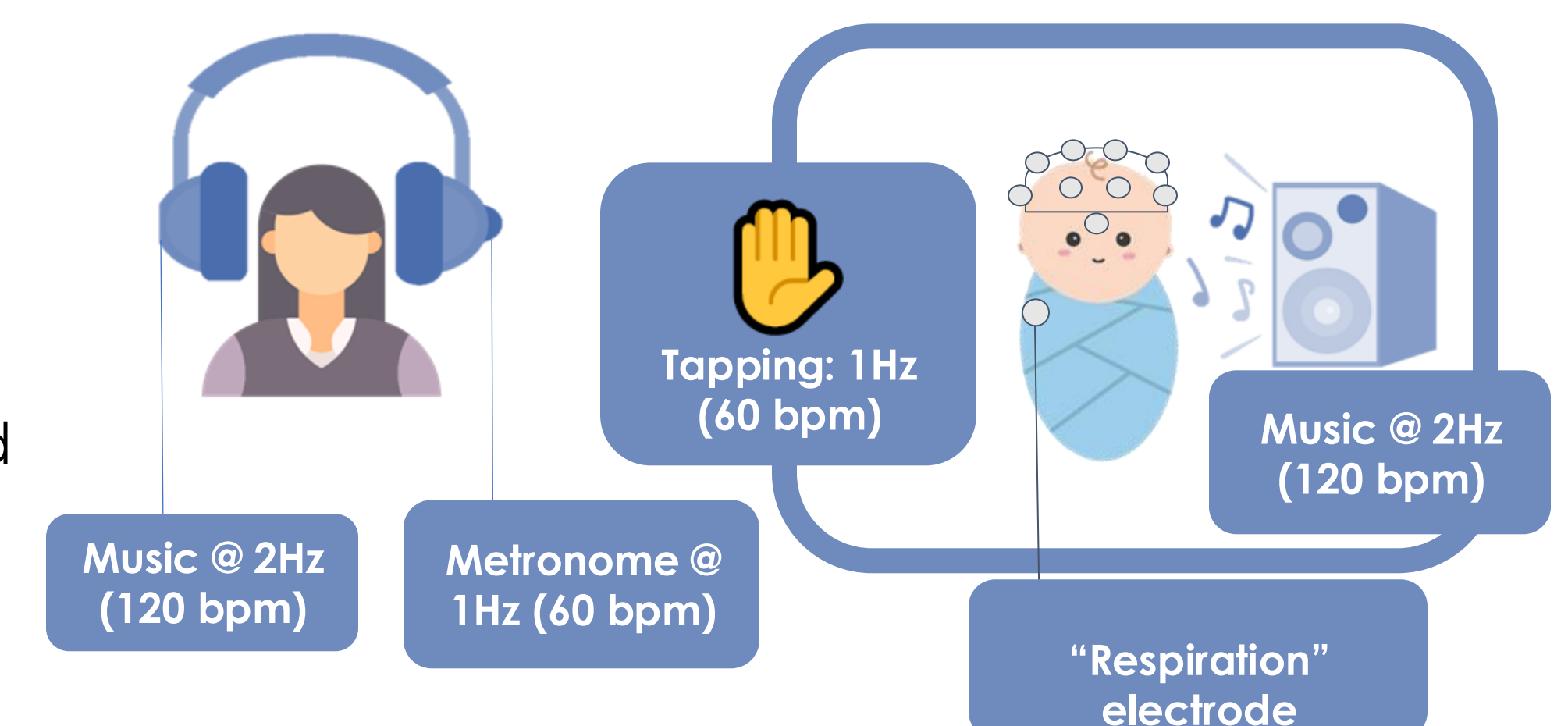
Song 1 Ah! Vous dirai je, maman	Song 2 Savez-vous planter des choux	Song 3 Au clair de la lune	Song 4 Dans la forêt un grand cerf	Song 5 Doucement s'en va le jour
24s (3 Tap/NoTap trials x 7 reps = 168s (21 Tap/NoTap trials))	32s x 6 reps (4 Tap/NoTap trials) = 192s (24 Tap/NoTap trials)	32s x 6 reps (4 Tap/NoTap trials) = 192s (24 Tap/NoTap trials)	31s x 6 reps (4 Tap/NoTap trials) = 186s (24 Tap/NoTap trials)	31s x 6 reps (4 Tap/NoTap trials) = 186s (24 Tap/NoTap trials)

