

Neural Representations of Rhythm and Beat Perception

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Background

Introduction

- Humans spontaneously synchronize to the beat in acoustic rhythms.¹
- Strong-beat rhythms elicit activity in motor regions of the brain, such as the basal ganglia, cerebellum, supplementary motor area, and premotor cortex.
- Univariate analyses relate beat strength to average activity across a region.
- However, multivariate analyses indicate which rhythmic features are associated with reliable spatial patterns of activity across a region.
- Regions may encode or 'tune' to individual rhythms with a particular feature (e.g., a beat) by exhibiting a unique spatial pattern for each rhythm.

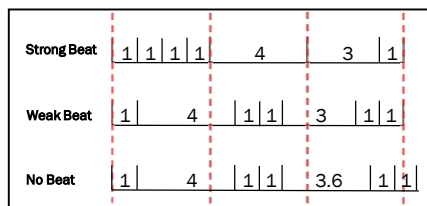
Hypothesis

- Motor areas may be tuned to strong-beat rhythms. Therefore, spatial activity patterns will be highly dissimilar between strong-beat rhythms.
- Motor areas may not be tuned to weak- or no-beat rhythms. Therefore, spatial activity patterns will not be dissimilar within these conditions.

Method

Stimuli

- 12 filled-tone rhythms
- 4 Strong-beat
- 4 Weak-beat
- 4 Non-beat

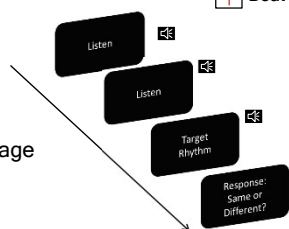


Beat Locations

Procedure

- Rhythm Discrimination Task.
- 8 Blocks of 24 trials each.
- 7T MRI Scanning.
- Analyze activity during 'Listen' stage

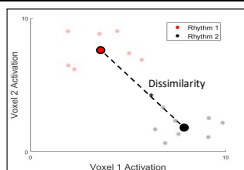
• $N = 9$



Dissimilarity Measure: Mahalanobis Distance Estimate

Dissimilarity Measure

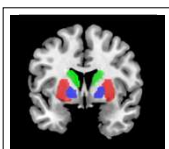
- Cross-validated Mahalanobis Distance².
- Continuous metric of dissimilarity between patterns associated with each stimulus.
- Larger distance = More dissimilar activity.



Region of Interest & Whole-Brain Searchlight

Region of Interest analysis

- Compare activity patterns across conditions in caudate, pallidum, & putamen.



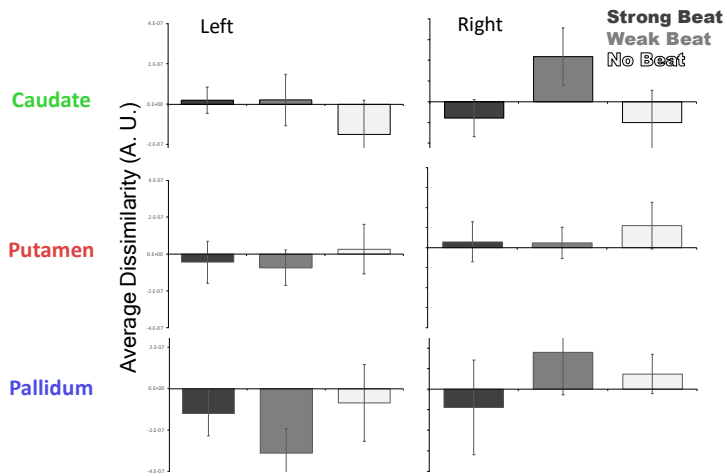
Whole-Brain Searchlight

- Compare activity patterns in spherical ROIs across entire brain



Basal Ganglia Regions of Interest

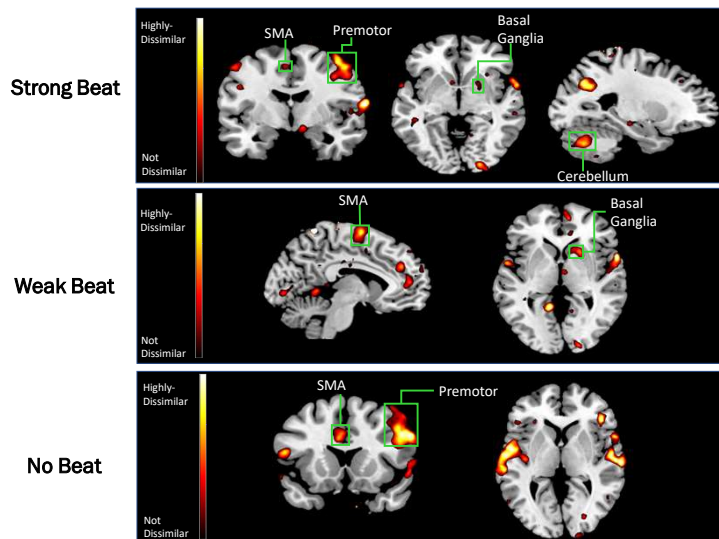
Activity Patterns in Basal Ganglia do not distinguish between Rhythms.



Zero and negative distances suggest that activity patterns in this region are not reliably different between individual rhythms.

Whole-Brain Searchlight

Average Distances between activity patterns for each Beat Strength Condition



Preliminary results reveal Premotor Cortex, SMA, and Cerebellum may be candidates for encoding individual rhythms.

Acknowledgements

References

¹Grahn, J. A., & Brett, M. (2007). Rhythm and beat perception in motor areas of the brain. *Journal of Cognitive Neuroscience*, 19(5), 893-906.

²Diedrichsen J, Zareamoghaddam H, Provoost S. (2016). The distribution of cross-validated Mahalanobis distances. *ArXiv*.

Thanks to:

