Effect of Timbre on Leman's Model of Periodicity Pitch

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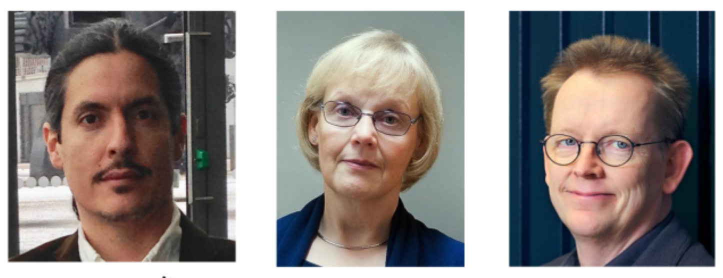

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Background

Leman's model of Periodicity Pitch (2000)

Leman's model has often been used to predict the sensory component of harmonic expectation (e.g., Bigand et al., 2014; Goldman et al., 2021). The model takes raw audio files as its input and filters them through a simulation of the peripheral auditory system to produce auditory nerve images and periodicity-pitch images. The output of Leman's model (*Tonal contextuality*, hereafter **TC**), predicts the harmonic contrast between two successive sonorities based solely on sensory input (as opposed to abstract representations of harmony). This model is a good candidate to predict the effect of timbre on the sensory component of harmonic perception because the model is based on spectral analysis and considers fine-grained spectro-temporal information to generate its output.

Aim

This study investigates the effect of timbre on Leman's model of *Periodicity Pitch* (2000).

Method

Stimuli

1250 two-chord stimuli

- **Chord pitch structure**: 50 two-chord combinations from Bigand et al., (1996). Always a C chord followed by a maj, min, dom7, or min7 chord. All possible root motions explored.
- **Chord timbre:** 25 instruments often used to play chords in popular and classical music.
- **Stimuli generation:** mono versions of instrument pre-sets from Logic Pro. IOI = 1500 ms, midi velocity = 75, and general loudness of the instruments equalized using pyloudnorm (Steinmetz & Reiss, 2021).

Analysis

- **TC** of the 1250 two-chord stimuli
- 165 timbral features for 1250 single chords used to create the two-chord stimuli and 625 single pitches used to create the chords (25 pitches x the 25 instruments).

Results

Spectral contrast in the range of 400-800 Hz was the timbral variable with the strongest correlation with **TC** (r (25) = -.85, p < .001). Octave-based spectral contrast roughly describes the energy differences between narrow-band signals and broad-band noise.

