



Classifying Musical Genre from BOLD fMRI

Matthew Fam · Honors Neuroscience Thesis

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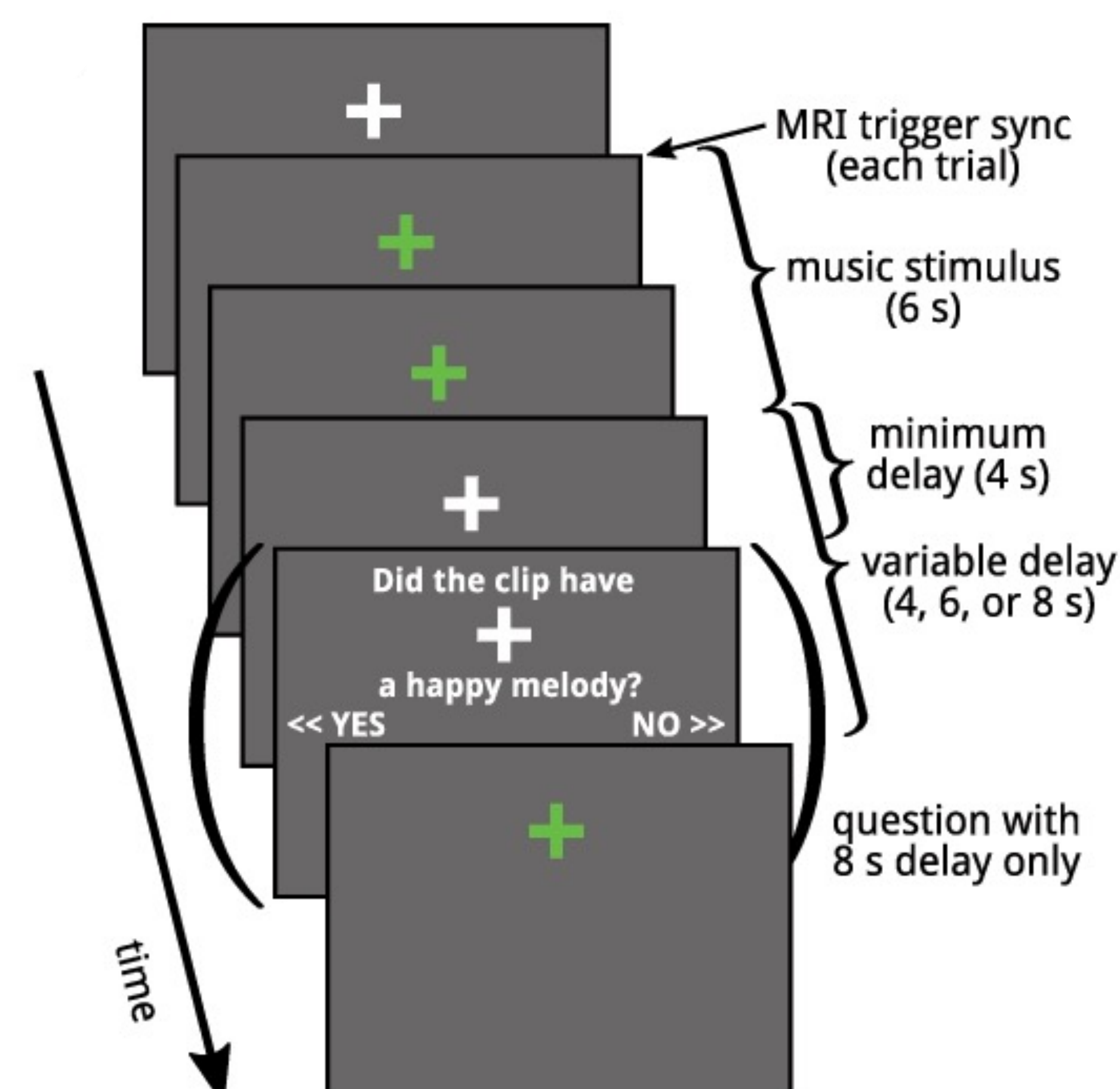
Introduction

Humans separate musical stimuli into genres. Musical preference, related to genre on an individual basis, has been used to predict human behavior¹ shown to modulate default mode network (DMN) activity and thus bring about common cognitive responses including self-referential thoughts and mind-wandering.² Sad music has been associated with greater activity between parts of the DMN than happy music.³ Though Mhierarchical encoding of musical features (i.e. timbre) has been shown,⁴ much less is known about how and where genre is encoded in the brain.

Questions

- I. Where are mental representations of genre encoded in the brain?
- II. Can genre be predicted from brain activity?
 - i. If so, what are the best ways of doing this?

