# Investigating neural representation of musical rhythm using fMRI and model-free analysis

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## Introduction

When listening to musical rhythm, humans perceive and spontaneously move to a periodic pulse-like meter.

- Simple rhythms induces internal representation of a meter[1,2]
- Complex rhythms with a less regular arrangement of sounds can still evoke a meter percept.
- Special role of sensory-motor network in meter processing: inferred from previous studies based on preferential activity by simple rhythms compared to complex rhythms[3,4]

QUESTION

Neural network for meter mainly driven by prominence of meter in the input, as previously inferred?

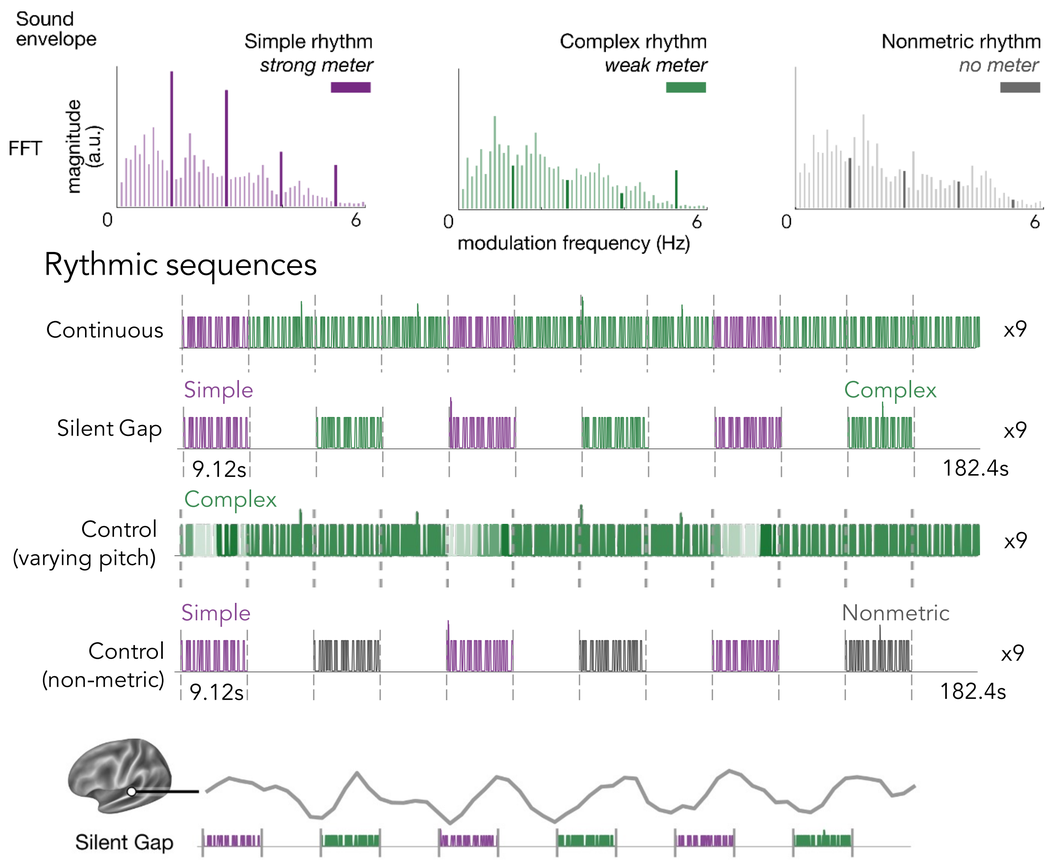
Same neural network when rhythms are presented in different context: continuous design vs. silent gap design?

Higher sensitivity in BOLD analysis by using model-free FFT approach[5]?

