

Music in the Brain

T. Christina Zhao

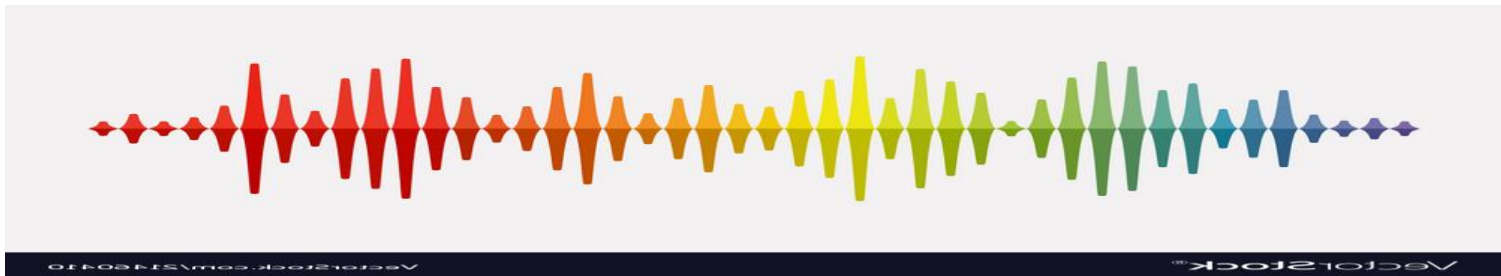
I-LABS, University of Washington

April 2019 at NTU



Music as acoustic signal

- Acoustic features
 - Frequency/Pitch
 - Rhythm/Beat/Meter
 - Spectro-Temporal/Timbre

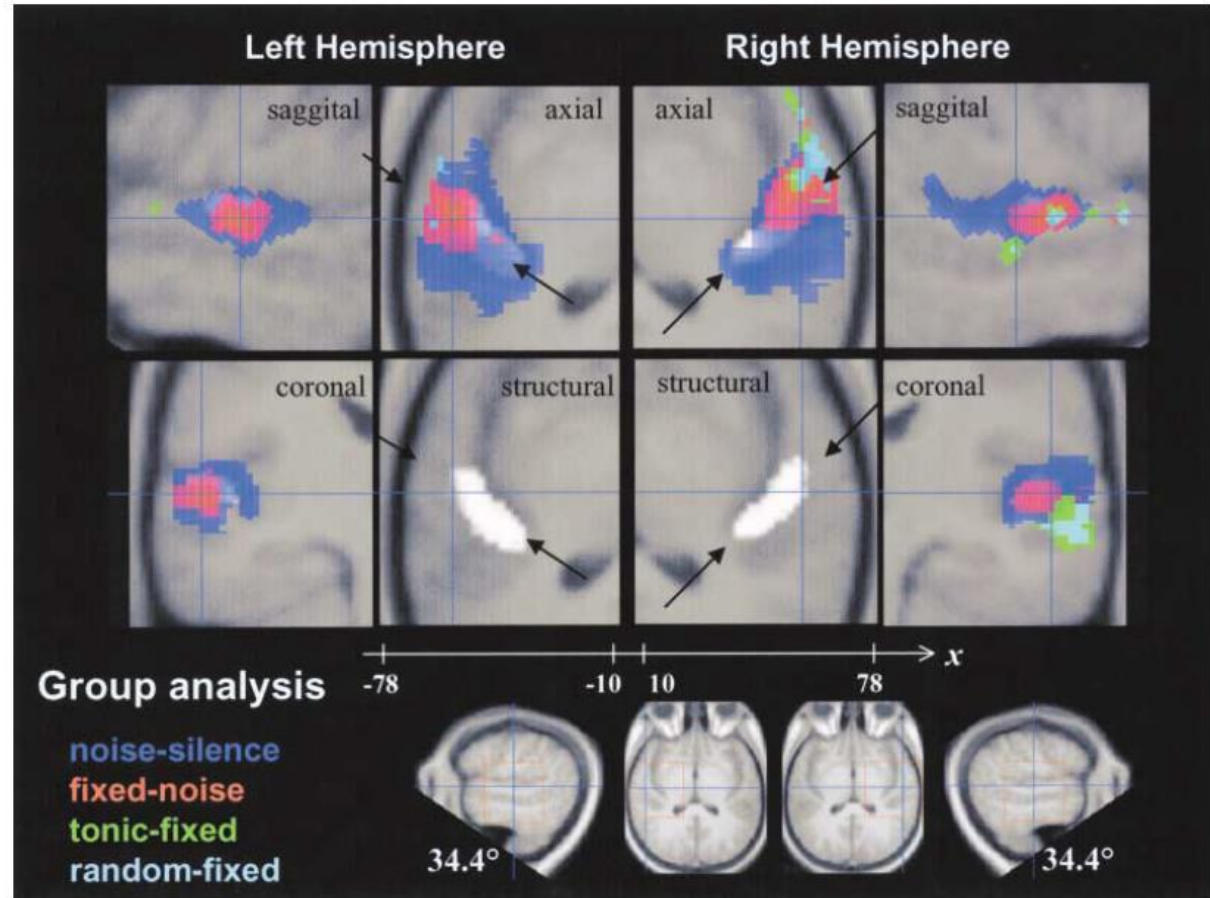


Today's Topics

- Neural processing of acoustic features in music
- What is the effect of music training?
 - Can it affect music processing?
 - Can the effects generalize to speech?

