The Influence of Tonal Structure on Tension in Sonata Form: A Case Study of Mozart and Beethoven Piano Sonatas

Authors: Che Xinchun, Sun Lijun, Yang Yufang, Yang Yufang

Date: 2020-09-08T00:00:00+00:00

Abstract

Musical tension constitutes a fundamental and essential component of music listening. This study selects musical works by Mozart and Beethoven, employing two methodological approaches—tension model computation and behavioral experiments—to investigate how tonal structure within sonata form influences tension. The findings demonstrate that tension variations across the three principal sections of sonata form—exposition, development, and recapitulation—exhibit significant differences: tension in the development section exceeds that of both the exposition and recapitulation, while tension in the recapitulation surpasses that of the exposition. These differences originate from variations in modulation distance and modulation frequency. By examining the impact of tonal structure on tension in large-scale, authentic musical compositions, this research provides empirical support and novel perspectives for scholarship in musicology.

Full Text

The Influence of Tonal Structure on Tension in Sonata Form: A Case Study of Piano Sonatas by Mozart and Beethoven

Che Xinchun[1],[2], Sun Lijun[1], Yang Yufang[1]

[1]CAS Key Laboratory of Behavioral Science, Institute of Psychology, Chinese Academy of Sciences, Beijing 100101, China
[2]School of Music, Nanchang Hangkong University, Nanchang 330063, China

Abstract

Musical tension is a fundamental and important aspect of music listening. This study selected works by Mozart and Beethoven, employing both tension model

calculations and behavioral experiments to investigate the influence of tonal structure on tension within sonata form. The findings revealed that tension varies across the three sections of sonata form—exposition, development, and recapitulation—with tension in the development section higher than in both the exposition and recapitulation, and tension in the recapitulation higher than in the exposition. These differences stem from variations in modulation distance and frequency. This study explores the impact of tonal structure on tension in large-scale, real musical works, providing evidence and new perspectives for musicological research.

Keywords: tonal structure; tension; sonata form; Mozart; Beethoven

Classification: B842

In the history of Western music, the piano sonatas of Mozart and Beethoven have long been regarded as representative works of tonal music from the Classical period (Eisen & Sadie, 2001; 杨燕迪, 2017). Mozart frequently employed sonata form in the first movements of his piano sonatas. Sonata form primarily consists of three sections: exposition, development, and recapitulation (Belkin, 2018; Rosen, 1997), which exhibit a fixed tonal layout. The development section features greater modulation frequency and distance compared to the exposition and recapitulation (Belkin, 2018; Webster, 2001). Building upon this foundation, Beethoven further expanded the expressive power and structural functions of sonata form (Kerman, et al., 2001; 邹彦, 2018), presenting more intense contradictions and conflicts that evoke more dramatic emotional responses in listeners (丁旭东, 2010; Lockwood, 2005).

Researchers speculate that this may stem from Beethoven's use of more complex and varied harmonic progressions and freer modulations (Kerman et al., 2001; Lockwood, 2005). Although previous studies have found that many acoustic elements can convey musical emotion (e.g., Farbood & Finn, 2013; Granot & Eitan, 2011), tonal structure possesses characteristics specific to music compared to other natural environmental sounds, unlike tempo, dynamics, or timbre. However, due to the lack of effective quantitative methods for analyzing musical emotion and tonal structure in musicology, researchers have been unable to derive objective results based on empirical data. In fact, tension serves as the foundation and core element in evoking listeners' emotions (Berry, 1976; Hindemith, 1937), permeating the entire process of music listening. It is central to the musical experience and constitutes an important bridge connecting musical sound to listener perception. Therefore, by focusing on musical tension, we can better reveal the differences in how people listen to Mozart and Beethoven sonatas and their underlying causes.

