Comparative study of saxophone multiphonic tones. A possible perceptual categorization.

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ABSTRACT

Background

A number of studies have been devoted to the production of multiphonics in woodwinds, focusing on the possibilities and difficulties of intonation, fingering, pitch of components, and production of trills [1, 2]. However, most of them disregard the timbric and dynamic qualities of these tones, or are aimed to the detailed analysis of a few multiphonic examples. Recent research also served to unveil the physical principles that give rise to these complex tones [3], including the interaction with the vocal tract of the performer [4]. In comparison, the psychophyisics of the multiphonic perception have received much less attention, and a complete picture of how these multiple sonorities are eventually grouped into perceptual classes is still missing.

Aims

This work presents a comparative study of a comprehensive collection of multiphonics of the saxophone, from which a possible categorization into perceptual classes is derived. In order to do this a threefold analysis is performed: musical, psychoacoustical and spectral.

Method

Based on previous research from the musical perspective [5], an organization of the perceptual space for the multiphonics into four main classes was proposed. As a first step, a total of 120 multiphonic tones of the alto saxophone, spanning a wide spectrum of possible sonorities, were analyzed using Schaeffer's concept of 'sound object'[6]. This preliminary categorization was focused on the musical attributes of the tones (quality of surface, internal musical intervals, dynamics) but also their characteristics of intonation and possibilities of modulation between different sonorities. As a preliminary result, four types of sonorities was founded: "Complex multiphonics" (high degree of dissonance, quality of surface rough with the presence of a ninth, between ***mf*** and ***ff***), "Tremolos" (beating integrated to the sound, with the velocity of the Tremolo changing according to the tuning of the eighth, with the presence of an eight -slightly out of tune- and a ninth, between ***mp*** and ***f***), "Bichords" (consonant sonority with the presence of a minor or mayor third, between ***pp*** and ***mf***) and "Multiharmonics" (smooth surface, high degree of consonance, dyads and triads with the presence of a seventh, between ***ppp*** and ***mp***).
From this analysis, a representative subset of 15 multiphonic tones was selected, including samples for each of the four groups proposed. These representative tones were used in a psychoacoustical experiment (pair comparison test [7]) in order to obtain a judgement of similarity between them. This was done with a 5 element similarity scale, corresponding with "non similar", "barely similar", "likely similar", "pretty similar", "mostly equal". The multiphonics used were stationary, lasted 3 seconds and they were presented with a loudness between 57 and 65 db SPL. The subjects were told to focus on timbre attributes only and were all musically trained in electroacoustic music. The results obtained were analyzed using multidimensional scaling. Finally, by means of a spectral analysis of the tones, possible cues used by the listeners to evaluate similarity were obtained.

Results

As a main result, multidimensional scaling shows a perceptual organization that closely resembles the classification proposed from the musical point of view, clustering the four main classes on a two dimensional space. From the spectral analysis, we find a possible correspondence of the two meaningful dimensions with the modulation frequency of the multiphonics (related to the size of the internal grain) and the spectral center of gravity (related to the intensity of the blowing and the intonation).

Conclusions

A perceptual categorization for the multiphonics is of uttermost importance in musical composition. This works advances a possible organization of these tones for the alto saxophone that could be eventually extended to other woodwind instruments.

Keywords

Saxophone, multiphonics, multidimensional scaling, perceptual timbre space

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