

# Neural coding of auditory rhythm develops in the course of the third trimester of human gestation

Inserm U1105

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## 1 Introduction

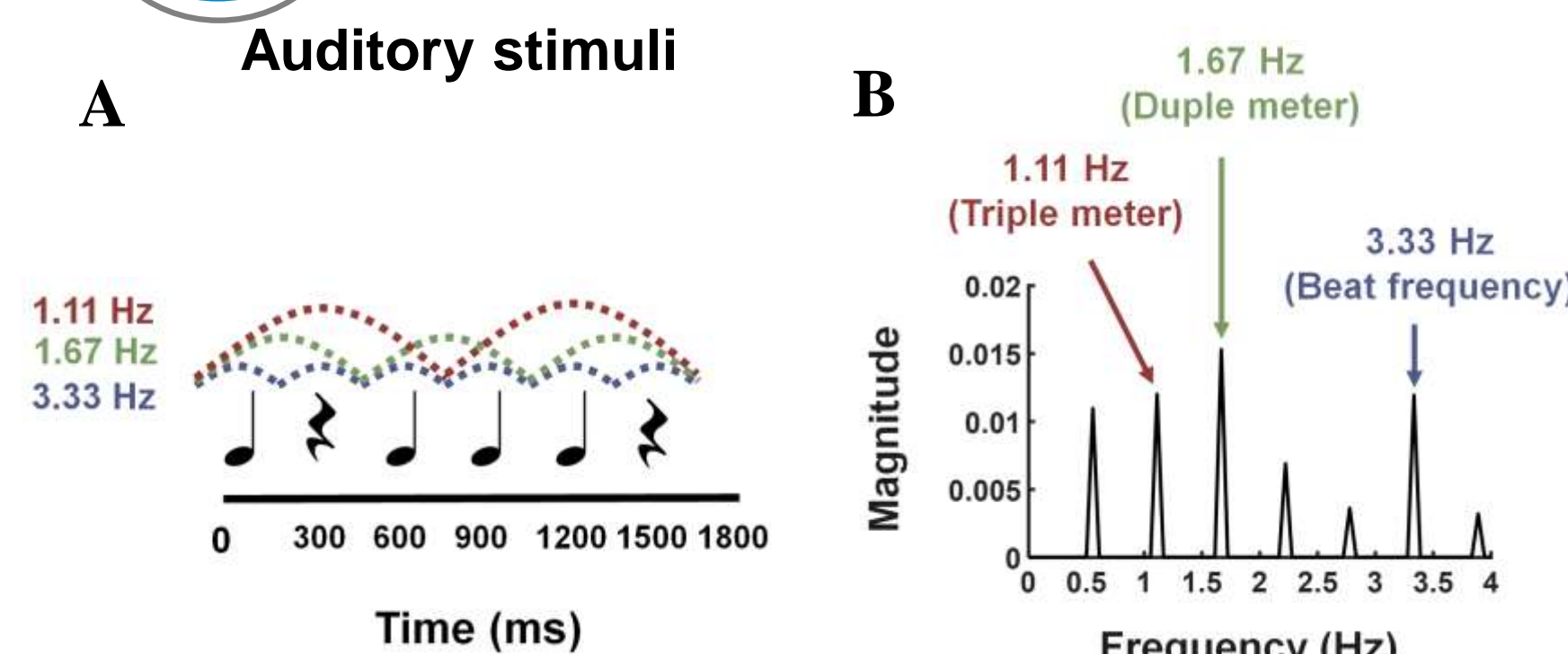
Rhythm perception and synchronization to periodicity at different timescale are of high importance from the developmental point of view for language development, music behaviors, bonding, and social interaction early in development.

• We evaluated how the encoding of the metrical hierarchy (from beat to meter) develops and evolves in the course of the third trimester of gestation by comparing brain-stimulus synchronization at the beat- and meter-related frequencies between two groups of premature newborns.

