AN EXPERIMENT ON THE ROLE OF PITCH INTERVALS IN MELODIC SEGMENTATION

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ABSTRACT

This paper presents the results of an experiment to test the influence of IOI, dynamics, pitch change, and pitch direction change on melodic segmentation, extending an an earlier experiment [4]. The new results show little to no significant influence of pitch, when evaluated by a linear or log-linear statistical model with regression. This supports the earlier findings, which are in contrast to the commonly made assumption that greater pitch intervals lead to melodic segmentation.

1 INTRODUCTION

The segmentation of melodies plays an important role in melody perception, cognition, and retrieval (e.g. [3], [5]) and applications in music e-learning, like 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 to derived quantities such as the change of direction in successive pitch intervals (see [2], [1]). This assumption has been tested empirically in [4] for pitch intervals up to 5 semitones, where neither pitch intervals nor changes of pitch interval direction were significant in linear or log-linear regression models. There was however the question whether there could be a significant effect for larger pitch intervals.

2 EXPERIMENTAL DESIGN

The experiment uses mostly the same design as [4], which is therefore 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 completely tested in [4].

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. Some additional parameters were varied at random in this experiment: the initial pitch and loudness, the assignment of factors to group lengths, and the 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.

3 RESULTS

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

3.1 Pairwise Experiments

In the IOI-Pitch stimuli we varied pitch and inter-onset-intervals. Table 1 shows the logistic regression analysis of the results with segmentation conformance as the dependent variable. It shows clearly that the effect of inter-onset intervals is significant, while that of pitch intervals

Logistic Summary Table for inp = dir period

Count	519
# Missing	0
# Response Levels	2
# Fit Parameters	11
Log Likelihood	-226.632
Intercept Log Likelihood	-251.463
R Squared	.099

Logistic Model Coefficients Table for inp = dir period

	Coef	Std. Error	Coef/SE	Chi-Square	P-Value
1: constant	-8.966	4.989	-1.797	3.230	.0723
age	.506	.175	2.887	8.334	.0039
pitch	-.032	.035	-.927	.859	.3541
velocity	4.738E-4	.035	.014	1.863E-4	.9891
ioi	1.969E-6	1.391E-6	1.415	2.003	.1570
len	.043	.018	2.389	5.707	.0169
ioi strength	-.012	.003	-4.447	19.777	<.0001
int strength	-.050	.037	-1.353	1.830	.1761
input	.473	.279	1.694	2.870	.0903
gender: 2	.919	.289	3.178	10.102	.0015
ioi period: 3	.355	.278	1.277	1.631	.2015

Table 1. Regression analysis of the IOI pitch factors.

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 the Pitch-Direction stimuli the regular pitch intervals change direction and additional pitch intervals. The regression analysis shows that only the assignment of the dynamics cue to the three note segmentation has a significant effect.

The Pitch-Velocity stimuli combine the pitch changes with velocity accents. In the regression analysis only the strength of the loudness accents aresignificant, while the pitch intervals were not. Interestingly gender and the association of dynamics with segments of size three were highly significant.

3.2 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 user 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.

4 DISCUSSION

The results of the pairwise tests show significant effects on perceived 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 [4] 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 ([2], [1]). 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 some surprising results that gender and in one case age shows significant effects. The effect of age seems likely to be not generalisable due to the small age range of the subjects. Also unexpectedly, there was an interaction between the segment length and type of cue in some cases, indicating that some factors are more effective for certain segmentations. 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 tests, 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 direction changes, at least considering linear and log linear effects in the ranges of intervals up to an octave. It seems however plausible that pitch does have a significant effect on melodic segmentation, as it plays such an important role in melody and music in general. The data of the pairwise experiments indicate the fifth and octave may have special effects. This seems to indicate that the so far assumed linear relation has to be reconsidered and replaced with a more complex model.

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