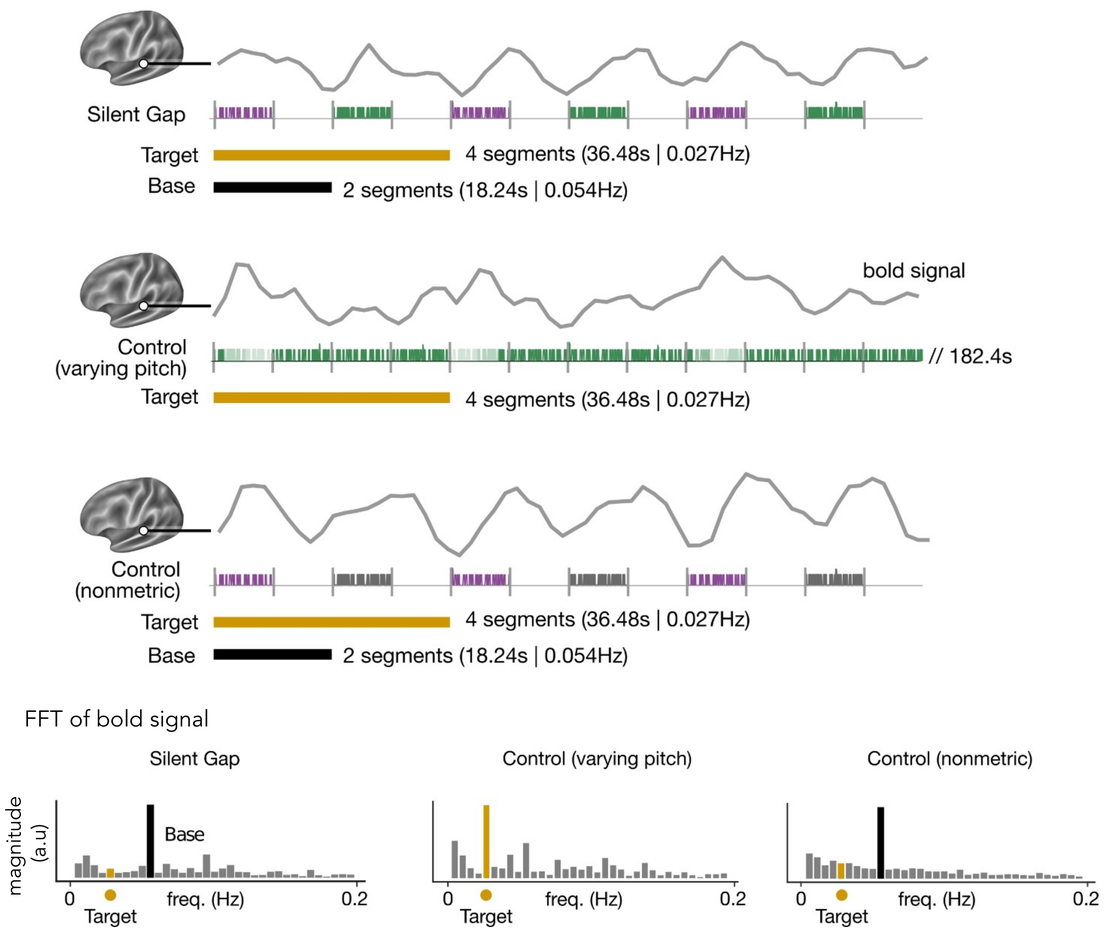
## Materials and Methods

N = 22 for continuous and gap design exp, N = 10-12 for control exp , 2 fMRI sessions