## 2 Materials & Methods

**Participants:** Forty-six healthy premature neonates, with a mean recording age of  $32.46 \pm 2.13$  wGA, divided into two groups, based on their age at the time of recording:

- Age range of 28-33 wGA: n = 23
- Age range of 33-36 wGA: n = 23

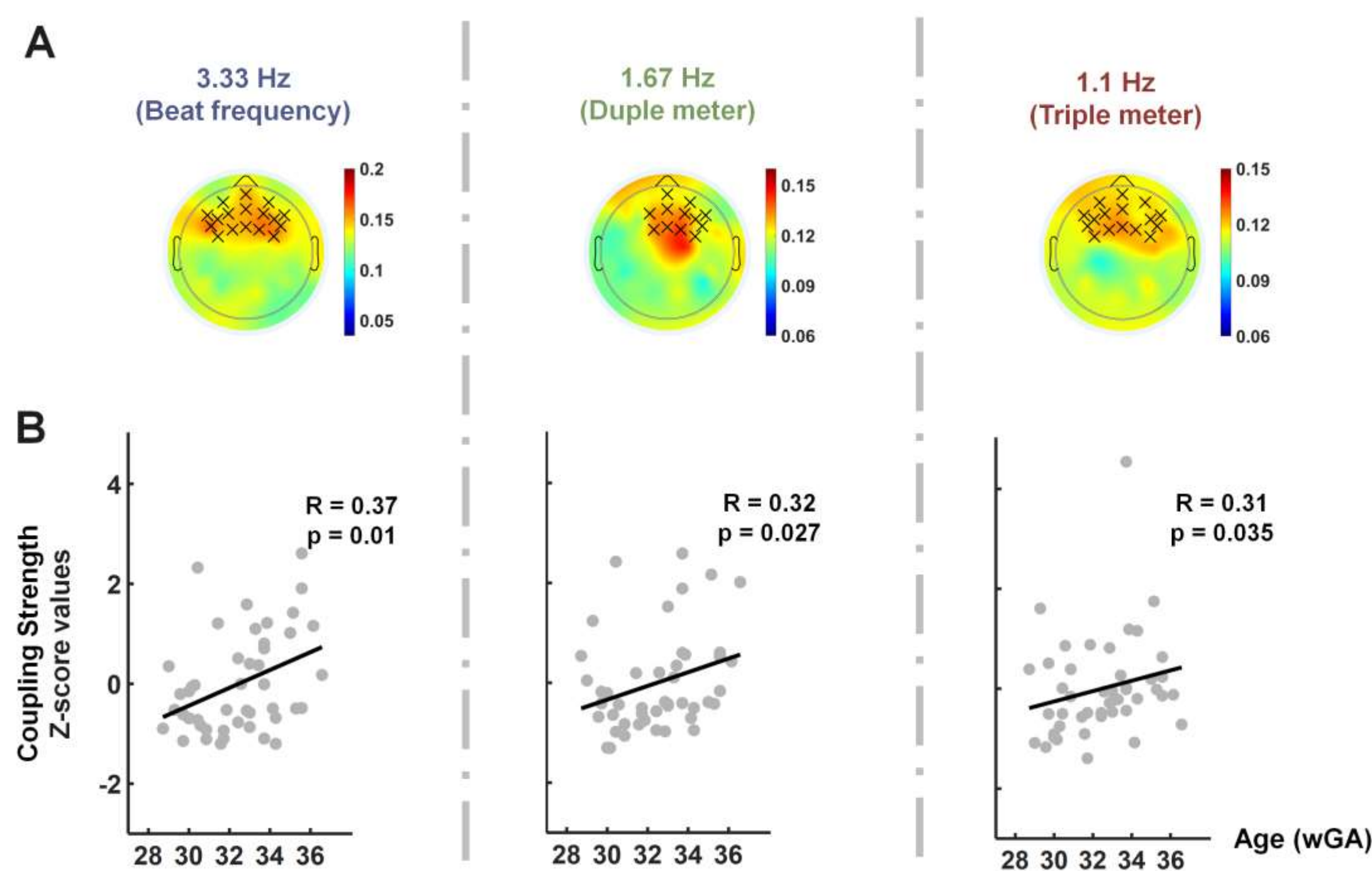


**Figure 1:** (A) Single repetition of the 6-beat ambiguous pattern. The dashed lines: the beat and metrical levels. (B) The frequency spectra of the stimulus sound envelope.