Experimental Design



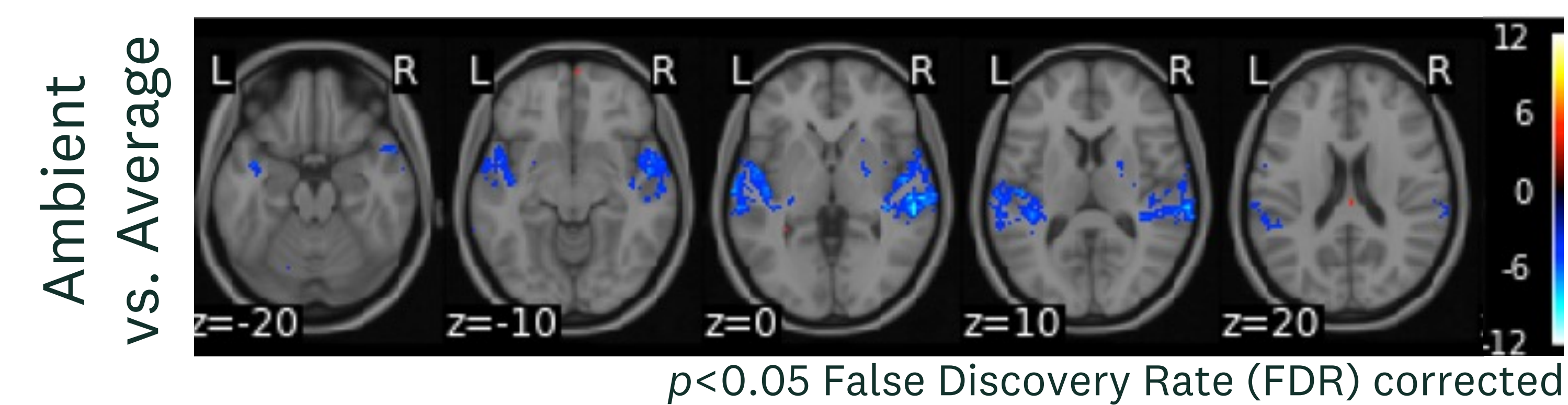
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Use of short stimuli was meant to minimize the affect the confounding of musical preference with the resulting brain activity.

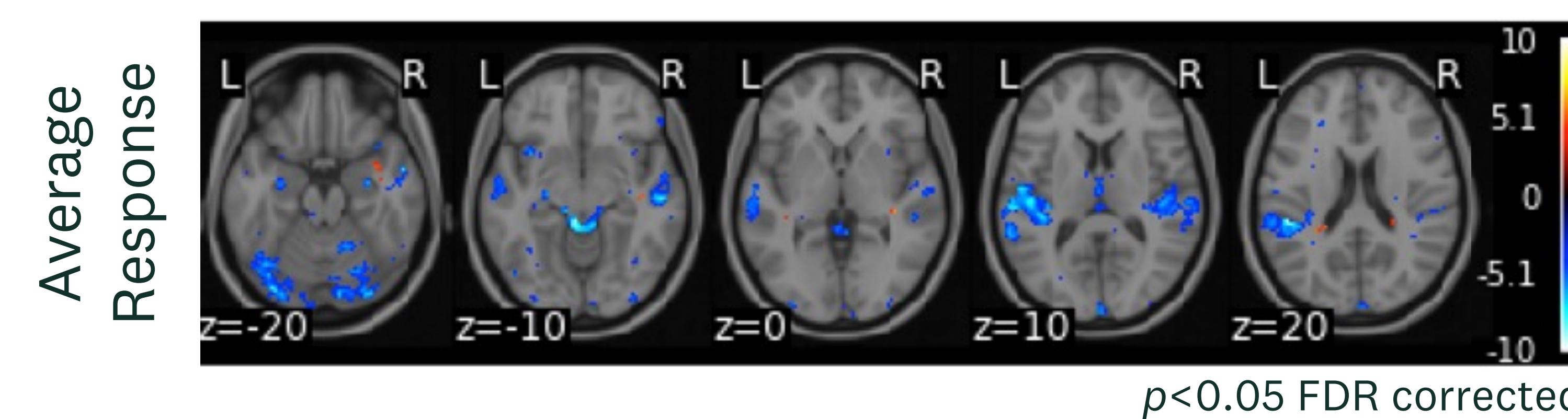
Open-source data from *studyforrest* extension dataset^{5,6} 25 stimuli—5 6-s clips for each of 5 genres (Ambient [A], Symphonic [S], Country [C], Rock ‘n’ Roll [R], Metal [M])—were presented to subjects in different orders during 8 runs.