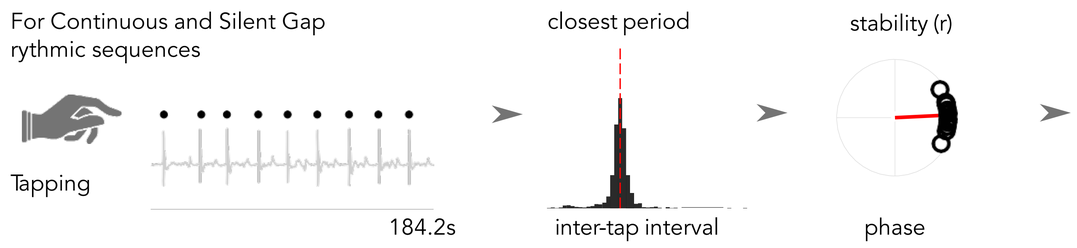
STIMULI DESIGN




FMRI ANALYSIS

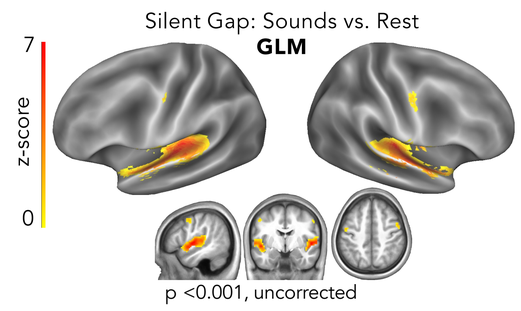


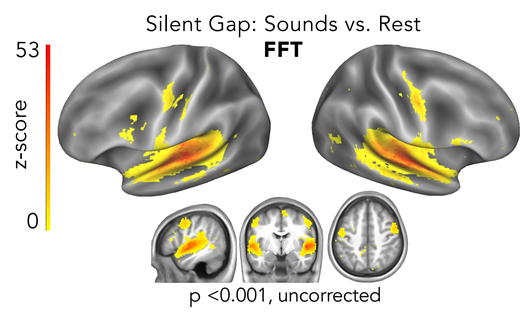

BEHAVIORAL ANALYSIS



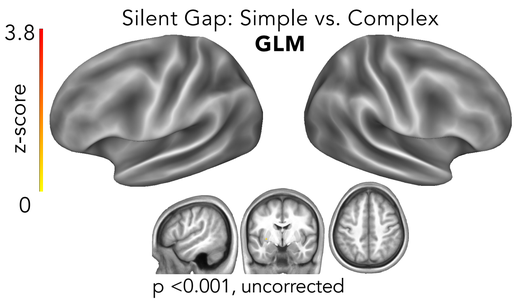

## Results

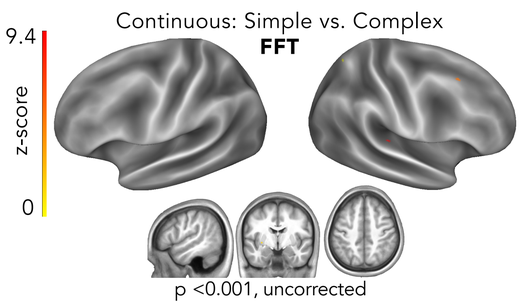
### General response to sounds: FFT yields stronger results than GLM