Neural Processing of Acoustical Features in Music

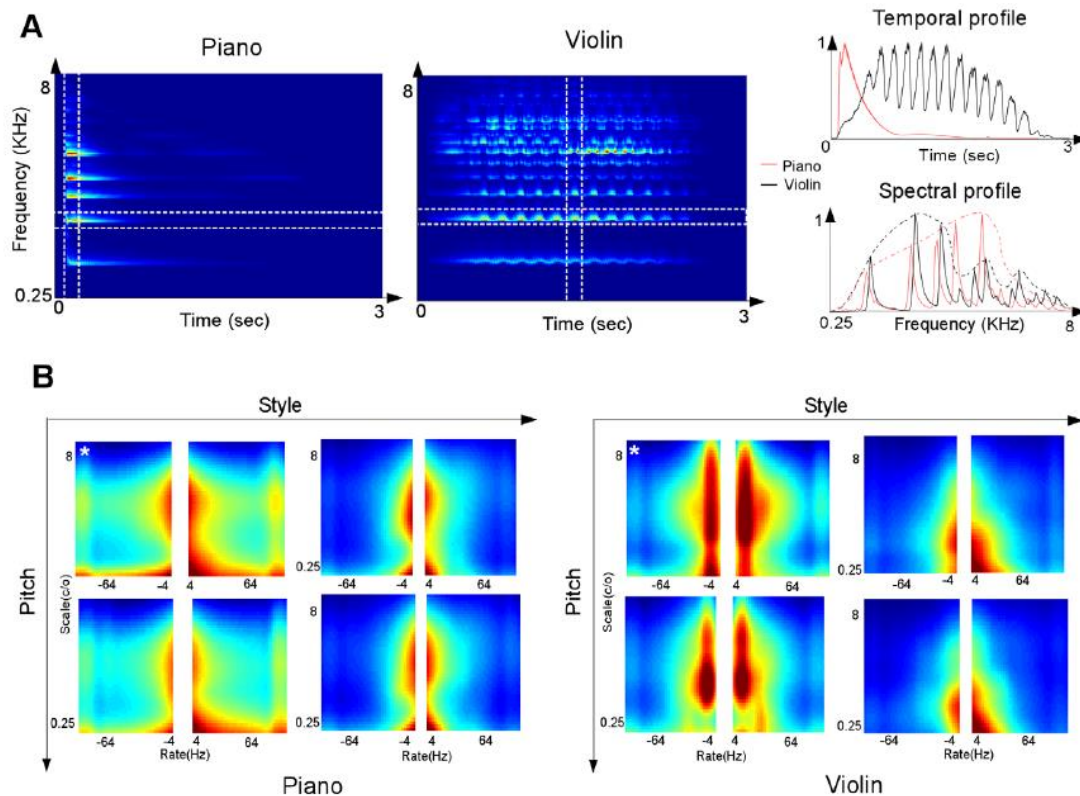
- Pitch



Patterson, R. D., et al. Neuron, 2002

Neural Processing of Acoustical Features in Music

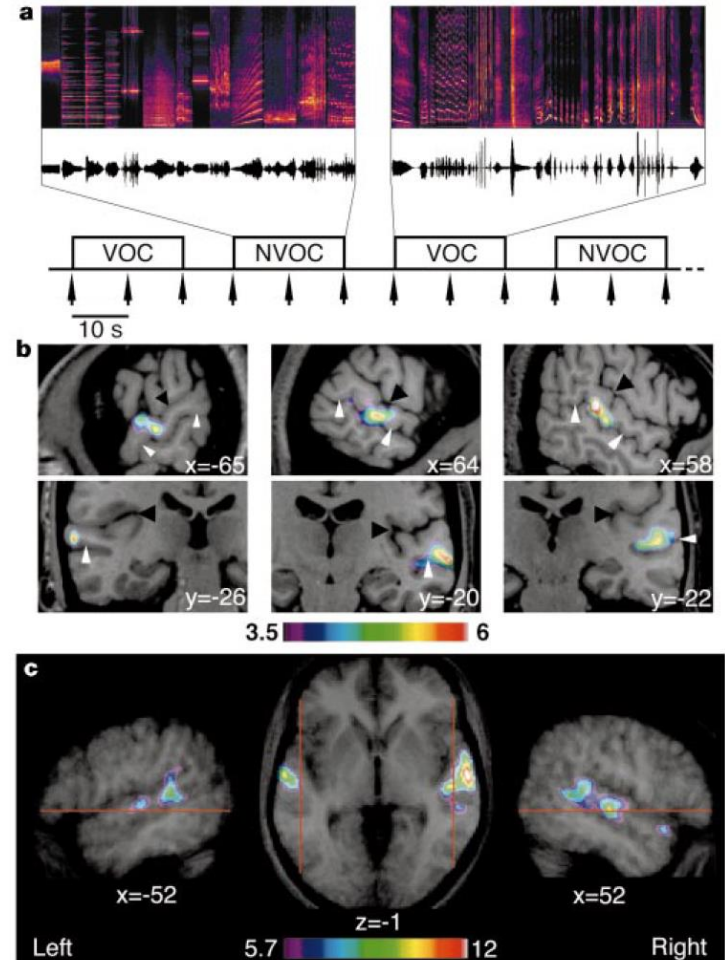
○ Timbre



Patil et al, Plos One, 2012

Neural Processing of Acoustical Features in Music

- Voice-selective areas
(Belin et al., Nature, 2000)



Neural Processing of Acoustical Features in Music

- Rhythm, Beat and Meter

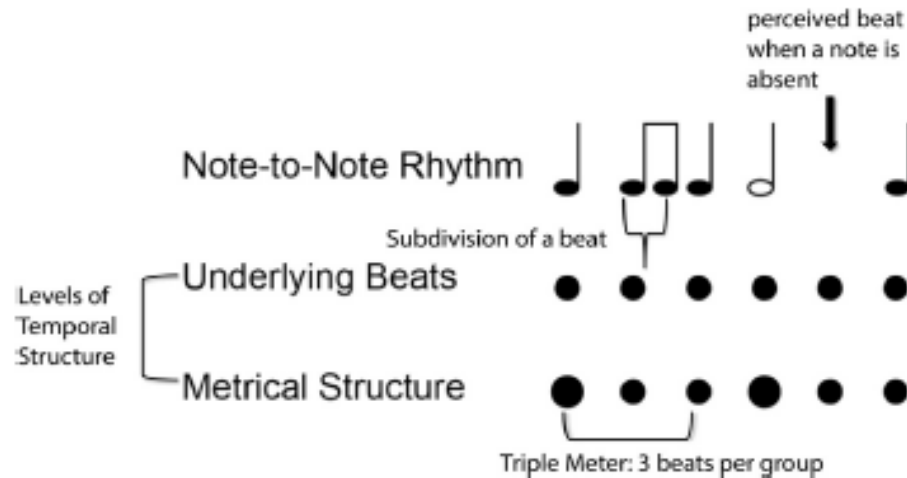
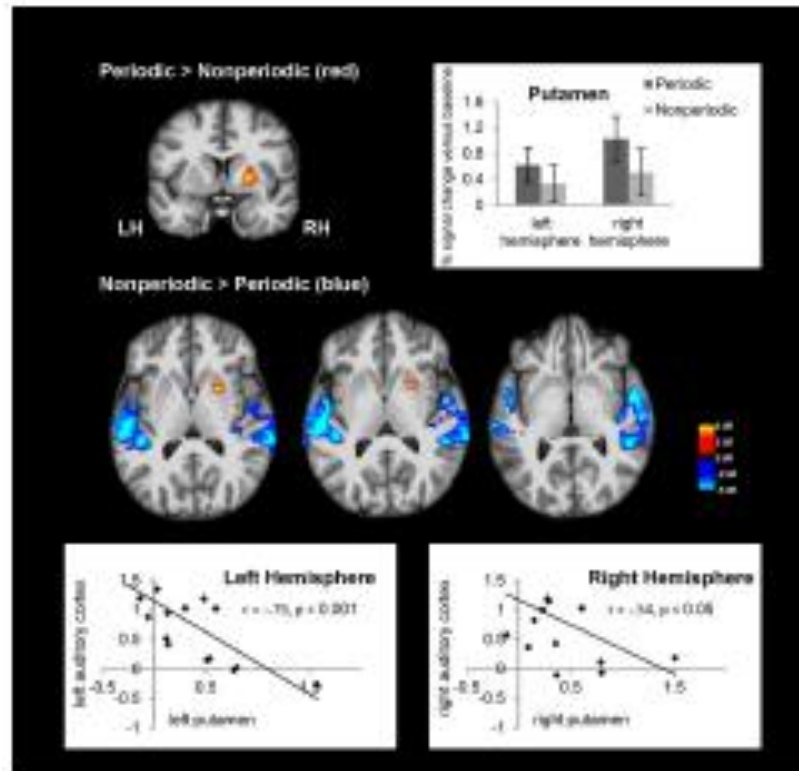


Fig. 1. Illustration of the hierarchy of temporal structure in music.

