

Post-tonal harmonic tension and theoretical hybridity

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Abstract

Despite the large body of research that has examined tonal and atonal harmonies to our perception of tension, there is no work that describes or explores the perception of post-tonal chords, but more specifically, chords that contain both tonal and post-tonal features.

As there is no theoretical model that fully accounts for neoclassical practices, some have responded to this problem is by extending the individual methods' application – Schenkerian, neo-Riemannian, and pitch class set theories – or by simultaneously using more than one analytical approach, both of which invokes theoretical hybridity.

This paper applies the concept of calculating the total amount of voice-leading movement, to examine its relationship to our perception of tension and release. To do this, three neoclassical pieces by Hindemith, Ravel, and Stravinsky are selected to analyze the relationship between theoretical and perceived tension. The findings suggest that in addition to calculating the horizontal motion between harmonies, physical and acoustical factors play a critical role in relating theoretical to perceived tension. This approach is adaptable to other neoclassical works and in addition, this study could have implications in other musical fields such as performance practices and analyzing formal functions in post-tonal repertoire.

KEYWORDS: *neoclassical, tension, perception, music theory, music analysis*

Introduction

Understanding how one perceives musical tension can vary significantly depending on the readers' lens, a music-theoretical or psychological perspective. On the one hand, Bigand, Parncutt and Lerdahl state that musical tension from a purely theoretical perspective can be generally explained by a few variables, such as the function of chords within a tonal context (Riemann, 1893; Schenker, 1979), acoustical or sensory consonance (Rameau, 1971) and its melodic organization (Bigand, Parncutt and Lerdahl, 1996). On the other hand, a psychological perspective of musical tension investigates other factors such as cognitive approaches that justify the importance and role of tonal

contexts (how chords have specific functions in tonal contexts) (Bharucha, 1984; Bigand, 1990; Krumhansl, 1990; Lerdahl, 1988; Lerdahl, 2001), and theories in musical perception that reveal the chords' psychoacoustical features (Parncutt, 1989; Roberts & Shaw; 1984). This psychological approach can also be extended to the study perceptual aspects of auditory perception and its impact in music perception such as dynamics and timbral elements such as pitch register, roughness, brightness and density (Burnsed & Sochinski, 1988-2001; Granot & Eitan, 2011; Hutchinson & Knopoff, 1978; Ilie and Thompson, 2006; Krumhansl, 1996; Misenhelter, 2001; Pressnitzer, McAdams, Winsberg, & Fineberg, 2000; Plomp & Levelt, 1965).

One common trait between these perspectives is the emphasis of establishing a stable tonal center to derive sentiments of musical tension (Lerdahl and Jackendoff, 1983; Bigand, 1993; Bigand, Parncutt, & Lerdahl, 1996). These studies and observations have undoubtedly stemmed from the analysis of tonal repertoire and although some work has been extended to atonal repertoire (Dibben, 1994; Lerdahl, 1989; Krumhansl, Sandel and Sargeant 1987; Dibben 1999), understanding musical tension in repertoire that embodies both tonal and atonal elements, such as neoclassical repertoire, is an area of research that remains to be explored.

Despite the large body of research that has delved the various different aspects of music that attribute to our perception of tension, there is no work that describes or explores the perception of post-tonal chords, but more specifically, how these chords will be perceived without reference to a tonal center. The appraised literature therefore points out two key points: one, a lack of research into understanding and measuring post-tonal tension, a series of chords that encompass atonal and tonal elements and two, the importance of using psychoacoustical factors such as roughness to support empirical analyses into chordal tension. This study therefore seeks to explore a different way to measure musical tension in post-tonal repertoire, by taking the approach of calculating the total amount of voice-



leading movement between chords – and extending Lerdahl’s model of calculating tonal tension (Lerdahl & Krumhansl, 2007; Lerdahl, 1988; Lerdahl, 1996). The aim of the experiment is to establish if the values from the model approach have a direct relationship to how we perceive tension and release specifically in post-tonal repertoire.

Method

The design of this experiment derives from one component from a “hybrid” theoretical model, which encompasses elements from three different theories – Schenkerian method, neo-Riemannian theory and pitch-class set theory (Baker, 1980 & 1990; Hicken, 1974; Lewis, 1981, Morrison, 1991; Baker, 1983; Cinnamon, 1993; Pople, 1989; Travis 1959; Wilson, 1984). This model was created to address the harmonic issues posed by post-tonal repertoire, more specifically neoclassical works, as these works contains vestiges of tonality as well as post-tonal elements. Rather than applying the conventional Roman numeral labelling, calculating the total amount of minimal movement between each voice in the chords or more loosely, pitch collections (PCns), will provide a different and concise representation of the harmonies. This will be known as the Aggregated Voice-Leading (AVL) movement. (The AVL differs to voice-leading movement as AVL is the sum of all the voice-leading movement whilst voice-leading movement denotes the individual movements.) This aspect of the model suggests that there are potentially correlations between tension and release to the numerical fluctuation within the harmonic contents. In order to test this empirically, a number of extracts – taken from the model’s application – are tested for listeners to rate the amount of tension through the use of a tension rating scale, from 1 to 5.

In addition, several commonly used descriptors of music associated with measuring tension were extracted to provide an alternative or broader account of the tension within the music. Tonal stability, roughness, and several variables denoting other characteristics of the pitch collections such as mean pitch, median range, and the number of notes in a PCn. Tonal stability and roughness were extracted from the last pitch collection of the clip using MIR Toolbox (Lartillot & Toiviainen, 2007). The other calculations of the other properties of the pitch collections was carried out with MIDI toolbox (Eerola & Toiviainen, 2004).

