Perceptual characteristics of spaces of music performance and listening

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Introduction

Four major auditory percepts (loudness, pitch, duration and timbre) are considered of interest in Music and Acoustics. Compared to the other three ones, timbre is the most complex and least understood characteristic of sound (Zacharakis & Pastiadis, 2014). Given the multidimensional nature of timbre on its own, the combination of timbre and reverberation creates a large number of additional variables that affect the perception of timbre.

In room acoustical quality research history, the main goal has been to investigate what is considered a "good listening environment" (Kuusinen, 2016). Today, concert hall design aims at specific acoustic properties that can be reproduced using acoustic simulation and acoustic measurements. (Kahle, 2013). Several researchers attempted to describe the features of room acoustic halls, with as few as possible number of verbal descriptors (e.g. Kuusinen, 2016,).

Weinzierl, Lepa, & Ackermann, (2018), created a measuring instrument for the auditory perception of rooms. Three types of stimuli (orchestra, solo, speech) were used under 35 x 2 (rooms x listener positions) different room acoustics instances. The participants were asked to interpret the stimuli with 46 different room acoustical quality descriptors. Hence, the Room Acoustical Quality Inventory (RAQI) was produced.

In this paper we attempt to investigate aspects of the interaction between musical timbre and reverberation using semantic descriptors of room acoustics with the use of the 9-factor RAQI (Quality, Strength, Reverberance, Brilliance, Irregular Decay, Coloration, Clarity, Liveliness, Intimacy) by Weinzierl, Lepa, & Ackermann, (2018) as the verbal description mechanism.

Method

Our research is based on two verbal characterization experiments. Both of these experiments used the 9-factor RAQI as verbal descriptors. In both experiments, the participants were asked to quantify each RAQI factor for each stimulus sound (orchestra, solo trumpet, and speech in the 1st experiment and various instruments producing a single tone in the 2nd experiment). The RAQI terms appeared both in English and Greek. Three room acoustics conditions were considered, e.g. anechoic, medium reverberation (DTU), high reverberation (Hagia Sophia). In the second experiment a set of individual instruments' tones (similarly to Zacharakis, Pastiadis, & Reiss, 2014) were quantified using the RAQI, under the 3 aforementioned acoustical conditions, attempting to identify interactions of different instrument families/timbres with reverberation conditions. The participants were highly trained musicians.

Results

In Experiment 1, in most cases, in the orchestral stimuli (Polyphonic timbre) there was an augmentation in RAQI score in moderate reverberation and a decrease in high reverberation. In the solo instrument the relationship between the RAQI scores and reverberation is not monotonic. In Experiment 2 lower reverberation enhanced RAQI scores with percussions or keyboards, while winds, brass and strings led to higher RAQI scores in conditions with higher reverberation. The RAQI scores show consistency between different types of sounds in low and high reverberation but tend to be instrument dependent in medium reverberant environments.

Discussion

Timbre's interaction with reverberation (in terms of room acoustics characterizations) varies among instrument families. A significant differentiation lies in the type of timbre, namely polyphonic or monophonic. Although the RAQI score shows consistent quantifications in low-high reverberation, the variability in particular factors across different timbres and reverberation conditions is important for the evaluation of both the statistical properties of RAQI per se and the investigation of the relation between timbre and room acoustics.

References

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