Regarding the relationship between tonal structure and tension, researchers have explored this from both theoretical modeling and empirical perspectives. In music psychology, the primary frameworks are the Generative Theory of Tonal Music (GTTM) and the Tonal Tension Model (TTM). Lerdahl and Jackendoff (1983) proposed that the tension of a musical event depends on its hierarchi-

cal position within the tonal structure—events at higher hierarchical levels are more stable and evoke weaker tension, while those at lower levels evoke stronger tension. Moreover, local tension-resolution patterns are nested within global tension-resolution patterns, creating hierarchical tension-resolution movements at larger time scales. Building upon this, Lerdahl and Krumhansl (2007) integrated four components to quantify tension: prolongational structure, pitch space model, surface-tension model, and attraction model. These theoretical models focus on the relationship between tonal structure and tension, quantifying tension for each event in a musical progression. Based on these frameworks, this study examines how tonal structure drives tension in real musical works while simultaneously testing the degree of match between theoretical models and actual listening experiences.

In empirical research, scholars have employed behavioral tension rating tasks to investigate the influence of tonal structure on tension. In such studies, participants typically listen to a harmonic sequence composed of multiple chords and then rate the tension evoked by a particular chord on a Likert scale, with the scale endpoints representing the two poles of tension: very weak (or relaxed) and very strong. Using this paradigm and strictly manipulating the tonal structure of chord sequences, researchers have found that less stable harmonic structures evoke higher tension, thereby validating tonal tension models (Bigand & Parncutt, 1999; Bigand, et al., 1996; Sun, et al., 2020). However, real musical works contain far more complex tonal structures, and how musical tension is generated, accumulated, and resolved as music unfolds over large time scales remains underexplored (Lehne, et al., 2013).

This study examines the relationship between tonal structure and tension at the movement level. Sonata form is particularly adept at conveying emotional conflict through its specific tonal layout. We selected Mozart' s Piano Sonata in C Major (K.309) and Beethoven' s Piano Sonata in E Major (Op.14/1), both first movements, as experimental materials. As representative composers of the high Classical period, both Mozart and Beethoven employed traditional harmonic progressions consistent with Western functional harmony. However, Beethoven utilized more innovative tonal structures in his sonata forms compared to Mozart, making this comparison valuable for deeply exploring how tonal structure influences tension. This study employs tension model calculations to examine tonal structure' s influence on tension from a theoretical perspective, while behavioral rating analysis investigates how tonal structure and other acoustic elements affect tension from an actual listening experience perspective. By analyzing the relationship between model calculations and behavioral ratings, we provide evidence for the contribution of tonal structure to tension progression. We hypothesize that, given the crucial role of form in organizing musical structure, both model calculations and behavioral ratings will show higher tension in the development section compared to the exposition and recapitulation. Additionally, since previous research has confirmed tonal structure' s influence on tension (Lerdahl & Krumhansl, 2007; Steinbeis, et al., 2006), we hypothesize a significant correlation between tension model calculations and

behavioral ratings.

2.1 Tonal Tension Calculation Model

Based on Lerdahl and Krumhansl' s Tonal Tension Model, this study calculated tension values for both sonatas. The tonal tension calculation model comprises four components: (1) Prolongational structure—The tension value of a musical event is related to the higher-level event it attaches to in the prolongational structure, inheriting that event' s tension value. (2) Pitch space model, which represents the tonal spatial distance between the current musical event and the higher-level event it attaches to. This distance is determined by the distance between the two events' keys on the circle of fifths, the distance between the events themselves on the circle of fifths, and the number of non-shared tones in the basic space. (3) Surface-tension model, which represents the consonance level of the current musical event, determined by the position of melodic and bass tones within the chord and the number of non-chord tones. (4) Attraction model, which represents the harmonic attraction between the current event and the immediately following event, calculated as the sum of melodic attraction values across all voices. Finally, the sum of these four values constitutes the tension value for the musical event.

This study selected the scores of Mozart' s Piano Sonata in C Major (K.309) and Beethoven' s Piano Sonata in E Major (Op.14/1), both first movements, as analytical materials. To examine tension changes across entire movements, we identified the 12 most critical musical events in each piece according to the model' s calculation method and constructed tree structures of musical tension based on each event' s values. Additionally, following the model' s calculation intervals, we extracted behavioral data at varying time intervals based on chord changes to compute behavioral results corresponding one-to-one with model calculations for correlation analysis.