Procedure

EEG recorded using 128-channel EGI system

Baby placed supine in crib

Sounds played through speaker; tactile patted manually

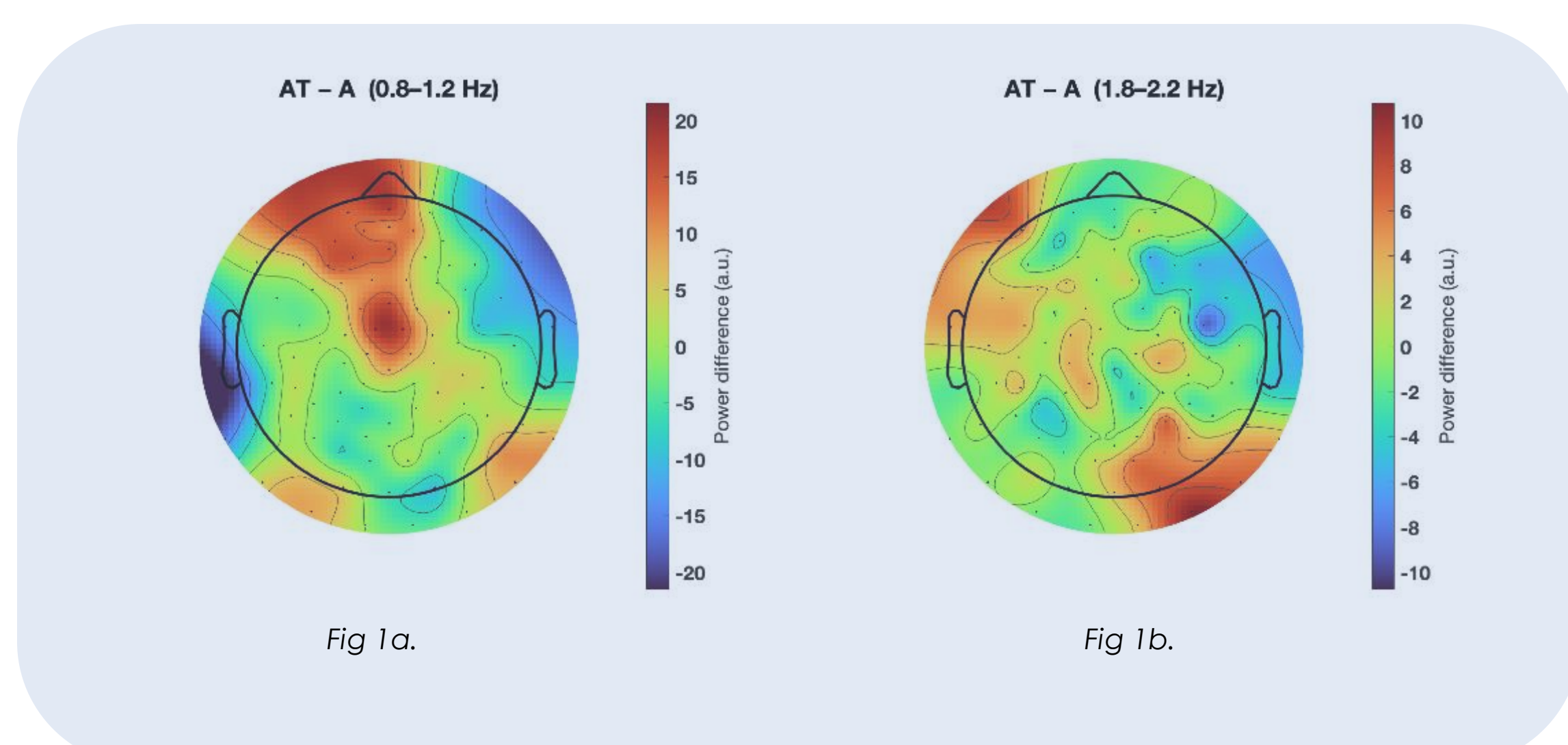


EEG Recording & Preprocessing

- Recorded at 1000 Hz, then downsampled to 500 Hz • Bandpass filtered (0.5–25 Hz)
- Artifact cleaning: ICA and ASR (Artifact Subspace Reconstruction)
- Epoching time-locked to NoTap window in both conditions (post-tap silent window in AT, matched window in Auditory-only)

