

# Functional Differences in the Neural Substrates of Auditory Cognition as a Consequence of Music Training

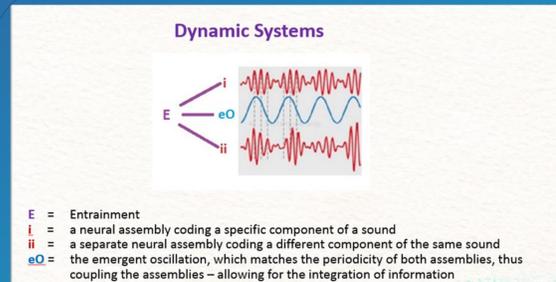
Naomi du Boisa\*, José M. Sanchez Bornot<sup>a</sup>, Dheeraj Rathee<sup>a, b</sup>, KongFatt Wong-Lin<sup>a</sup>, Pramod Gaur<sup>a, c</sup>, Mark A. Elliott<sup>d</sup>, and Girijesh Prasad<sup>a</sup>

a Intelligent Systems Research Centre, University of Ulster, Magee Campus, Derry, NI, UK  
 b School of Computer Science and Electronic Engineering, University of Essex, Colchester, UK  
 c Birla Institute of Technology & Science, Pilani, Dubai Campus, UAE.  
 d School of Psychology, National University of Ireland, Galway, Republic of Ireland  
 \* Corresponding author: Naomi du Bois



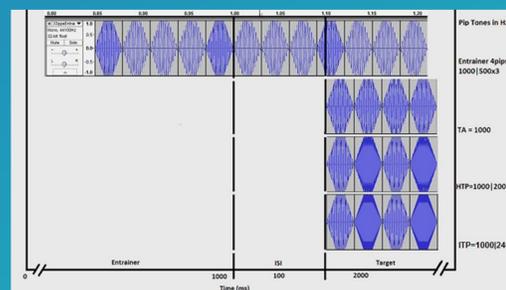
## Background

- This study investigated differences in the neural dynamics of the auditory perceptual system of individuals with music training compared to those with no music training.
- Previous studies have demonstrated that musical deviants (syntactically irregular chords) elicit event related potentials/fields with negative polarity.
  - The early right anterior negativity (ERAN) and the right anterior temporal negativity (RATN) responses with peak latencies at ~200 ms and ~350 ms, respectively, post stimulus onset<sup>1, 2</sup>.
- Magnetoencephalography was used to examine the neural response to a deviant sound when the auditory system was primed using stimulus entrainment to evoke an auditory gamma-band response between 31 Hz and 39 Hz, in 2 Hz steps.
- Participants responded to the harmonic relationship between the entrainment stimulus and the subsequent target stimulus.
- Gamma frequencies carry stimulus information; thus, the paradigm primed the auditory system with a known gamma frequency and evaluated any improvement in the brains response to a deviant stimulus.



Above: Entrainment refers to the alignment in phase, or coupling of two independent oscillatory systems, in such a way that their periods of oscillation become related<sup>3</sup>.

## The Auditory Priming Paradigm



Above: The auditory priming paradigm uses stimuli, referred to as pip-trains, to prime the system with entrainment frequencies (the eO), and examines any facilitating effects in known responses to deviations from the harmonic structure of a sound

## The experimental procedure

- Location: Northern Ireland Functional Brain Mapping (NIFBM) facility, UU, Magee Campus, Derry.
- Sample: Adults - Group 1 ( $n = 11$ ); musicians (+/>grade 4), Group2 ( $n = 10$ ); no music training.
- Instructed to attend to the first stimulus – the entrainer and respond as rapidly and accurately as possible to the second stimulus – the target.

Scan the QR codes to hear the 33 Hz entrainment trial.



Target Absent (TA) trial

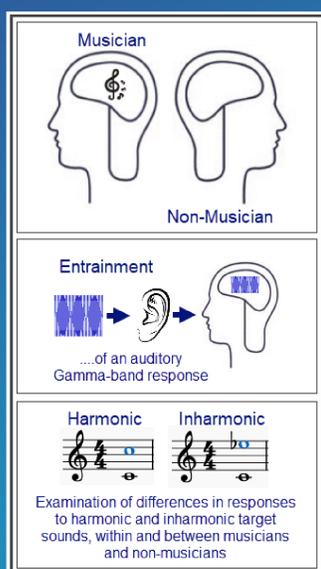


Harmonic Target Present (HTP) trial



Inharmonic Target Present (ITP) trial

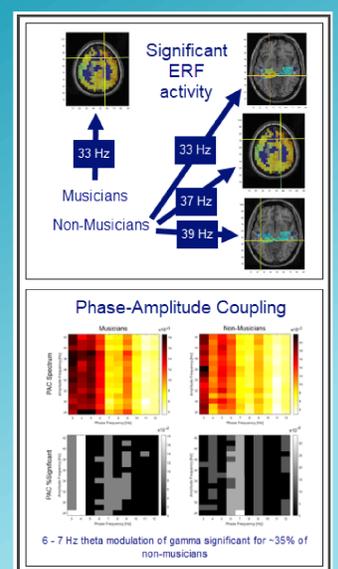
## Objective



## Methodology and Main Outcomes

Combined MEG neuroimaging and reaction-time (RT) methods

- The main finding from the analysis of the RT data is that entrainment of 33 Hz, 37 Hz, and 39 Hz resulted in responses to inharmonics (deviants) that were significantly faster compared to harmonic responses.
- The main findings from the source analyses of the neuroimaging data, in the later time window for the RATN response, converged with the RT results.
  - Following 37 Hz and 39 Hz entrainment, the ERF difference for inharmonics compared to harmonics, for non-musicians, was significant – located in the right superior frontal cortex (37 Hz), and the left inferior temporal lobe (39 Hz).
  - Differential ERF difference activations were found for musicians and non-musicians following 33 Hz entrainment – with a source location in the left parahippocampal and fusiform gyri for non-musicians and in the left middle frontal gyrus for musicians.
- The phase-amplitude coupling (PAC) analysis revealed more consistent 4 Hz and 9 Hz modulation of gamma for musicians.
- Following 33 Hz entrainment, a 6-7 Hz modulation of gamma was significant for ~35% of the non-musician group – which is consistent with findings based on RT data, from previous research in this area<sup>4, 5</sup>.



## Conclusion

- Musicians auditory cognition relies on top-down processes, while non-musicians rely on bottom-up processing, and therefore, their auditory cognition is facilitated by the entrained gamma-band response.
- The findings of this research provide the first evidence in support of faster reaction-time responses due to an interaction in phase of an entrained gamma-band response of 33 Hz and a lower endogenous theta rhythm of approximately 7 Hz – which has been consistently reported in previous research using this paradigm and a functionally similar paradigm using visual stimuli.

### References

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