2.2.1 Participants

Based on effect sizes from previous tension literature (Sun, et al., 2020), we calculated an effect size of f = 0.39 and used G*Power 3.1.9.4 software (Faul, et al., 2007) to determine the required sample size. Results indicated that a repeated-measures ANOVA achieving 95% statistical power at the 0.01 level required 26 participants. Therefore, 28 participants (5 males; age = 20.18 ± 1.56 years) were recruited for the behavioral tension rating experiment. Given that the selected musical works contain both local and long-distance tonal dependencies, and considering task difficulty, we selected participants with long-term systematic training in Western musical instruments (8–12 years). All participants were right-handed with no visual, hearing, or neurological impairments and provided informed consent.

2.2.2 Experimental Materials

We selected Mitsuko Uchida' s performance of Mozart' s Piano Sonata in C Major (K.309) first movement (duration: 5 minutes 45 seconds) and Igor Levit' s performance of Beethoven's Piano Sonata in E Major (Op.14/1) first movement (duration: 6 minutes 13 seconds) as experimental audio materials. To investigate the influence of tonal structure on musical tension, we specifically controlled for key, meter, tempo, and duration. Both pieces are in major keys, use 4/4 meter, are marked Allegro, and have roughly equivalent overall lengths and proportions for the three main sections. For the Mozart sonata, the three main sections span: 1–186 seconds, 187–244 seconds, and 245–344 seconds; for the Beethoven sonata: 1–199 seconds, 200–246 seconds, and 247–343 seconds. To ensure similar tempi, we adjusted both performances to 152 beats per minute using Riffstation software. However, subtle expressive factors such as timbral changes and rubato could not be eliminated through software. Therefore, we selected performances by two pianists with relatively similar interpretive styles.

Experimental Procedure

The experiment was presented using PsychoPy v3.0. Participants listened through Sony MDR-XB450AP headphones while a slider appeared on the right side of the screen, ranging from 0 to 100, with higher values indicating greater tension. Participants' task was to continuously rate musical tension by vertically dragging the slider with the mouse. The presentation order of the two pieces was counterbalanced across participants. After listening, participants rated their familiarity with each piece on a 7-point scale. Prior to the formal experiment, participants practiced using the slider to rate tension by listening to other musical excerpts.

2.2.4 Data Analysis

First, we converted each participant' s ratings to Z-scores. We then calculated average tension values for the exposition, development, and recapitulation sections of both pieces and conducted a two-way repeated-measures ANOVA with piece (Mozart, Beethoven) and formal structure (exposition, development, recapitulation) as within-subject variables. If the main effect of formal structure was significant, post-hoc tests were conducted; if the interaction between piece and formal structure was significant, simple effects analysis was performed. Additionally, to examine the correspondence between model calculations and behavioral data, we extracted behavioral data at intervals based on chord changes, following the model' s calculation intervals, to compute behavioral results corresponding one-to-one with model calculations for Pearson correlation analysis.

3.1 Model Calculation

Based on the 12 critical musical events, Figures 1A and 1B [Figure 1: see original paper] present the prolongational structures of the first movements of

Mozart' s and Beethoven' s piano sonatas, respectively. The prolongational structures of both pieces show high consistency in three aspects: (1) Regarding structural positions, the 12th event occurs at the end of the recapitulation, occupying the most important position in the prolongational structure; the 8th event marks the beginning of the recapitulation, dividing the piece into two main parts; and the 5th event occurs at the end of the exposition, separating it from the development. This indicates that both composers support important structural positions with significant musical events that align with crucial division points in sonata form. (2) Regarding chord quality, all events except the 6th share identical chord qualities: tonic (I), secondary dominant (V/V), dominant (V), secondary dominant (V/V), dominant (V), dominant (V), tonic (I), dominant (V), tonic (I), dominant (V), tonic (I). This suggests that in large-scale structures like sonata form, composers employ similar harmonic progressions to organize important structural points. (3) Regarding model predictions, values for hierarchical structure, tonal pitch space, and surface tension are essentially consistent across both pieces, with only melodic attraction differing.

