

Psychoacoustic experiment in the research of musical sound timbre

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The methodology of psychoacoustic experiment for musical sound timbre research is discussed and illustrated by examples. The common levels of the research – description, correlation and causality – applied to timbre research are explained. The concept of complex acoustic taxonomy is introduced as a schematic description of the methodology created for the characterization and structuring of objects of interest (sound sources, sounds and sound percepts), for the labeling of the methods of their investigation and classification (instrumentally deterministic classification of sources, physically statistical taxonomy of sounds and subjectively statistical taxonomy of percepts), and for the signaling of the search of their mutual relations. Proposed psychoacoustic experiment basic steps may lead not only to the classification of timbral features or dimensions but up to the search for timbre perception causality in the physical structure of a musical signal, or in the conditions of generation of musical signal. The method of verifying of hypothesis on sound timbre or its causality is an extension of the listening test method usually used for timbre description.

The use of the methodology is illustrated on examples of results of timbre research made in Musical Acoustics Research Centre. An approach using psychoacoustic experiments without listening was applied in the project of investigation of verbal description of sound timbre in Czech language. Different groups of musicians take part in the tests (string instrument players, wind instrument players, piano players, composers and conductors, and sound designers). Three basic common dimensions of sound timbre were confirmed: 1. *gloomy / dark – clear / bright* (*temný / tmavý – jasný / světlý* in Czech), 2. *harsh / rough – delicate* (*drsňý / hrubý – jemný*), 3. *full / wide – narrow* (*plný / široký – úzký*). The timbre of stationary violin sound was investigated using signals of five different pitches. The main perceptual features were explained via verbal attributes and acoustic characteristics (levels of individual harmonics, level in critical bands, etc.). Spectral sources and their dependence on pitch of *sharp* and *narrow* attributes were found. For the attribute *rustle*, characterizing one aspect of timbre of high violin tones, not only responsible spectral characteristics but also the physical source in bow – string interaction and violin body resonances were found. The relations between directivity of violin sound radiation and perceived sound quality were studied and preferred quality directions were established. Organ pipe sounds of four different stops recorded *in situ* in twelve pipe organs of four European countries (six baroque, two Romantic and four contemporary) were used in listening tests. The main perceptual features of organ sound were interpreted using verbal description and various acoustic characteristics. The results of all above described listening tests are compared with common dimensions found in non-listening experiment.