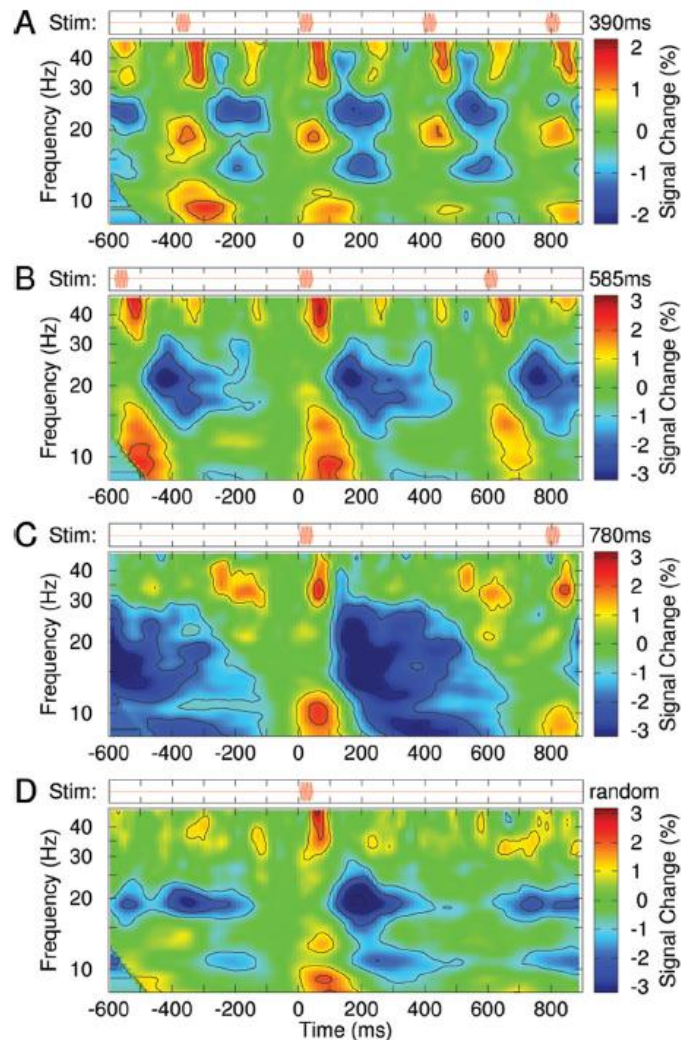
Zhao et al.,
Neuropsychologia, 2017

Neural Processing of Acoustical Features in Music

- Tracking Isochronous Beat (Geiser et al, J Neuro, 2012)



Neural Processing of Acoustical Features in Music

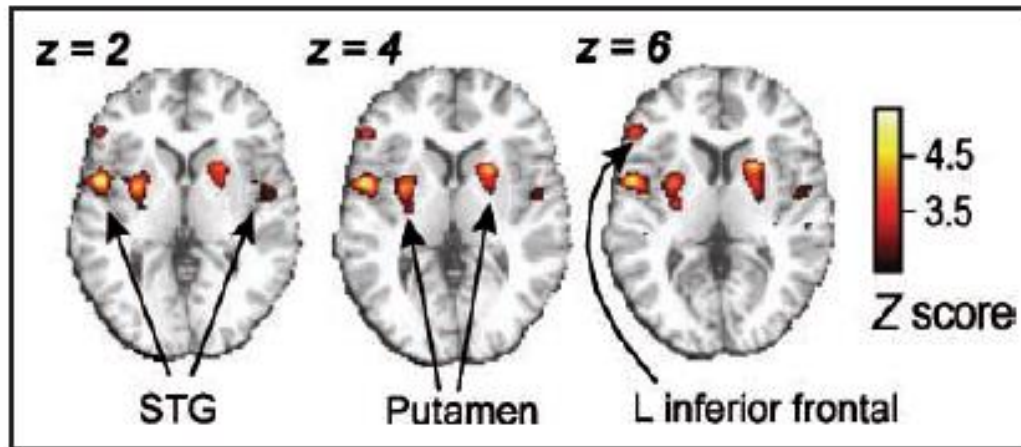
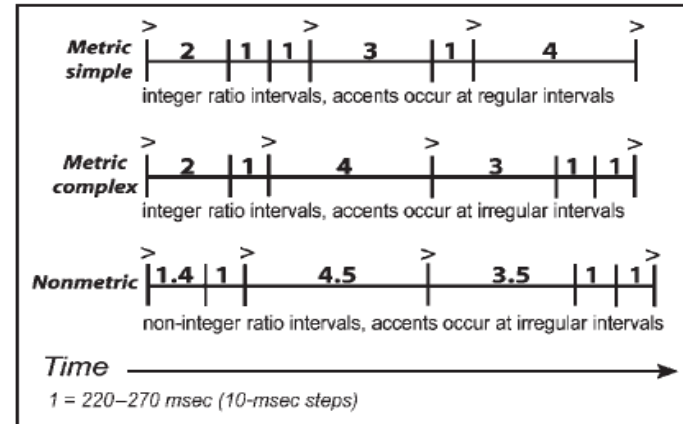


- Tracking Isochronous Beat--- Beta-band Rebound (Fujioka et al, J Neuro, 2012)

Neural Processing of Acoustical Features in Music

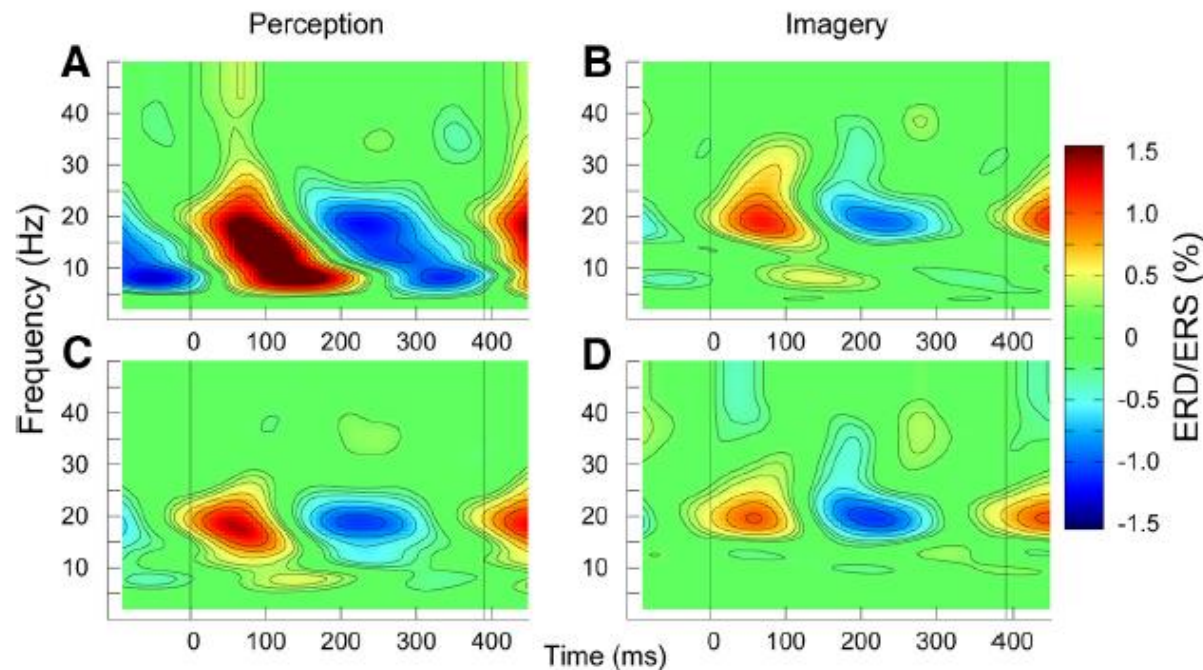
○ Processing Meter

(Grahn & Brett, J Cog Neuro, 2007)



Neural Processing of Acoustical Features in Music

- Processing Meter – Perceived vs. Imaginary (Fujioka et al., J Neuro, 2015)

