Patterns of tension/relaxation in music: A consideration of psychoacoustic and cognitive influences

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Perceiving patterns of tension/relaxation is essential to the comprehension and appreciation of music. Since music exists both as a collection of psychoacoustical events and as a system of hierarchical relationships understood at a cognitive level, it is reasonable to explore different influences on the perception of tension. To what degree do psychoacoustic and cognitive factors influence listeners' perception of tension in music? Recent work (Bigand, Parncutt, & Lerdahl, 1996) has addressed this question using short chord sequences. The present studies pursue the issue using an excerpt of real music that has received much attention from music theorists--the first nine bars of the second movement of Beethoven's *Waldstein* (Opus 53) piano sonata. We evaluated the psychoacoustic dissonance conveyed by isolated elements of the excerpt and compared perceived dissonance with perceived patterns of tension/relaxation conveyed by the musical context to musically sophisticated listeners.

Experiment 1

The aim of the first experiment was to obtain measurements of listeners' perceptions of dissonance of isolated chords extracted at different time points in the *Waldstein*.

Participants

Fourteen volunteers from the Queen's University community all met the minimum musical training requirement of Royal Conservatory grade VIII or equivalent, and had an average 13.7 years of musical training. None reported any degree of familiarity with the *Waldstein*.

Materials and Procedure

The stimuli consisted of the 15 successive solid or arpeggiated chords that constitute the first nine bars of the second movement of the *Waldstein*. The sonata was performed by an accomplished pianist and recorded in MIDI format. Chords were then extracted from the MIDI file. The chords were heard through Sennheiser HD-480 headphones connected to a Roland FP-1 digital piano. A Macintosh computer running MAX software controlled the timing and presentation of stimuli and the collection of responses. After each presentation of a chord, listeners rated perceived dissonance on a six-point scale. Each of eight blocks of trials contained each of the 15 chords, randomly ordered. The first block was a practice block, and its data were not included in the analyses. In order to avoid any carryover effects of the tonality of the previous trials the chord heard on each trial was randomly transposed within the range 3 semitones below to 3 semitones above the original notation of the excerpt.

Results

Perceived dissonance varied significantly among different chords ($F_{(14,182)} = 26.70$, $p < .001$). The mean dissonance rating for each chord is plotted in Figure 1, where the x-axis represents the successive time points, from 1 to 15, at which each chord was extracted.

Experiment 2

The first aim of the second experiment was to measure listeners' perceptions of tension for segments of the Waldstein presented in context. The second aim was to assess the degree to which the ratings could be accounted for by the dissonance ratings from Experiment 1, as well as by our quantification of phrase structure derived from a music theoretic analysis of the excerpt (Lerdahl, 1988).

Participants

Fourteen volunteers from the Queen's University community all met the same musical training requirement as Experiment 1, and had an average 12.3 years of musical training. They had all participated in a previous experiment in which they had been required to perform the *Waldstein* excerpt from memory.

Materials and Procedure

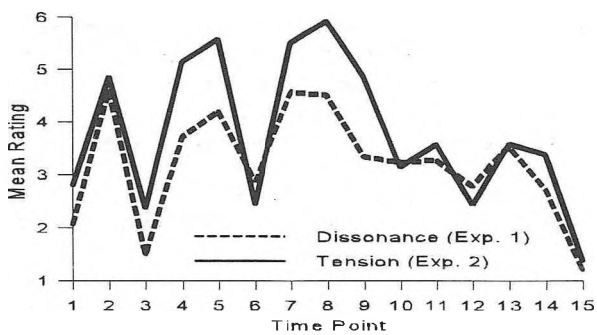
The stimuli consisted of 15 segments from the *Waldstein*. Each segment contained all the musical material up to one of 15 successive time points in the first nine bars of the second movement. Thus the final chord of each segment was one of the chords tested in Experiment 1. The segments were presented in chronological order and were not randomly transposed between trials. In other respects, the procedures was the same as Experiment 1. After each presentation listeners rated the perceived tension at that time point on a six-point scale.

Results

Listeners' ratings of perceived tension varied across time points ($F_{(14,182)} = 37.91$, $p < .001$). The mean tension rating for each segment is plotted in Figure 1, where the x-axis represents the successive time points at which each segment stopped. It can be seen that the fluctuation in tension ratings for the segments closely resembles the fluctuation in dissonance ratings for the isolated chords. As well as the fluctuations, however, the tension ratings show an increase up to time point 8 that is not present in the dissonance ratings. This difference may be attributed to the phrase structure of the excerpt.

The tension ratings collected in the Experiment 2 were highly correlated ($r_{(13)} = .90$, $p < .001$) with the dissonance ratings collected in Experiment 1. In addition, however, the tension ratings were also highly correlated ($r_{(13)} = .65$, $p < .01$) with a quantified predictor representing phrase structure. This predictor was derived from a music-theoretic analysis of the excerpt (Lerdahl, 1988). A multiple regression was then performed using dissonance ratings and phrase structure as predictors of perceived tension ($R = .96$). A significant contribution to the predictability of perceived tension was made by both the dissonance ratings ($t = 8.67$, $df = 12$, $p < .001$) and phrase-structure ($t = 4.23$, $df = 12$, $p < .01$).

Figure 1



General Discussion

The present experiments attempted to assess the role of both psychoacoustic and cognitive factors in listeners' experience of musical tension. The results reported here show that listeners' perceptions of tension are best predicted by a model that includes both information about the dissonance associated with individual musical events, as well as information about how the individual events are organized in terms of phrase structure.

References

Bigand, E., Parncutt, R., & Lerdahl, F. (1996). Perception of musical tension in short chord sequences: The influence of harmonic function, sensory dissonance, horizontal motion, and musical training. *Perception & Psychophysics, 58*, 125-141.

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