

# Exploring the Role of Temporal Fine Structure and Envelope in Timbral Coding

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**Abstract**—While the neural response to simple, stationary, and periodic auditory signals can be fairly well investigated, responses to auditory stimuli that are more complex, such as speech and music, are less well-characterized. Particularly, music is psychoacoustically complex. It is not well-understood how humans perceive the nuances of music, and how hearing impairment may affect the perception of such nuances. Before we can fully understand perception, we must first investigate how musical attributes like timbre are coded by the auditory periphery. By using a simulated auditory nerve model and comparing neural responses to stimulus envelope (ENV) and temporal fine structure (TFS), it is possible to see how timbral coding might be affected by hearing impairment. In this project, both instrumental timbre and articulation timbre were considered, and variations in coherence spectra of neural responses and Hilbert TFS/ENV were observed across instruments, articulations, and hearing impairment conditions.

**Index Terms**—auditory, neuroscience, music, modeling, envelope, temporal fine structure, timbre

## I. INTRODUCTION

The field of auditory neuroscience has made leaps and bounds in understanding how we perceive and code sounds that reach the cochlea. However, despite much study of perception of speech intelligibility and discrimination, the perception and coding of *music* still is quite understudied and remains an enigma.

Much progress has been made on developing methods and analyses by which we can study how features of a particular sound stimulus reach the auditory nerve, and how they may be processed by higher order systems within the brain and brainstem.

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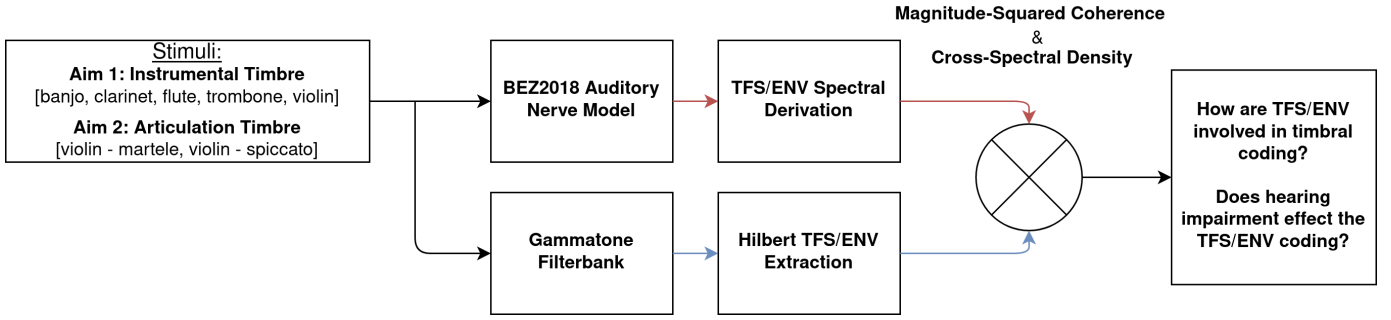


Fig. 1. Methods Flow Chart. Stimuli were passed through the BEZ2018 auditory nerve model and gammatone filterbank. The output of the nerve model (red) was analyzed by extracting the envelope component of the resulting apPSTH,  $s(t)$  or fine structure component  $\phi(t)$ . The cross-spectral density or magnitude-squared coherence between these signals and the Hilbert envelope or temporal fine structure, respectively was computed to attempt to investigate the relevance of these features.

equations with commas or periods when they are part of a sentence, as in:

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TABLE I  
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Table Head	Table Column Head		
	Table column subhead	Subhead	Subhead
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#### ACKNOWLEDGMENT

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