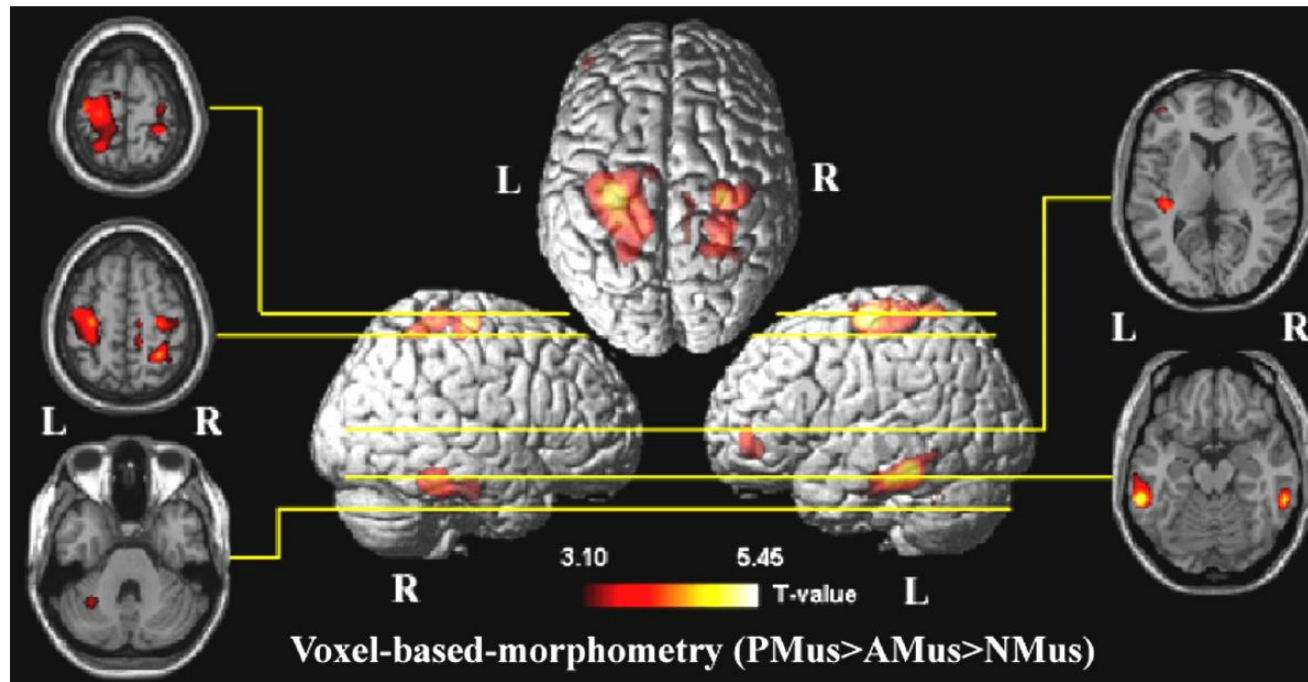


A large, semi-circular inset on the left side of the slide shows a microscopic image of neurons. The neurons are depicted with their cell bodies and a dense network of branching processes, rendered in a light blue color against a darker blue background. The inset is partially obscured by a dark blue circle.

Questions?

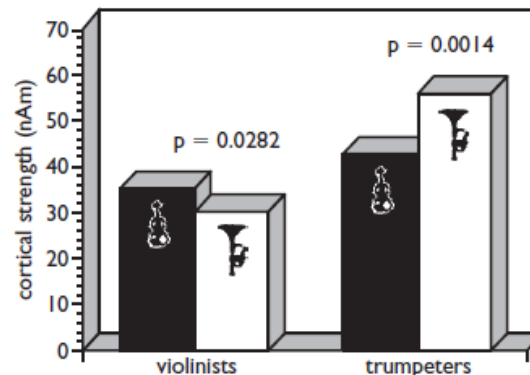
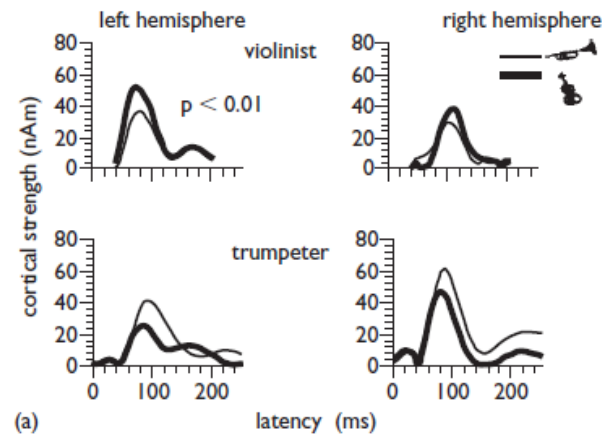
How does music training affect the brain?

- Effect on Neural Structure (Schlaug et al., Ann. N.Y Acad. Sci., 2005)



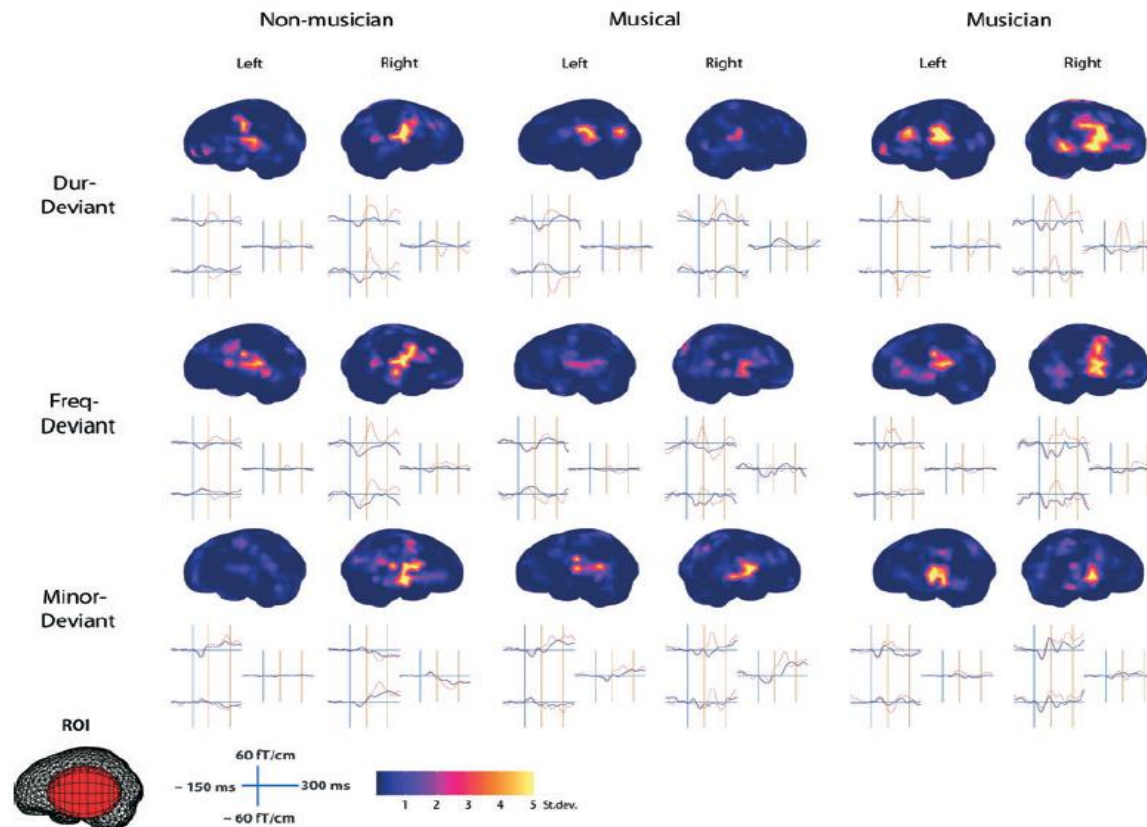
How does music training affect the brain?

