

An Experiment on the Role of Pitch Intervals in Melodic Segmentation



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This poster presents the results of an experiment to test the influence of IOI, dynamics, pitch change, and pitch direction change on melodic segmentation, extending an earlier experiment (Weyde, 2004). The new results show little to no significant influence of pitch on segmentation, when evaluated by a linear or log-linear statistical model with regression. This supports earlier findings we made, which are in contrast to the common assumption that greater pitch intervals lead to melodic segmentation.

Introduction

The segmentation of melodies plays an important role in melody perception, cognition, and retrieval (e.g. Melucci and Orio 2004, Weyde and Datzko 2005) and applications in music e-learning, like the automated generation of exercises from a given annotated music score. A common assumption is that the Gestalt principles of proximity and similarity can be applied to the different musical dimensions of pitch, time, dynamics, and derived quantities such as the change of direction in successive pitch intervals (see Lerdahl and Jackendoff 1983, Cambouropoulos 2001). This assumption has been tested empirically in (Weyde, 2004) for pitch intervals up to 5 semitones, where neither pitch intervals nor changes of pitch interval direction had significant effect in linear or log-linear regression models. There was however the question whether the outcome would be different for larger pitch intervals and other factors could be relevant.

Experimental Design

The experiment uses mostly the same design as (Weyde, 2004), which is described here only briefly: The experiment uses a forced-choice design, where subjects listen to a melody and are asked whether the length of segments in the melody is 2 or 3 notes. Subjects were presented short melodic sequences, which were designed to be completely isochronous and uniform except for two conflicting segmentation cues, of which one indicated a segmentation into groups of two notes and the other into groups of three. The intensity of the cues was varied.

This approach was chosen to approximate the situation of actual melodies, where there is normally more than one cue present. Pairs of cue types were used, as all combinations of values for three or more factors would have led to huge numbers of stimuli.

Four cues were tested: inter-onset-intervals, loudness accents, pitch intervals, and changes in pitch direction. Each of the cues was varied in several steps. The following values were used:

- additional inter-onset-interval values of 30, 60, 90, 120, and 150 ms
- loudness accents of 15, 30, 45, 60, and 75 MIDI velocity units
- pitch intervals between notes of size 2, 4, 6, 7, 8, 9, 10, 11, and 12 semitones, alternating up and down
- changing direction, with pitch intervals of 1, 2, 3, and 4 semitones between every pair of successive notes

Each of these was used to cue segments of both two and three notes length. For the smaller pitch intervals not all values were used, as they had already been exhaustively tested in Weyde (2004).

In addition, a set of examples with only one factor used in segmentation cues was created for each factor and two melodies without segmentation cues, i.e. completely uniform and isochronous sequences. Additional parameters were varied at random in this experiment:

- initial pitch and loudness
- assignment of factors to segment lengths
- total length of the melody

They were also used as independent variables in the regression analyses, to find out if and how they influence the segmentation.

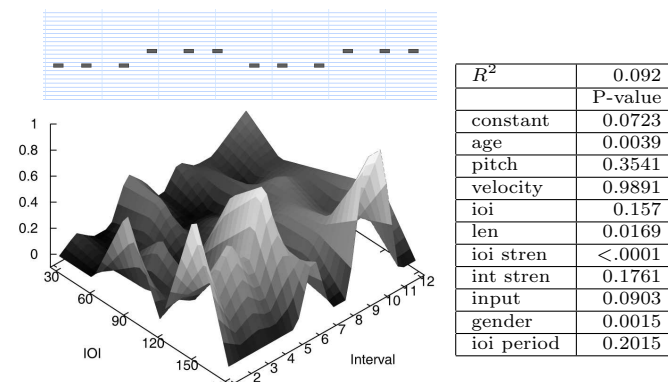
The experiments were conducted in one session where each subject listened to all stimuli. The stimuli were presented via MIDI with a piano-like sound on a personal computer with a program that asked to choose of either '2' or '3' as preferred segment length. The stimuli were presented in random order with a short break of randomised length between the presentations. The subjects were ten music students between 20 and 23 years of age, five male and five female.

Results

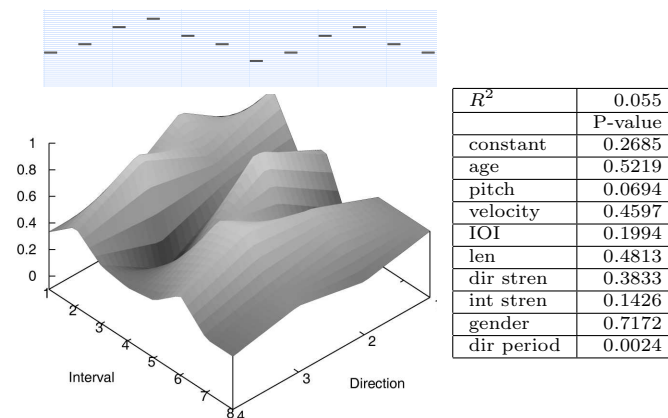
In the following selected results and regression analyses of the experiments are presented.