Results

The main results from the study are summarized as follows, with regard the relationship between MTR and AVL values. Firstly, there are instances where the model calculations (AVL) would depict a higher amount of tension whilst the perceived tension (MTR) is much lower. This simply demonstrates that VL calculations and assessing the PCns is not sufficient in determining real-time tension and release in music. Secondly, the arrangement of the PCns could also play a factor in participants’ ratings. Additionally, the number of notes within the PCn may have had an effect on how listeners perceived tension. A movement from a PCn with more notes to less notes may result in a lower MTR but the AVL might project the opposite result. Thirdly, there may also be a correlation between listeners’ preconceived notions of consonance and dissonance to release and tension. This could suggest the importance of the PCn’s contents rather than its movement, as its unique quality may hold the key in influencing listeners’ perception rating. For instance, there are cases of PCns that contain no voice-leading changes yet they are represented with a higher MTR.

Discussion

On the whole, this study has shown that listeners’ perception of tension is dependent on a few factors, ones that go beyond the mere use of AVL calculations. External factors include register (e.g. shift from higher to lower registers may result with a small MTR), number of notes (e.g. shift from a larger to smaller number of pitches in a PCn) and its pitch organization (e.g. root position triads tend to hold less tension whilst its inversions tend to be more tense).

Other variables that may better account for post-tonal tension can include chord size, range of the PCns, mean pitch and applying Krumhansl and Kessler’s (1982) key profiling system. A comparative analysis between these variables (as well as MTR, AVL and roughness) illustrating the means, standard deviations and correlations with confidence intervals demonstrates this. One can observe the following points: firstly, that the roughness has a high correlation with the size of chords, thereby suggesting that the varying number of notes has an impact on listeners’ perception; secondly, that there is a strong correlation between roughness and chord size to mean tension ratings, which then reinforces the importance of physical factors in perception of post-tonal harmonies; thirdly, other physical variables such as the registral range and the

tonal stability of the chords, also have a strong correlation to tension ratings as well.

Perhaps post-tonal features could be described from analyzing other physical factors such as roughness, chord size and range. Unfortunately, based on the analysis of these additional variables, there is a stronger correlation between these physical factors to perception than simply using the AVL and roughness.

One step that can be taken further with these additional variables is to perform a regression analysis. The regression analysis suggests that an adequate model can be created to account about 72% of the variance in the tension ratings. This analysis suggests that the two factors that are most crucial in accounting for the tension ratings are the **chord size** and **tonal stability**. The signs of the beta coefficients suggest that tension is negatively linked to tonal stability whereas higher chord size, roughness, mean pitch seem to contribute to higher tension ratings. Despite the overall success of the regression model with these variables for this material, it is important to realize that the model would require more data in order to form generalized statements, for different contexts. Although the AVL loses out in the process, what this ultimately demonstrates is that unlike tonal tension, other physical and psychoacoustical factors must be analyzed and accounted for to understand the treatment of post-tonal tension, to create a better measurement.

Conclusion

This study examined listener judgements of musical tension for selected segments from three selected neoclassical works: the first movement from Hindemith's Second Piano Sonata, *Mouvement de Menuet* from Ravel's *Sonatine*, and the first movement from Stravinsky's *Concerto for Piano and Wind Instruments*. The focal point of this study was to investigate an unexplored aspect of tension: the perception of harmonies in music that embodies both tonal and post-tonal features, how listeners would perceive tension without reference to a tonal center. The methodology employed is novel, drawing upon the AVL, an element from a hybrid theoretical model (comprising elements from Schenkerian, neo-Riemannian and pitch-class set theories), by calculating the individual VL movement between each segmented vertical sonority, PCn. This therefore provided a renewed perspective on how tension is reflected in listeners' musical perceptions from this repertoire.

As this study focuses purely on one parameter – harmony – in an attempt to measure how we perceive

post-tonal tension, future studies can be explored and expanded to several directions. It is clear from established studies that other parameters such as rhythmic and metric influences need to be accounted for when analyzing our perception from tension. One possibility could be through Volk's (2008a, 2008b) computational model, "Inner Metric Analysis," and combining the model with the voice-leading calculational approach set out in this study. The method of this study can be adapted in future studies to utilize continuous measurements instead of discrete measurements. As discussed by Britten and Duke (1997), continuous measurements may be a more beneficial measurement tool to better understand participants' changing perceptions *during* the listening experience.

As only one instrumental timbre was used for this study, future studies can extend to the use of other instrumentation to explore how perception responses changes depending on the timbre, exploring how this can have an impact on perceived emotions, and how a spectral analysis can further enhance or reinforce the findings. The stimuli set can also be expanded to include other works by different composers, but of the same time period, to explore the relationship between these composers' harmonic idiom to listeners' perception. Another possibility is to extend the AVL method, comparing the perception of the PCns to its original stimuli, from the music, bringing in the examination of other parameters. As this study focused on harmony to measure tension, this can be extended to include other parameters to further support this notion. BaileyShea and Monahan (2018) for instance consider a new method for describing musical energetics (relating to musical tension as perceptions of musical movement or force) that is not dependent on tonality.

Correlating tension ratings to physical and psychoacoustical features is perhaps the next step one should take in theorizing post-tonal harmonic tension, as accounting for the AVL simply does not suffice in such repertoire. In creating an abstract model, there will be potential implications in music analysis as this could ultimately be a tool to assist in explaining formal functions such as closure in post-tonal music. Although additional follow-up experiments would undoubtedly reinforce the findings, the analysis and observations from this study demonstrate a new perspective on perceiving tension that neither belong to the tonal nor post-tonal realm. The study has shed light on the complexity of these harmonies and the various external factors that affect listeners' perception. Further

examination into post-tonal tension perception will in the bigger picture assist in our understanding of the interrelationships between performance practices, refining theoretical and perceived interpretations and musical structures.

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