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Acoustical correlates of violin timbre descriptors

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Background in violin performance and construction

Performers often discuss the sound quality of a violin or the sound obtained by particular playing techniques, calling upon a diverse vocabulary. But how do those words relate to each other? How consistent are they between players? How reliably can they be used by teachers, or performers explaining to violin makers what they want?

Background in instrumental acoustics and psychoacoustics

The terms that players use can be assumed, in principle, to relate to perceived acoustical features of violin spectra. A method for identifying critical aspects of these features involving "virtual violins" has been developed and applied by the authors in a number of previous publications (e.g., Fritz et al, 2007). This involves recording the forces applied to a violin bridge while the violin is being played normally, using piezoelectric sensors, and filtering these recordings using the measured response of a chosen violin; aspects of this response are then modified to provide a range of "virtual violins". The method is adapted here to address the questions outlined above, and to explore aspects of the results reported by Dünnwald (1991) in his measurements of over 700 instruments.

Aims

The study explores the English terms used by violinists to characterise the range of violin timbres, and analyses the relationship in perception of a subset of the most distinctive verbal descriptors to specific acoustical features of computer-generated ("virtual") violin sounds modelled on real violins.

Main contribution

11 experienced violinists (English native speakers) supplied 5 to 10 words they would use to describe violin timbre generally. Terms from descriptions of violins in *The Strad* magazine occurring between 1996 and 2007 were also collected. Overall, 61 common descriptors were found (>3 occurrences each).

12 other experienced violinists were then asked to arrange these terms on a two-dimensional grid, with words with similar meanings lying close together and words with different meanings lying far apart. Participants made four arrangements, each relating to a different situation where timbre might be described: overall sound quality; sound quality of the lower violin strings; sound quality of the higher strings; and ease of playing. These data were then analysed with multidimensional scaling techniques. The results of multidimensional scaling demonstrate consistent use among violinists of a previously informal vocabulary. Scaled descriptor maps

demonstrate different dimensions used by violinists when describing timbre. They also highlight which terms are used for similar purposes.

Four terms that were either found to be highly differentiable under MDS, or were stated to be important by Dünnwald (1991), were employed in a listening experiment. The terms used were *bright*, *clear*, *harsh* and *nasal*. A two-note sequence edited from a real performance was used as the driving signal for "virtual violins". Use of the two-note sequence was motivated by the results of a preliminary study empoying the two-note sequence as well as the longer phrase from which it was derived; this study showed that listeners' judgments were likely to be relatable to features of the violin sound when the two-note sequence was used, whereas their judgments were oriented towards musical aspects of the stimulus such as the melodic shape when the phrase was employed.

A further group of 14 experienced violinists was used in this listening experiment. The spectrum of a reference virtual violin was filtered into five contiguous frequency bands (five octave-wide bands starting from 190 Hz) and the level in each band was randomly and independently varied over a 10-dB range. Each subject listened to pairs of sounds and selected the sound which corresponded best to a given term, e.g., they had to pick which of the two sounds was more *bright*. Results yielded a high degree of consistency between subjects for the terms *harsh*, *clear* and *bright*; all these terms were associated with an increase of energy in the frequency range 1.6 kHz to 3.2 kHz (Band 4). Findings for the term *nasal* initially appeared less consistent; however, subjects could be divided into two groups, each showing high consistency. An increase in Band 4 increased *nasality* for one group while decreasing it for the other.

It should be noted that these findings are in conflict with the suggestions of Dünnwald (1991); he postulated that *clarity* should be increased by decreasing energy in the frequency range 4200-6400 Hz, while *nasality* should be reduced by decreasing energy in the frequency range 650-1300 Hz.

Implications

These terms and their relations will be useful for violin makers and luthiers, and specialists in setting up and adjusting instruments during discussions with performers. The terms provide tools for acoustical research into the perceived quality of instrumental sound. Both the identification of word consistency between players and establishment of correlations between descriptor terms and particular acoustic features of violin sounds can contribute to development of pedagogical methods, as well as ways of annotating music scores for composers and arrangers.

References

Dünnwald, H. (1991). Deduction of objective quality parameters on old and new violins. *Journal of the Catgut Acoustical Society Series 2, 1*(7), 1-5.

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