Pairwise Experiments

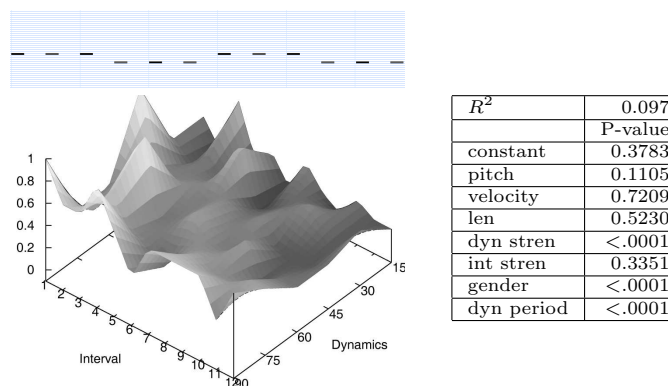
In IOI-Pitch stimuli we varied pitch and inter-onset-intervals. Below the stimulus, the results, and logistic regression analysis are given. The dependent variable is the conformance of the segmentation with the period of the ioi pattern. The results show clearly that the effect of inter-onset intervals is significant, while that of pitch intervals is not. Surprisingly, the other significant variables are gender, age, and the length of the melody (in that order). All other factors are not significant.



In Pitch-Direction stimuli, the regular pitch intervals change direction and additional pitch intervals appear in regular intervals. The regression analysis shows that only the assignment of the direction cue to the segment length ('dir period') has a significant effect.



The Pitch-Velocity stimuli combine pitch changes with velocity accents. In the regression analysis the strength of the loudness accents is significant, while the size of the pitch intervals is not. Interestingly gender and the association of dynamics with segment length ('dyn period') were highly significant.

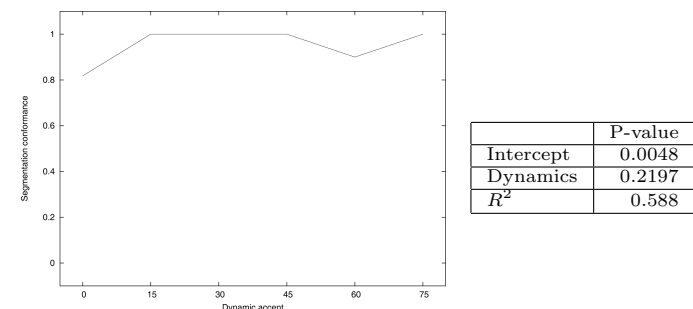


Single-factor experiments

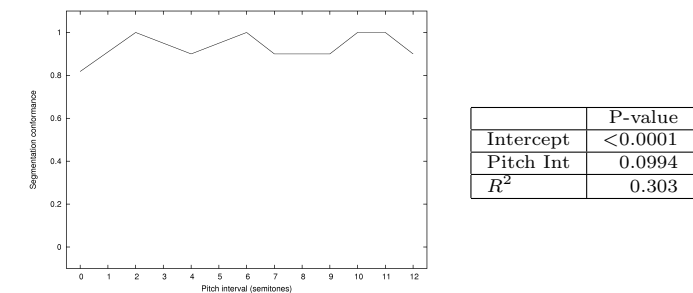
In addition to the pairwise experiments, we used several stimuli that contained only segmentation cues using a single factor. The hypothesis here was that with only one factor being available, this would directly cause segmentation boundaries. In addition the question was whether there would be a higher likelihood of subjects' segmentation conforming to the cues depending on the strength of the cue.

The actual results were dominated by saturation effects, only IOI shows a significant linear relation to the segmentation.

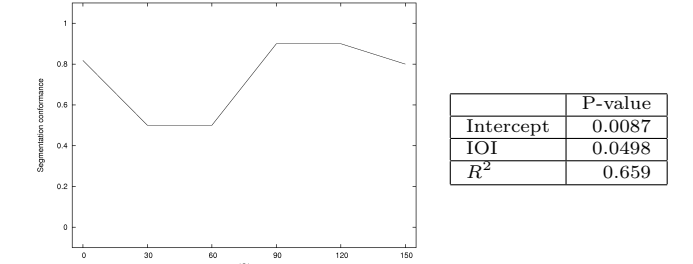
For the intensity accents, the results below show a saturation effect of the segmentation conformance, even for little accent strength.



For the pitch intervals, the analysis showed again a saturation effect of the segmentation conformance, independent of the interval size.



For inter-onset-intervals, the graph and the regression analysis show a different picture than the previous two. The segmentation conformance increases for greater IOIs and there is a saturation effect at 90 ms.



Discussion

The results of the pairwise experiments show significant effects on chosen segmentation for velocity and IOIs, but not for pitch or change of pitch interval direction. This result is consistent over all tested pairs. It is also consistent with the earlier experiment in Weyde (2004) and extends this to larger intervals up to an octave. This contrasts to most currently accepted assumptions on melodic perception being directly related to pitch interval size (Lerdahl and Jackendoff 1983, Cambouropoulos 2001). The single factor stimuli shows that pitch intervals do however have an influence on segmentation if they appear as the only segmentation cue.

In addition there are surprisingly significant effects of gender and in one (likely not generalisable) case of age. Also unexpectedly, there was an interaction between the segment length and type of cue in some cases. Other factors, like absolute pitch, loudness, tempo, and melody length had little to no influence in the ranges tested.

The results are consistent throughout this and previous experiments, showing significant influence of pitch and velocity on segmentation. It seems therefore justified to claim that rhythm and dynamics have a considerably stronger influence on segmentation than pitch interval size and interval direction changes, considering linear and log linear effects in the ranges of intervals up to an octave. However, it seems plausible that pitch does have an effect on melodic segmentation, as it plays such an important role in melody and music in general. The apparent special role of the fifth and octave and relatively little variance explained by the models indicate that the so far assumed linear relation may have to be reconsidered and possibly replaced with a more complex model.

References

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