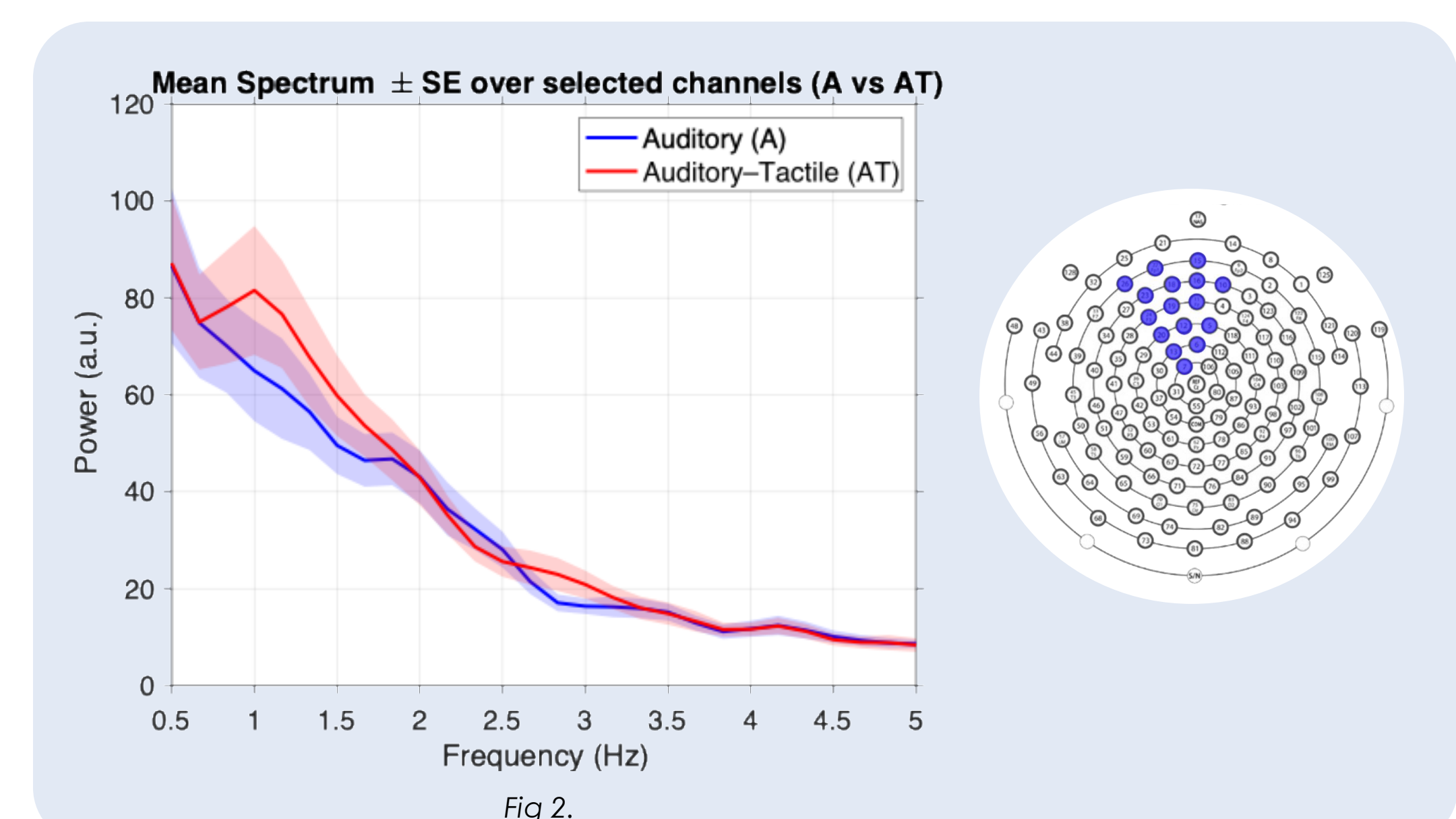
3 Preliminary Results

In the **Auditory-Tactile** condition compared to the **Auditory-only** condition, we expect increased neural power at **1 Hz** (the beat and tapping frequency) and possibly around **2 Hz** (its harmonic). Preliminary results show enhanced activity in **frontocentral regions** around **1 Hz** (Fig. 1a, 2), but effects are less clear around **2 Hz** (Fig. 1b).



Next steps:

- Increase the sample size to improve signal-to-noise ratio.
- Conduct **coherence** and **mTRF analyses** to assess brain-stimulus synchronization and quantify the unique variance explained by **amplitude envelope** and **spectral flux**.



4 References

- [1] Goswami, U. (2022). Language acquisition and speech rhythm patterns: an auditory neuroscience perspective. Royal Society Open Science, 9 (7), 211855.
- [2] Cirelli, L. K., Trehub, S. E., & Trainor, L. J. (2018). Rhythm and melody as social signals for infants. Annals of the New York Academy of Sciences, 1423 (1), 66–72.