

Discrimination of string quartet timbres evaluated by sound duration

Emily Graber*, Jonathan Berger

Center for Computer Research in Music and Acoustics, Stanford University. Stanford, California, USA

*contact emgraber@stanford.edu



Background

The minimal time duration needed for timbre discrimination, investigated across categorical groupings of voice, strings, and percussion, has been found to be as low as 8 ms for instruments and 4 ms for voice¹. Here, we explore timbre discrimination within a more musically restricted palette. **In a novel experiment design, we compare excerpts recorded by professional string quartets with varying durations.** Other characterizations of timbre, like multi-dimensional scaling models², do not address the perception of such 'similar' timbres as those coming from equivalent moments in multiple recordings. **Our initial findings suggest the role of sound intensity in timbre production and discrimination.**

Hypothesis

We expect the threshold for discrimination to be dependent upon distinct features of the timbre which may or may not be present at the sound onset. To test this, we made stimuli starting from midpoints as well as the onset of each excerpt.

Timbres

[1] *pp ordinario* (3rd Quartet, Ricapitolazione, m. 55)

[2] *pp con sordino* (2nd Quartet, III Lento, m. 54)

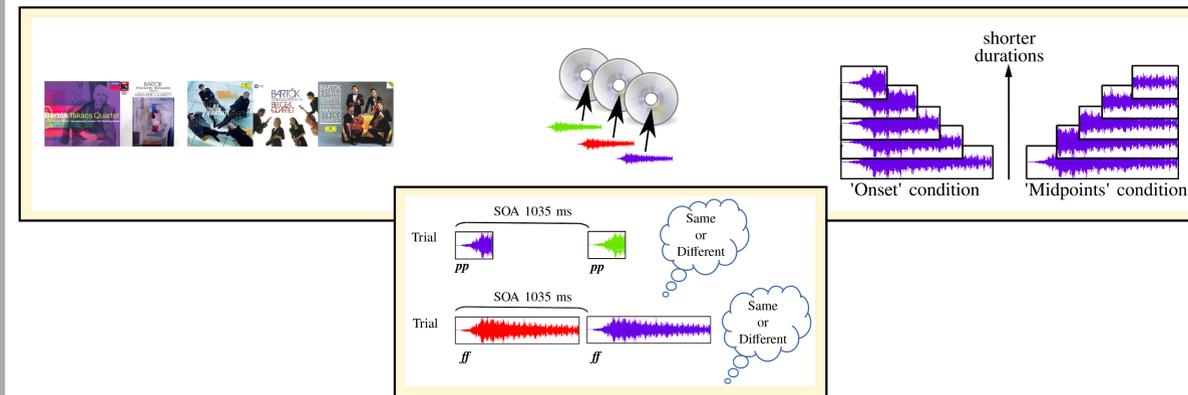
[3] *ff* (6th Quartet, I, m. 23)

We chose three excerpts from string quartets by Bela Bartok notable for their rich and distinct timbres.

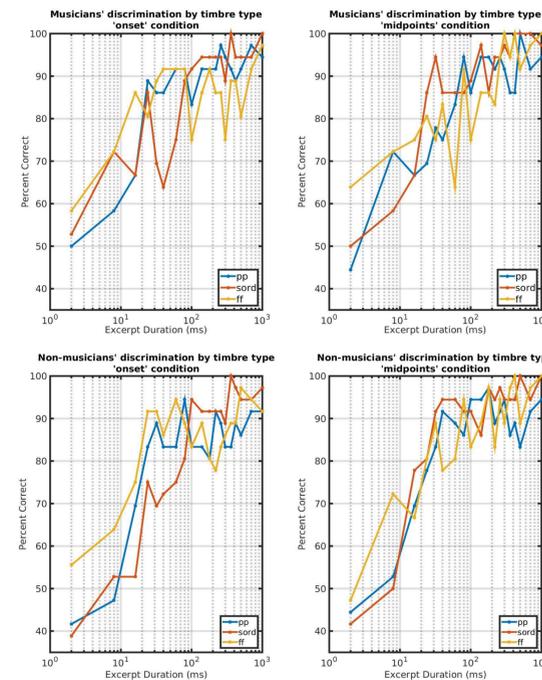
Experiment

Three exemplary renditions of each excerpt were selected from five available commercial recordings to minimize pitch variation between the recordings. 19 normalized variants of different durations (2 - 1000 ms) were made from each excerpt in 2 conditions.