- Functional Processing (Pantev et al., NeuroReport, 2001)



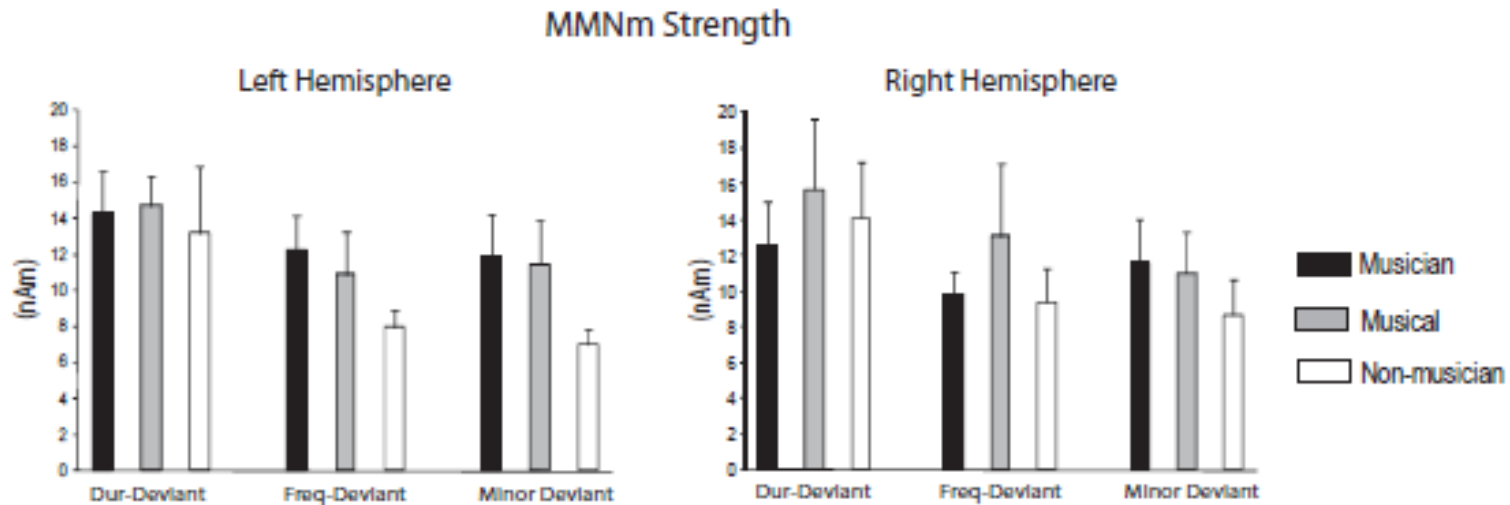
How does music training affect the brain?

- Pitch discrimination using MMR (Terviniemi et al., Euro J Neuro, 2011)



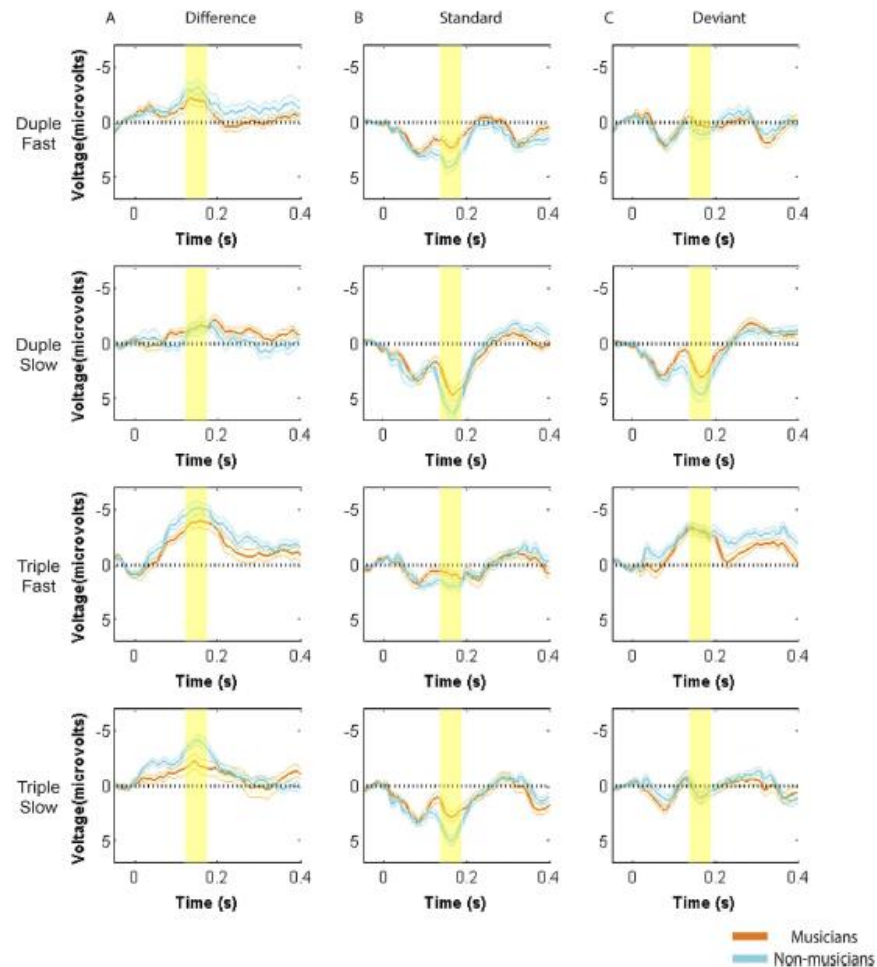
How does music training affect the brain?

- Pitch discrimination using MMR (Terviniemi et al., Euro J Neuro, 2011)



How does music training affect the brain?

- Meter processing using MMR (Zhao et al, Neuropsychologia, 2017)



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Questions?

Can it Generalize to Speech?



9-month-old
infants



Music Intervention
Group (n=22)



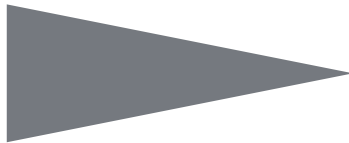
Control Group (n=25)