Results

Genre-Specific vs. Average Music Response

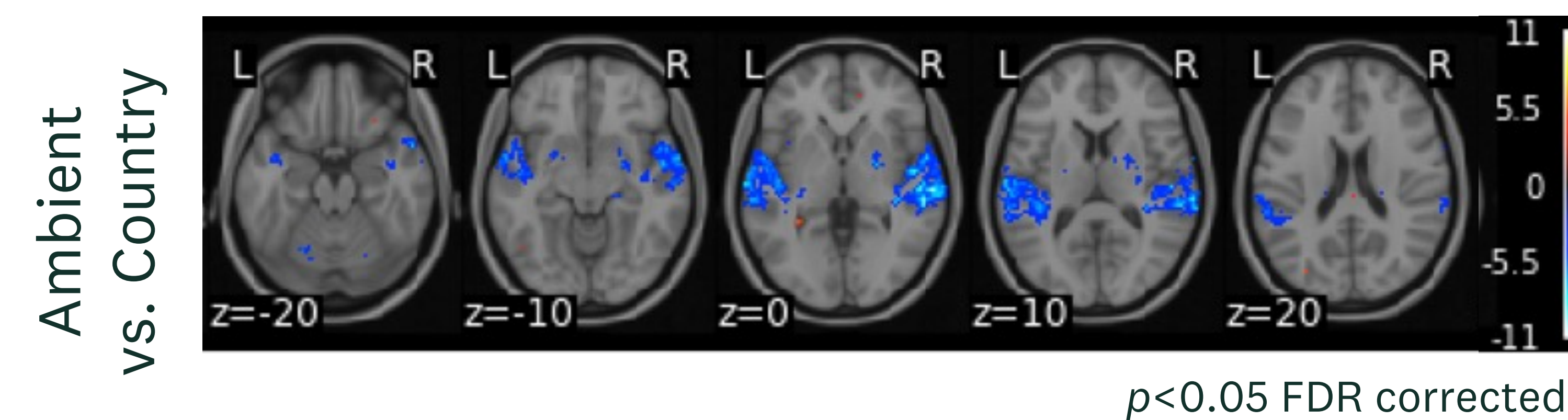


- All genres except Metal revealed significant contrasts from average musical response in Heschl’s gyrus (HG), the planum polare (PP), and superior temporal gyrus (STG)
- Ambient and Symphonic showed deactivation, whereas Country and Rock ‘n’ Roll showed positive activation relative to average musical response



- Average response across all genres revealed significant voxels in HG, PP, and STG in addition to the lingual gyrus (LG)

Pairwise Genre Comparisons



- Pairwise comparisons revealed significant voxels in the same brain regions (HG, PP, and STG) Country vs. Rock ‘n’ Roll, Metal vs. Rock ‘n’ Roll, and Metal vs. Symphonic produced no significantly different voxels

Results (cont.)

Multivariate Pattern Analysis (MVPA)

Cross-Validation Accuracy

Genre Pair	Mask						
	Composite	HG	aSTG	pSTG	PP	PT	LG
A vs. C	0.92***	0.90***	0.90**	0.92***	0.89***	0.92***	0.60**
A vs. M	0.84***	0.79***	0.81**	0.76***	0.83***	0.79***	0.55
A vs. R	0.88***	0.82***	0.79**	0.87***	0.80***	0.85***	0.56
A vs. S	0.71***	0.71***	0.74**	0.69***	0.71***	0.69***	0.51
C vs. M	0.74***	0.70***	0.73**	0.70***	0.70***	0.75***	0.53
C vs. R	0.61***	0.60***	0.58**	0.57*	0.65***	0.57*	0.54
C vs. S	0.85***	0.88***	0.89**	0.90***	0.89***	0.88***	0.58**
M vs. R	0.67***	0.66***	0.64**	0.67***	0.64***	0.62***	0.56*
M vs. S	0.72***	0.70***	0.72**	0.64***	0.74***	0.64***	0.52
R vs. S	0.81***	0.80***	0.78**	0.81***	0.79***	0.77***	0.52
M	0.78	0.76	0.76	0.75	0.76	0.75	0.55
SD	0.10	0.10	0.10	0.12	0.09	0.12	0.03

***p<0.001 **p<0.01 *p<0.05

- A support vector machine was able to create binary classifiers that accurately predicted genre above chance among any pairwise combination (based on beta values from regression to a general linear model)
- Prediction appeared to be driven by voxels in HG, STG (anterior [a] and posterior[p]), PP, and planum temporale (PT); the frontal orbital cortex and inferior frontal gyrus pars opercularis were also capable of predicting genre significantly above chance for all but 3 and 2 genre pairs, respectively

Conclusions

Musical genre can be decoded from brain activity in HG, STG, PP, and PT. Though the LG is involved in processing musical stimuli, its inability to encode genre, confirms the presence of higher-order mental representations of music, separate from auditory stimuli—one being traditional genre designations.

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2. Wilkins, R. W. et al. (2014). "Network Science and the Effects of Music Preference on Functional Brain Connectivity: From Beethoven to Eminem." *Scientific Reports*, 4(1), 6130.
3. Taruffi, Pehrs et al. (2017). "Effects of Sad and Happy Music on Mind-Wandering and the Default Mode Network." *Scientific Reports*, 7(1), 1–10.
4. Casey, M., et al. (2012). "Population codes representing musical timbre for high-level fMRI categorization of music genres." *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 7263 LNAI/October 2015), 34–41.
5. Hanke, M. et al. (2014). "A high-resolution 7-Tesla fMRI dataset from complex natural stimulation with an audio movie." *Scientific Data*, 1(1), 140003.
6. Hanke, M. et al. (2015). "High-resolution 7-Tesla fMRI data on the perception of musical genres – an extension to the studyforrest dataset." *F1000Research*, 4, 174.