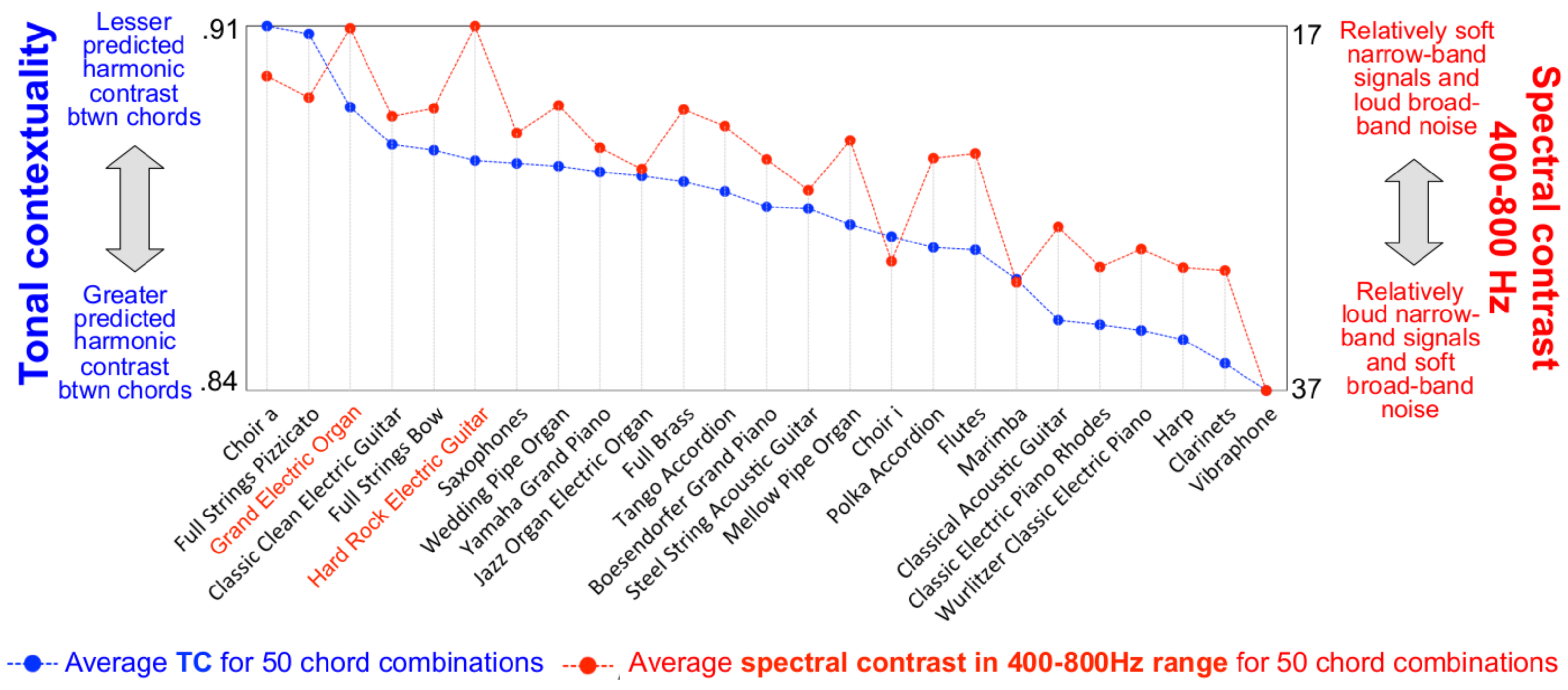

*Figure 1: **TC** and **spectral contrast in the 400-800 Hz range** for 25 instruments. All values are averages of the 50 chord combinations. The range of the two vertical axes in the plot was min-max normalized to facilitate comparison.*

Chords sung with the vowel [ɑ] and [i] had respectively one of the lowest and highest average **spectral contrast 400–800 Hz**, suggesting that **formants** can affect **spectral contrast** and **TC**.

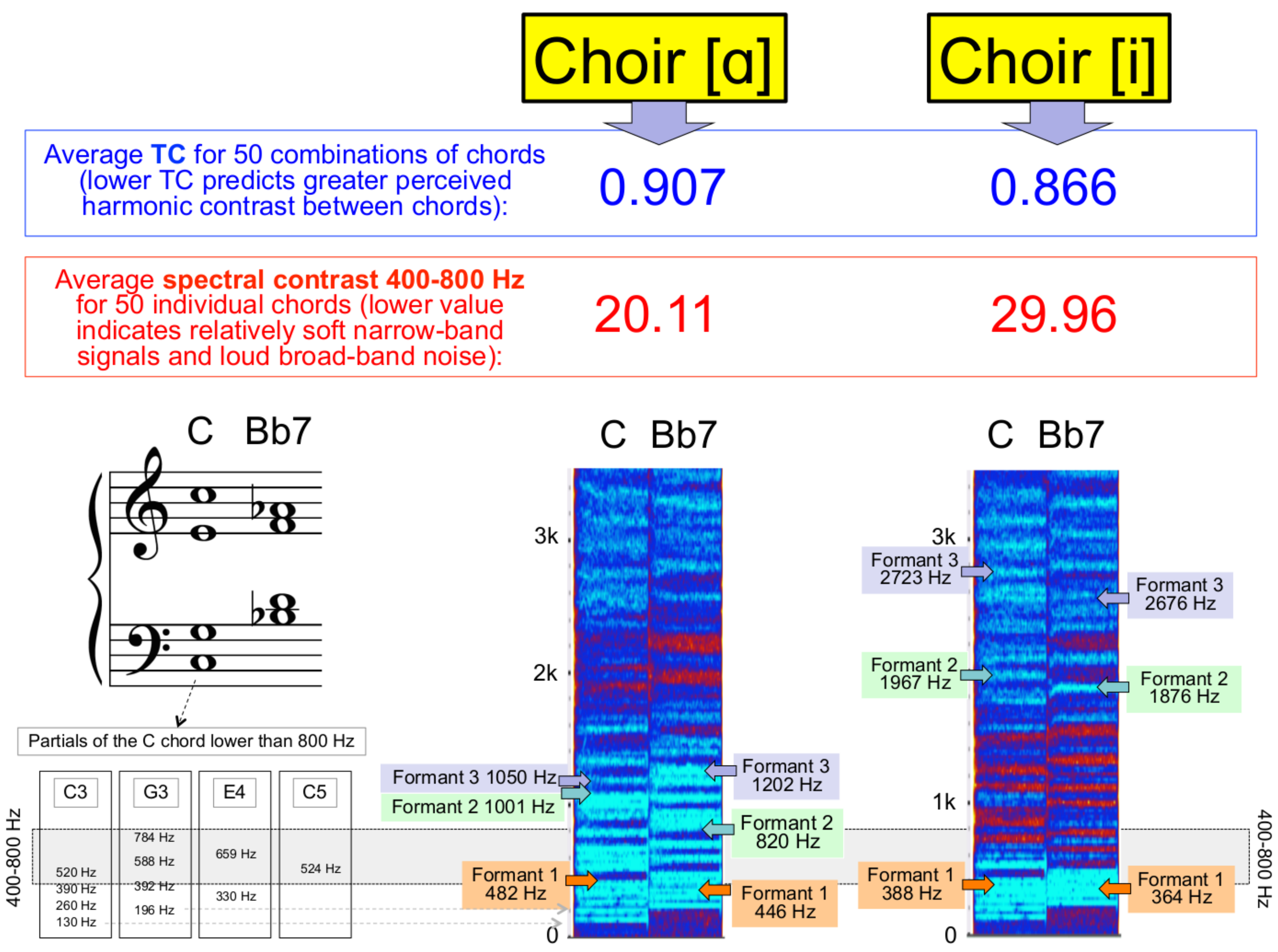

*Figure 2: Comparison between Choir [ɑ] and [i] in terms of **TC**, **spectral contrast 400-800 Hz**, and **formants 1 to 3**. Values for the first two variables are averages of the 50 chord combinations. Values for formants correspond to the specific chord succession C-Bb7 as voiced by Bigand et al. (1996).*

References

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