Zhao & Kuhl, PNAS, 2016

Current Study



10-month-olds



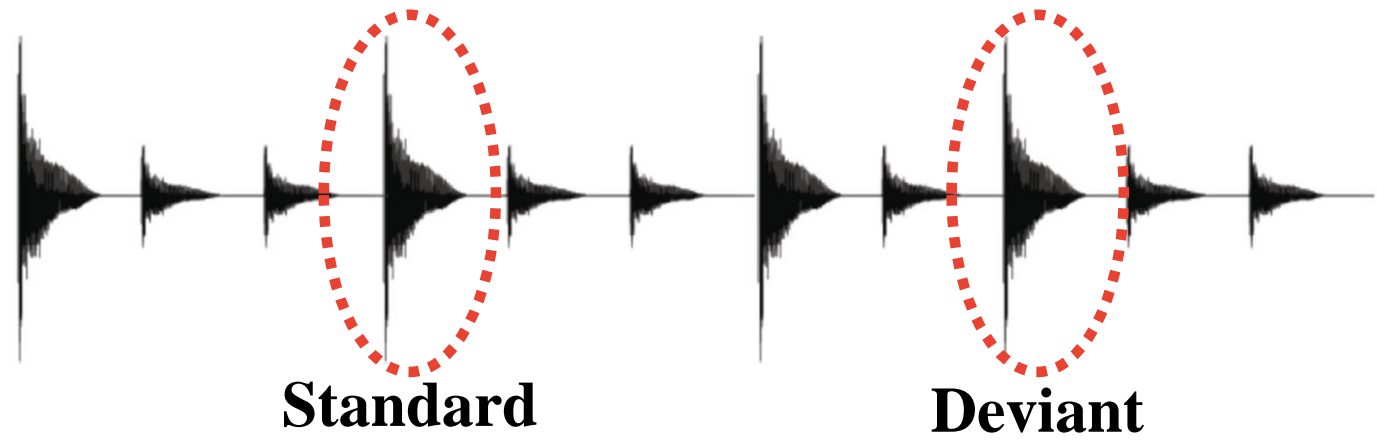
Current Study



MEG Recordings

900ms

Music Condition

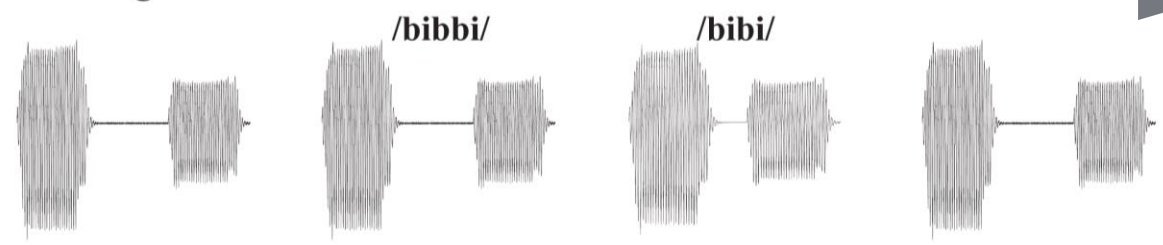


b

~1000ms

Speech Condition

Long recording

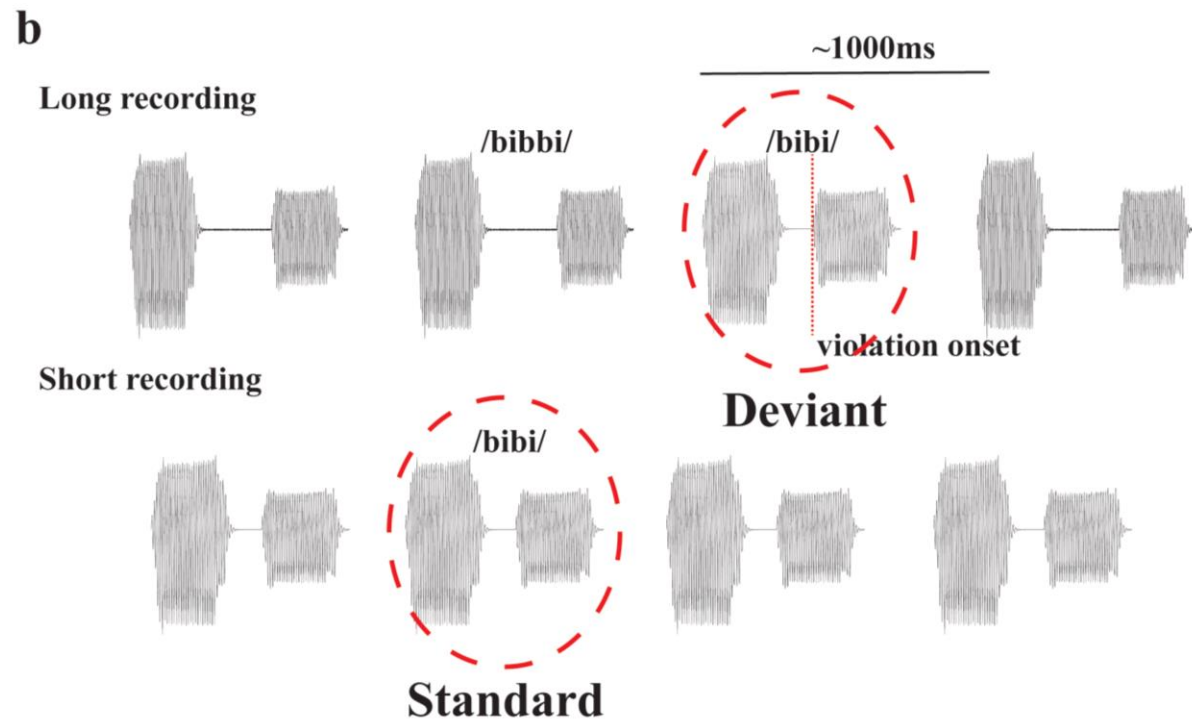


Current Study



MEG Recordings

Speech
Condition



Research Questions

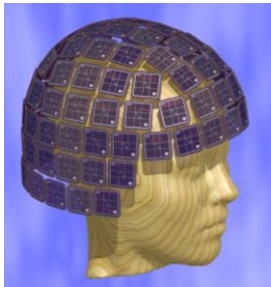


Does the Intervention group exhibit larger MMR

- * to violation in music meter (music condition)?
- * do we observe similar effects in both temporal regions and prefrontal regions between groups?

If so, can the same effects be observed for syllable structure change (speech condition)?