9 subjects (4 female, 5 male, mean age 29.6, normal hearing, 4 musicians, 5 non-musicians) participated in the experiment. The experiment lasted approximately 60 minutes total. There were two blocks each with 513 randomized trials of excerpt pairs where both members of every pair had the same timbre type and duration. Blocks were counter balanced across subjects.

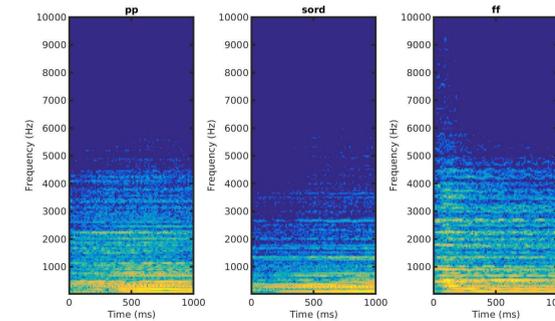


Results



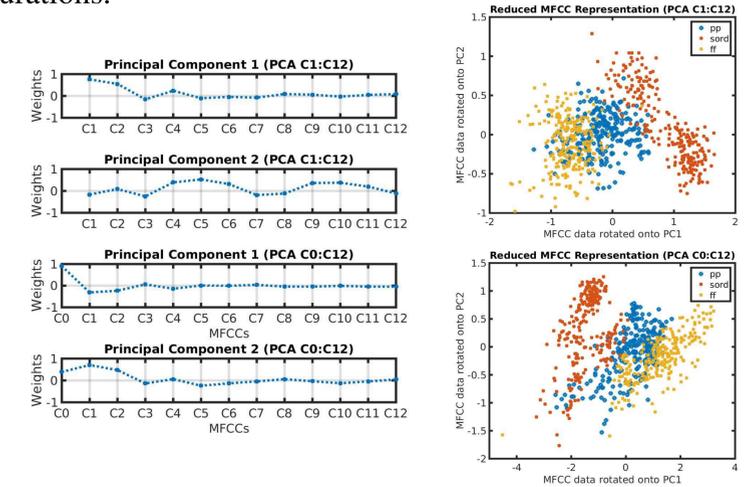
[left] Discrimination is more dependent upon timbre type than upon expertise or start point of the stimulus.

[below] The onset characteristics for each excerpt type are different. In general *ff* has the fastest attack, and *pp con sordino* has the slowest attack.



Results Continued

PCA on MFCCs with and without C0 show some overlap of the timbre types. Though the *pp ordinario* and *ff* timbres overlap the most, *ff* was discriminated the best at short durations. The spectrotemporal development of the *pp con sordino* excerpts may be responsible for both the larger clusters below and improved discrimination abilities at longer durations.



Next Steps

- ✘ Substantiate the role of intensity in timbre perception
- ✘ Differentiate memory abilities from discrimination abilities
- ✘ Relate 'strength' of timbre features within a stimulus to ease or quickness of discrimination and processing time
- ✘ Find duration short enough for *ff* stimuli to be discriminated at chance levels
- ✘ Correlate results to neuroimaging of same stimuli

References

1. Suied, C., Agus, T. R., Thorpe, S. J., Mesgarani, N., & Pressnitzer, D. (2014, March). Auditory gist: recognition of very short sounds from timbre cues. *J. Acoust. Soc. Am.*, 135(3), 1380-1391.
2. Grey, J. M. (1977, May). Multidimensional perceptual scaling of musical timbres. *J. Acoust. Soc. Am.*, 61(5), 1270-1277.