MUSICAL GROOVE IS CORRELATED WITH PROPERTIES OF THE AUDIO SIGNAL AS REVEALED BY COMPUTATIONAL MODELLING, DEPENDING ON MUSICAL STYLE

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ABSTRACT

With groove we mean the subjective experience of wanting to move rhythmically when listening to music. Previous research has indicated that physical properties of the sound signal contribute to groove - as opposed to mere association due to previous exposure, for example. Here, a number of quantitative descriptors of rhythmic and temporal properties were derived from the audio signal by means of computational modeling methods. The music examples were 100 samples from 5 distinct music styles, which were all unfamiliar to the listeners. Listeners' ratings of groove were correlated with aspects of rhythmic patterning for Greek, Indian, Samba, and West African music. Microtiming was positively correlated with groove for Samba and negatively correlated with groove for Greek, but had very small unique contributions in addition to the rhythmical properties. For Jazz, none of the measured properties had any significant contributions to groove ratings.

1. INTRODUCTION

People often find themselves spontaneously nodding or tapping their feet when they hear music, and much music is indeed intended for synchronised movement in the form of dance, drill, and ritual behaviours. There are indications that the connection between movement and the rhythmic component of music is biologically determined [1,2]. In order to examine these potential connections, it is important to find out which physical properties in the musical signal - if any - are correlated with listeners' experience of wanting to move to the music.

Music features several forms of temporal structure. A priori, one could assume that two of these are particularly relevant for groove: rhythmic patterning and systematic microtiming. Rhythmic patterning is the assignment of different sound events to certain canonical time values, i.e. to certain positions in the metrical grid. It seems likely that the degree of repetitive rhythmical patterning may be related to the experience of groove. Microtiming refers to deviations from canonical time values that are often found in real music performances. Systematic microtiming patterns are those that covary, either within [3] or across performers [4].

Here, we examine the correlation between ratings of groove and numerical descriptors of the sound signal that correspond to (a) the salience of periodic events close to preferred tempo; the relative salience of sound events that are faster than the beat level, both (b) those that repeatedly occur at small-integer (metrical) subdivisions of the beat level and (c) those that do not; and (d) recurrent micro-timing structuring of events. In addition to this, we also considered (e) unsystematic micro-timing [5].

2. METHODS

Nineteen non-musicians, ranged from 19 to 32 years in age, were paid for acting as listeners. Twenty music examples (ME) were selected by the authors as representative of each of five traditional folk music traditions from a certain region, here referred to as Greek, Indian, Jazz, Samba, and West African. The 100 MEs were copied from commercially available CDs and were copied from any position within the original sound track that constituted a representative and musically meaningful example of that track, containing at least one rhythmic phrase with a prominent steady beat. MEs were 9.06-14.55 s in duration, were adjusted to equal amplitude, and their tempi ranged from 81 to 181 BPM. The dependent variable was the participants' experience of Groove, defined as "evokes the sensation of wanting to move some part of the body" and rated on an 11-point scale. The scale appeared as a horizontal line anchored "not at all appropriate" (0) and "very appropriate" (10). Each session began with 10 MEs, two from each of the five styles but different from the experimental MEs, whose purpose was to orient participants about the range of properties to rate in the experiment. Ratings from the first block were not included in the analysis. The sound descriptors measured the magnitude of rhythmical and temporal properties corresponding to the psychological properties outlined in

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the introduction, namely Event density, Beat salience, Fast metrical levels, Systematic microtiming (MT), and Unsystematic MT. Details of the computational approach are the object of a forthcoming paper.

3. RESULTS AND DISCUSSION

The strongest correlations between Groove and the descriptors were found for Beat Salience and Event Density, and these correlations were also stronger among the Greek, Indian, and Samba styles than among West African and Jazz. Jazz exhibited very small correlations overall. Rhythmical descriptors seem to play a substantially greater role than do microtiming descriptors across all styles, and they also generally exhibit larger correlations within each style. There was also an interaction between descriptor property and music style, in that Systematic MT seems to play no role at all for Indian, Jazz, and West African, but a substantial role for Samba. Finally, Unsystematic MT seems not to play any role for groove. It is likely that the descriptors are to some extent intrinsically dependent and that the measured properties in the music examples covary to some extent. To assess the unique contributions of each descriptor, a stepwise multiple regression was performed for each style and for all styles together, the results of which are summarised in Fig. 1.

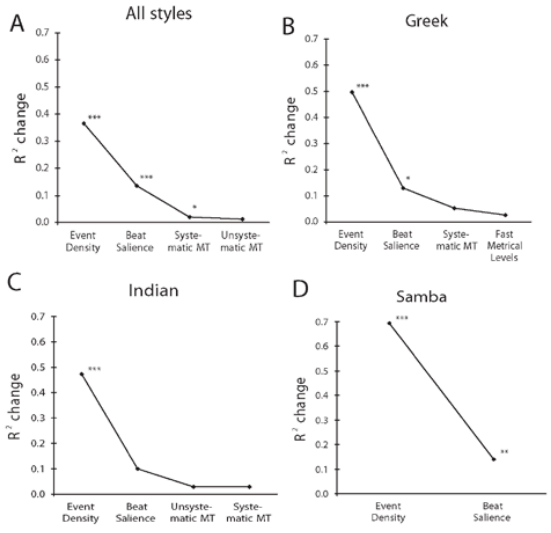

Figure 1. Changes in explained variance according to stepwise linear regression of groove ratings on the five descriptors. Note. *** = p < .001, ** = p < .01, * = p < .05.

Only one descriptor passed the entry criterion (F > 1.0) for Jazz and West African, respectively, and these are therefore not shown in the figure. Removing Fast Metrical Levels from the model subtracted 6.43 percent of the total explained variance by all descriptors (14.2%) for Jazz, and removing Beat Salience likewise subtracted 25.65 percent from the total 28.8 percent for West African. The changes in explained variance for Greek (total $R^2 = 0.709$; df = 5, 14), Indian (0.631), Samba (0.841), and for all styles pooled (0.537; df = 5, 94) are shown in the figure.

Jazz is commonly associated with expressive performance. In particular has groove been attributed to the swing ratio, the relative duration of the two "swung" notes in the rhythmic ostinato so characteristic for much classical jazz music. Not all jazz features swing in this sense, but 15 of the present Jazz examples did. Yet did not the variation in the swing ratio, nor any other microtiming pattern, exhibit even a tendency for being related to groove. Although contrary to popular belief, this corresponds perfectly with the finding that the swing ratio is trivially related to tempo [6], suggesting that its purpose is merely to make the two intervals discriminable, in effect to maintain a rhythmical pattern. Samba was characterised by high correlations with no less than four descriptors, which naturally proved to be highly redundant. This suggests that Samba employs all possible means to induce groove, as might be expected by music dedicated to dancing, including a strongly accentuated and continuously repeated beat provided by the *surdo* and accentuated Fast Metrical Levels by the *pandeiro*.

In conclusion, these results indicate a ubiquitous relation between the rhythmical descriptors and groove for all styles but Jazz, whereas relations with microtiming are in fact negative whenever they remain significant (for Greek and Indian). This provides further empirical evidence that periodicity is a key component for movement induction trhough music, and strengthens the position of groove as a perceptually salient dimension of music.

4. REFERENCES

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