Data Analysis



Preprocess Signal

Source modeling

Structure of the brain

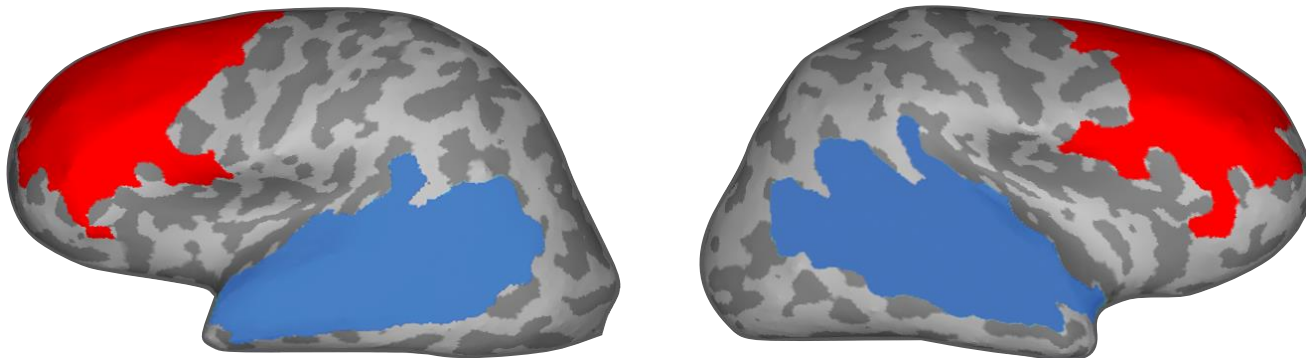


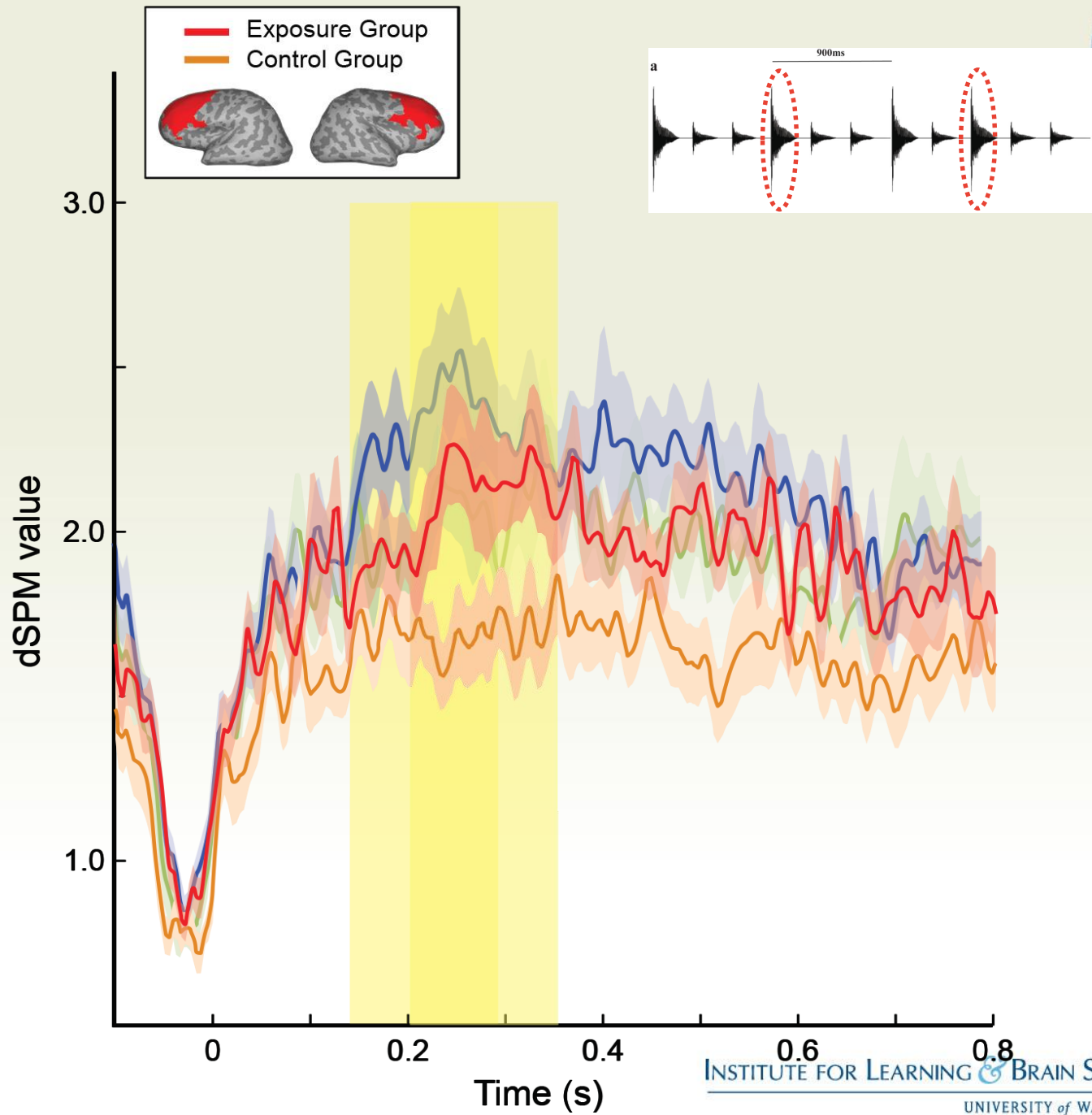
Data Analysis

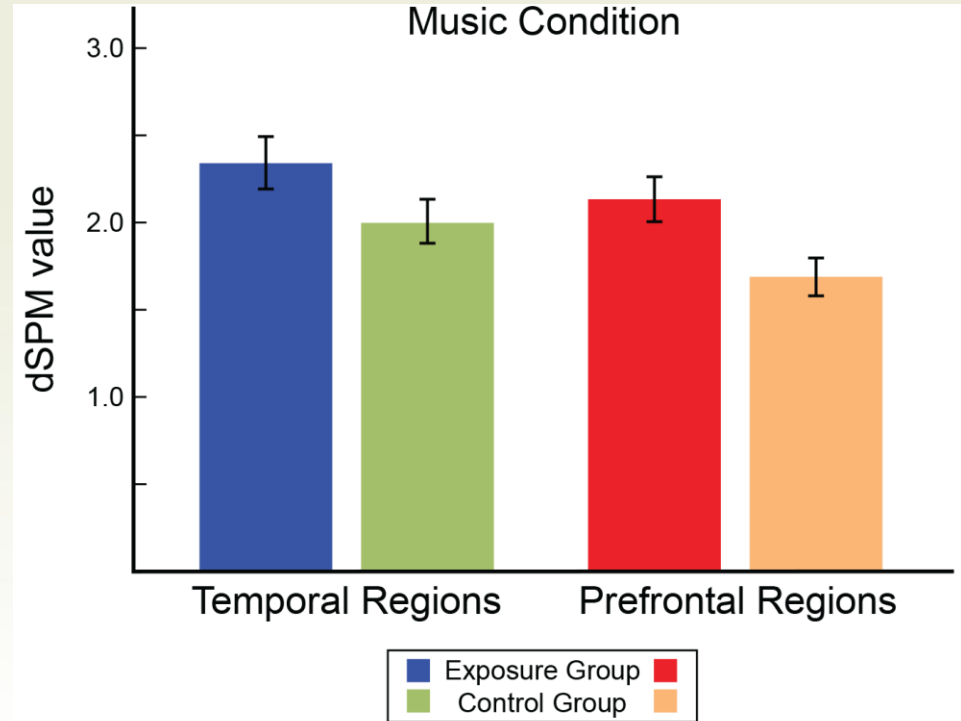
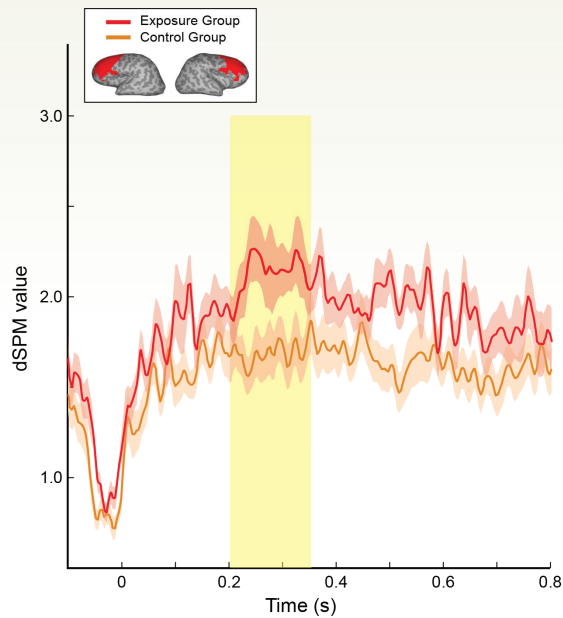
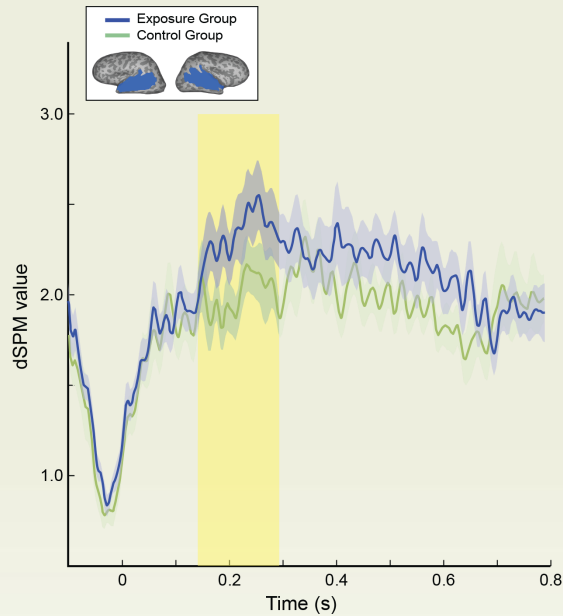


Difference wave calculated

Difference wave averaged separately for temporal and prefrontal regions in each individual

