

## Report on comparing rhythm and melody of speech and music: The case of British English and French. Kamlesh Lakshminarayanan 4095 5242 03 EE 675

Brass legend Roger Bobo noticed a strange phenomena while working with Japanese brass players. They had a tendency to play all tongued notes shorter than what was indicated in the score. This was because Japanese is a very staccato language spoken with plenty of silent spaces between syllables. In the paper, Patel et. al. quantitatively tries to establish the relationship between rhythm and melody of speech and music. The two classes of language rhythm considered are stress-timed (English) and syllable-timed (French) rhythm. In order to directly compare prosodic differences in speech and music, terms such as nPVI (Normalized Pairwise Variability Index) and prosogram are introduced.

"nPVI measures the degree of durational contrast between the successive elements in a sequence". Studies show that stress-timed languages have greater durational variability in consonantal intervals indicated by high nPVI values and lesser vowel content than syllable-timed languages. Interestingly, music from stress-timed languages have higher nPVI values than music from syllable-timed languages. Global variability features are captured by measures like standard deviation. Although this is different from nPVI, linguistics demand that it could drive nPVI differences making their distinction hazy. So, a Monte Carlo method is defined to quantify nPVI difference conditioned on variability difference. In order to quantify speech melodies, a prosogram model representation of intonation which captures the perceived pitch contour is established. The prosogram transforms the original fundamental frequency contour of the speech into a music-like representation of discrete tonal segments. They also offer pitch height and intervals to quantify variability.

An organized approach for speech and music selection was adapted. Several parameters were taken into consideration so as to minimize the possibility of misleading results and interpretations. This study focuses on vowel-based measures of rhythm because parallels in music are easily derivable. First, the vowel boundaries in the speech segments of both English and French using spectrograms are marked. A well defined music score serves as the measurement for duration in musical themes. The nPVI and variation coefficients (CV) are computed. To define the relationship between nPVI and CV a regression method followed by the Monte Carlo technique is performed. To determine the pitch patterns in speech, first the fundamental frequency contour is measured and then the prosogram analysis is performed. Here, a vowel is assigned a tone or glide based on if its pitch change is greater or lesser than a threshold. "For maximum comparability to music, only level tones were used in the quantification of pitch variability in speech". Measures of pitch height and interval variability are then computed. For music, "the themes were coded as sequence of pitch values thereby allowing computation of each tone's semitone distance from the mean pitch of the sequence". Pitch height and interval variability are then computed as in speech.

The studies made the following conclusions. In speech (English and French), there was a significant difference in nPVI and CV values. In music, nPVI difference was significant but CV was not. Monte Carlo analysis concluded that variability difference did not account for nPVI differences in speech and music. While pitch height variability between English and French did not differ by much, pitch interval variability in French was significantly lower than in English. Similar pattern was observed in music. The reason for this pattern remains unexplained. Rhythm-melody plot defines

several characteristics. One being that the line connecting English and French speech would lie at the same angle as the line connecting music from the two language bases. It can also be used to calculate the prosodic distance between speech and music from English and French. To understand how prosodic language patterns are reflected in music, the authors suggest a statistical method of studying languages. Future research may involve inter-relationship between rhythm and melody and the use of the RM space diagram to quantify non-native prosody.