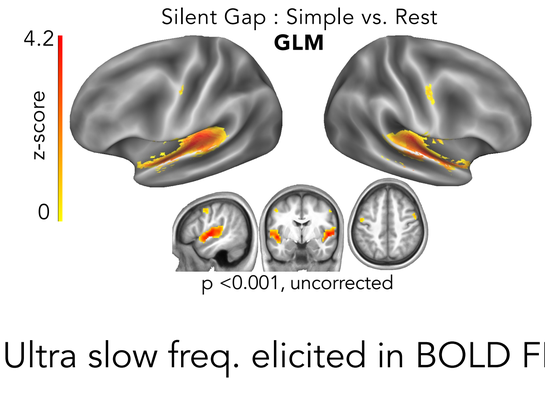



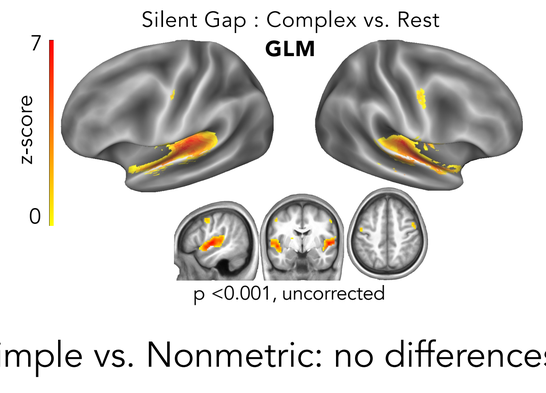

### Simple vs. Complex: no differences**



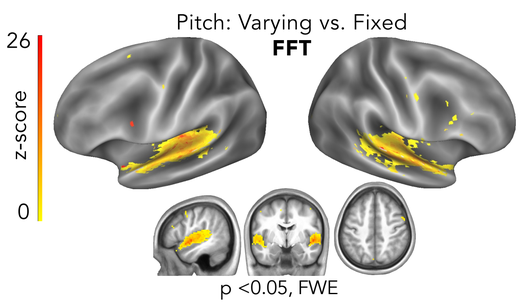




### Simple and Complex evoke the same sensorimotor network activity

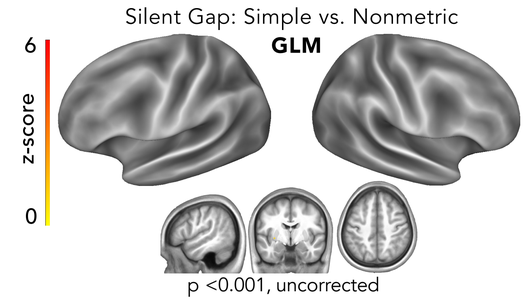


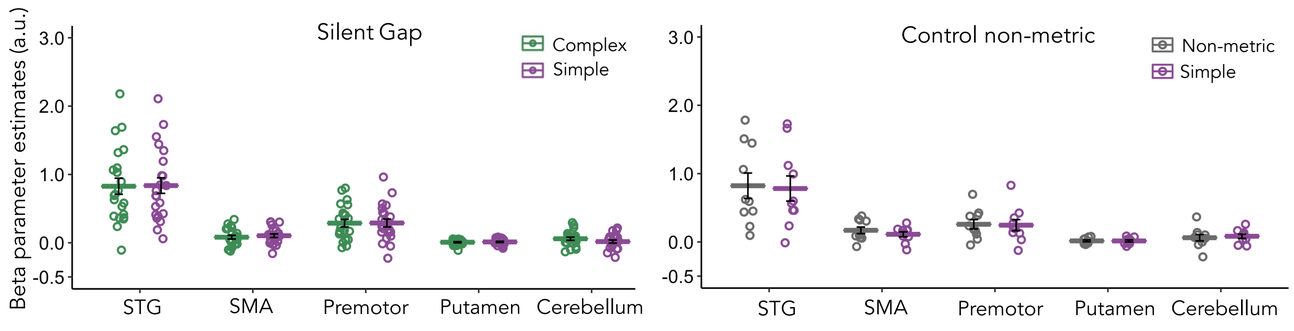

### Ultra slow freq. elicited in BOLD FFT



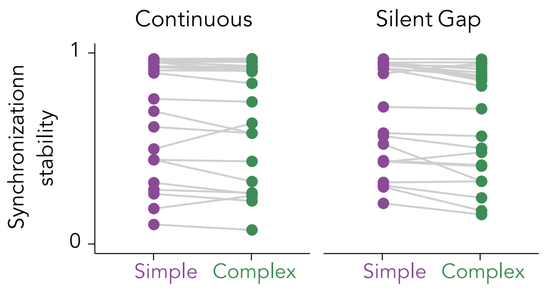

### Simple vs. Nonmetric: no differences




### ROI Analysis shows no differences across conditions




### Comparable tapping across conditions: no effect of rhythm complexity




GLM: Generalized linear model, conventional fMRI analysis
FFT: Fast Fourier transform, used in model-free analysis

**The null result was also observed by a FFT analysis on Silent Gap design.

## Conclusion

Simple and complex rhythms evoked similar activity as shown by the model-free analysis of both continuous and gap design, and GLM analysis. Importantly, fMRI results aligned well with a behavioural experiment where participants tapped perceived pulse comparably for simple and complex rhythms.

Together, these findings validate the frequency-tagging approach to analyze auditory responses captured with fMRI. Our results also challenge the view that complex rhythms fail to induce internal representation of meter. Furthermore, auditory-motor network may not be specific to meter perception.

## References

1. Nozaradan et al., 2017 Brain Topogr; 2. Lenc et al., 2018 PNAS; 3. Granh et al., Cogn Neuro 2007; 4. Granh et al., J Neuro 2009; Gao et al., Bra Struc Func 2018

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