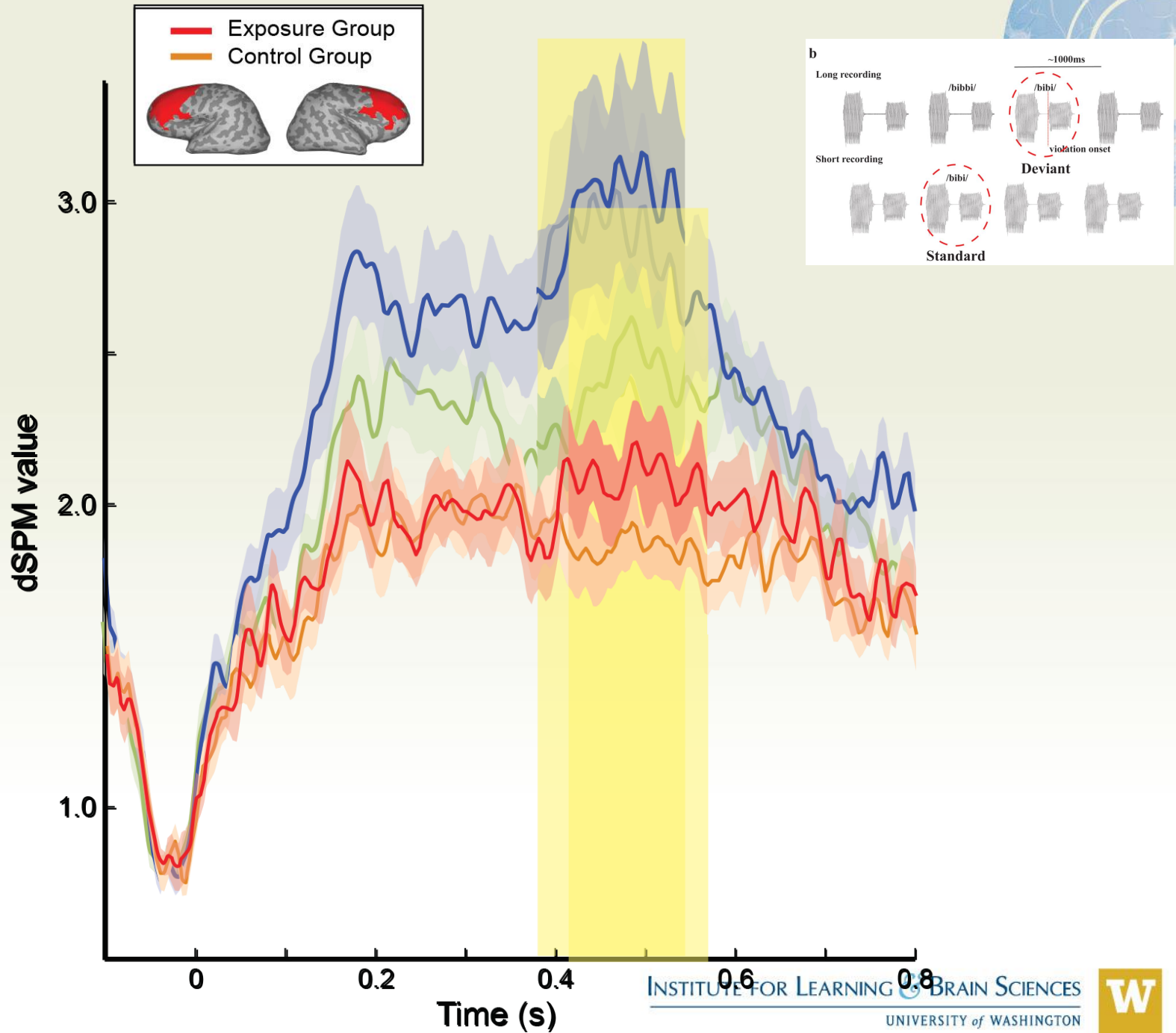


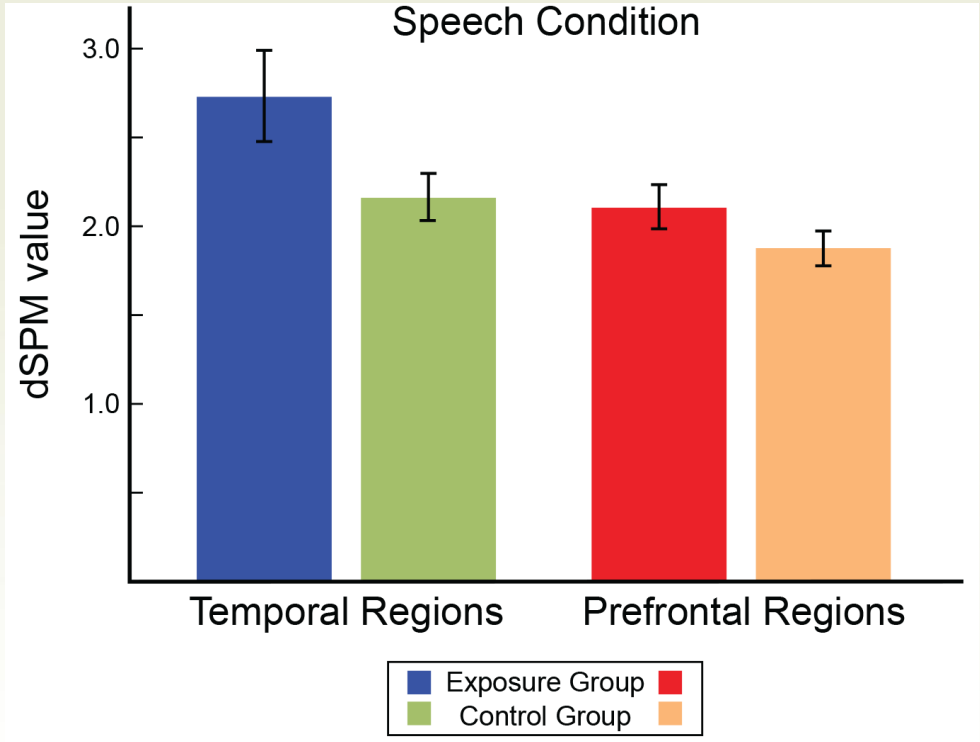
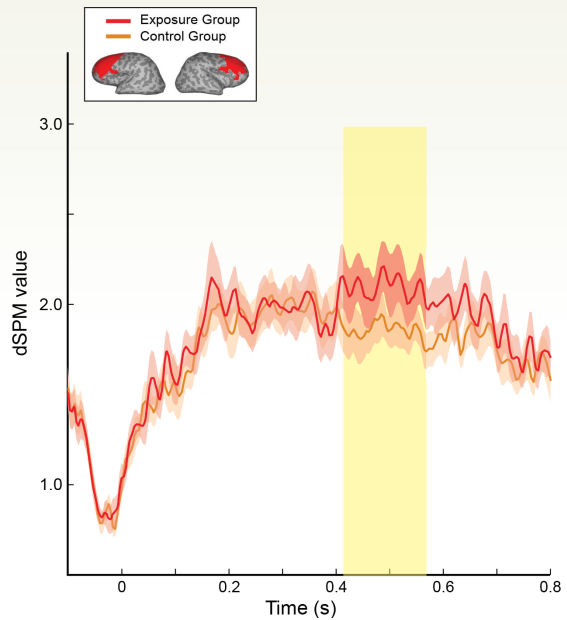
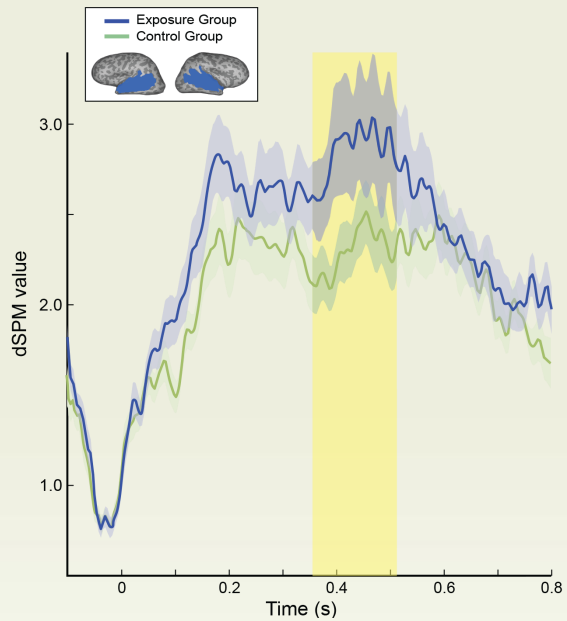




Mixed 2 (between group: exposure vs. control) X 2(within group: temporal vs. prefrontal) ANOVA







Mixed 2 (between group: exposure vs. control) X 2 (within group: temporal vs. prefrontal) ANOVA

Discussion



Current study provided strong evidence

- music intervention enhanced temporal structure processing in music
- effect observed in prefrontal regions in addition to temporal regions
- first to show generalization effect to speech domain at 9 month of age

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Questions?