**Brain-stimulus synchronization:** To evaluate the brain's synchronization (coupling strength) to the rhythmic sequences at beat and meter frequencies, we computed the phase difference between narrow-band filtered neural oscillations and the beat, duple, and triple periodic dynamics, approximated with sinusoidal oscillations at 3.33 Hz, 1.67 Hz, and 1.11 Hz, respectively.

## 3 Results

### Gradual evolution of the Neural synchronization with gestational age



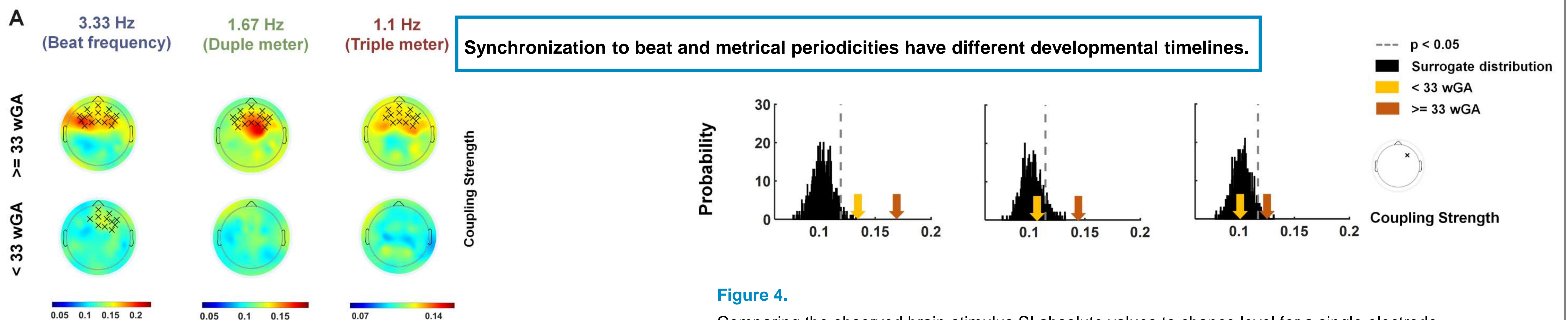
Neural synchronization to the rhythmic hierarchy develops gradually with gestational age for both beat and meter related frequencies.

**Figure 2.**

(A) The topographical scalp distributions of the grand average SI absolute values for both beat and meter related frequencies. (B) Relation between gestational age and neural response to the rhythmic hierarchy.

- Significant fronto-central cluster (black crosses) at both beat and meter related frequencies.
- Correlation analyses on the detected clusters, on the full cohort revealed significant for both beat and meter related frequencies.

### Development of neural Synchronization, from beat to metrical periodicities



Synchronization to beat and metrical periodicities have different developmental timelines.

**Figure 3.**

The topographical scalp distributions of the average SI absolute values

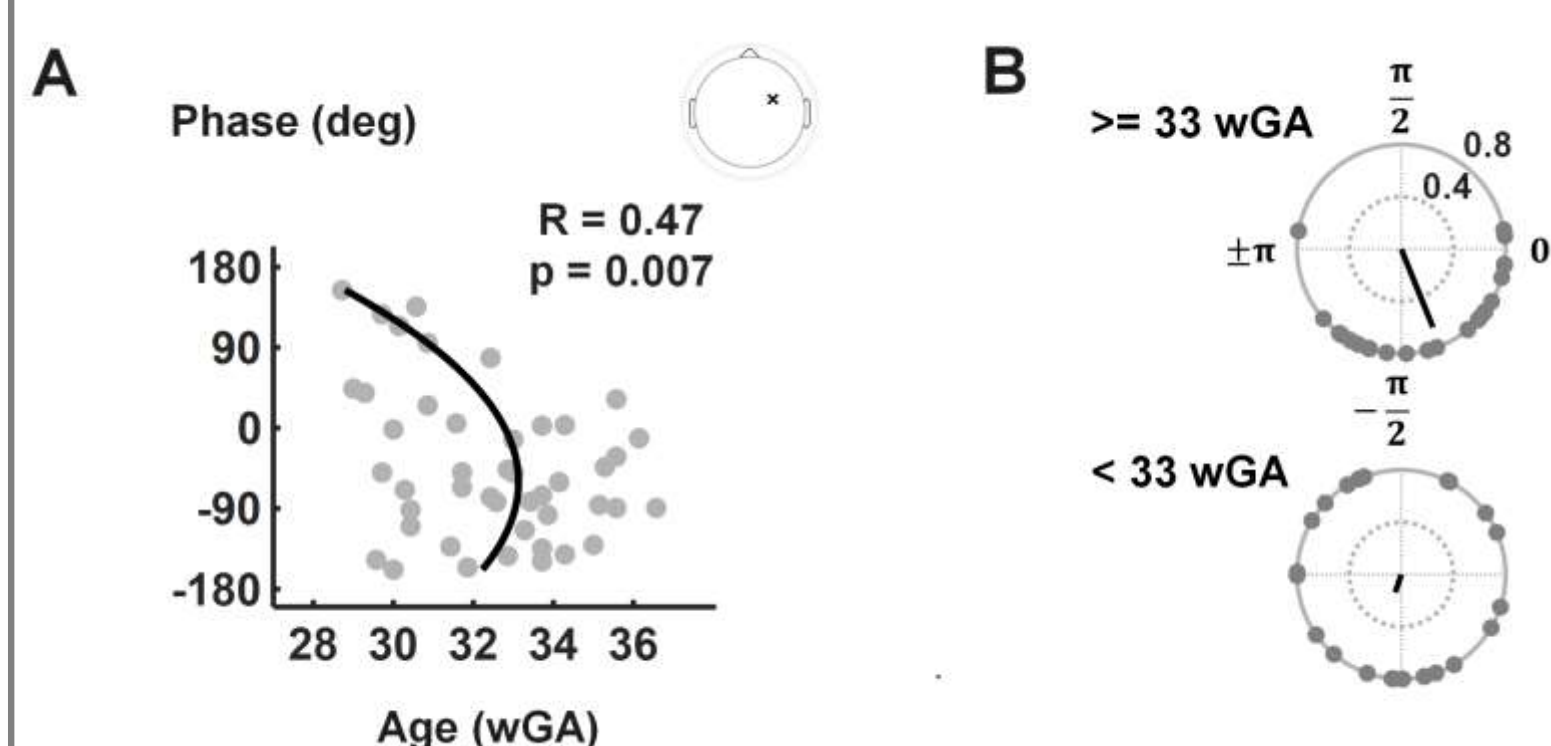
- For the older group significant clusters at both beat and meter related frequencies.
- For the younger group significant frontal cluster, only for the beat frequency.

**Figure 4.**

Comparing the observed brain-stimulus SI absolute values to chance level for a single electrode.

- Coupling strength was on average above chance level for both age groups at the beat frequency.
- Coupling strength was below the chance level for younger group, whereas it was above the chance level for older group at meter related frequencies.

### Modulation of synchronization to the beat periodicity with gestational age



Synchronization to the beat periodicity becomes more stable with gestational age.

**Figure 6.**

(A) Circular-linear scatter plot at beat frequency for one electrode. (B) Comparing phase coupling distribution between the older and younger age groups.

- There is a stable phase difference between the neural oscillations and the beat periodicity during late gestation.
- We observe a decrease in the variability of the coupling phase among participants with an increase in gestational age at birth

## 4 Conclusion

- Both younger and older age groups neurally synchronized to the fast periodicity related to the beat.
- However, neural synchronization to the meters, which necessitates the neural representation of the groupings, was present only in the older group.
- Coupling to beat periodicity becomes stable with gestational age at birth with a slow phase difference, similar to previous observations in adults.

## 5 Contact Information

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