Figure 1. Prolongational structures of Mozart's (A) and Beethoven's (B) sonatas. a = tension inheritance from the higher-level event in the prolongational structure; b = distance in pitch space between the event and its higher-level attachment; c = consonance level in the surface-tension model; d = attraction value to the immediately following event in the attraction model.

As the section with the most distinctive tonal changes in sonata form, the development section demonstrates that modulation frequency and distance are primary causes of tension variation. In Mozart' s Piano Sonata in C Major (K.309) first movement, the development exhibits high modulation frequency: the key changes from G major to g minor (measures 59–66, tension increases by 7 points), d minor (67–72, +7 points), a minor (73–74, -14 points), g minor (75–76, +13 points), and a minor (77–85, -13 points), creating a wave-like, gradual tension increase. In Beethoven' s Piano Sonata in E Major (Op.14/1) first movement, the development shows greater modulation distance: the key moves from B major at the exposition' s end to a minor (measures 72–78, tension increases by 18 points) and C major (79–89, +7 points), inducing a rapid tension rise.

3.2 Behavioral Experiment

Figures 2A and 2B [Figure 2: see original paper] display listeners' tension ratings for Mozart' s and Beethoven' s sonatas. A two-way repeated-measures ANOVA with piece (Mozart, Beethoven) and formal structure (exposition, development, recapitulation) as within-subject variables revealed a significant main effect of formal structure ($F(1,27) = 25.00$, $p < 0.001$, partial $^2 = 0.47$). Post-hoc tests showed that tension in the development section was higher than in both the exposition and recapitulation (ps < 0.001), and tension in the recapitulation was higher than in the exposition ($p = 0.047$) (exposition: $M = -0.15$, $SD = 0.04$; development: $M = 0.61$, $SD = 0.07$; recapitulation: $M = 0.17$, $SD = 0.10$). However, the main effect of piece was not significant ($p = 0.50$), indicating no

overall difference in tension levels between Beethoven' s and Mozart' s sonatas (Beethoven: M = 0.24, SD = 0.08; Mozart: M = 0.18, SD = 0.02). The interaction between piece and formal structure was also not significant (p = 0.29).

Figure 2. Model calculations and behavioral ratings for Mozart' s (A) and Beethoven' s (B) sonatas. The x-axis represents musical time in seconds; the y-axis represents Z-score transformed tension ratings.

To examine the correlation between behavioral data and model calculations, we conducted correlation analyses for both pieces, with theoretical calculations and behavioral ratings superimposed in Figure 2. Results showed significant correlations between behavioral data and model calculations for both Mozart' s sonata ($r = 0.20$, $p < 0.001$) and Beethoven' s sonata ($r = 0.11$, $p = 0.041$), indicating that the tonal tension model has some predictive power for tension variation.

This study employed both music tension modeling and behavioral experiments to explore the relationship between tonal structure and tension in sonata form. The findings demonstrate consistent patterns across both pieces: development > recapitulation > exposition, highlighting the importance of formal structure in tension progression over large time scales. The significant correlation between model calculations and behavioral ratings indicates that the tension model has predictive validity, though the relatively low correlation levels suggest that composers employ musical means beyond tonal structure to express tension changes.

4.1 The Influence of Tonal Structure on Tension

By constructing prolongational reduction trees from the tension model, this study found high consistency between Mozart' s and Beethoven' s sonatas in their important musical events, reflecting similar organizational approaches to musical structure and suggesting formal structure' s influence on tension. On one hand, important musical events occur at crucial structural nodes, with higher-level events dividing the exposition, development, and recapitulation in sonata form, demonstrating both independence and interdependence among these sections. On the other hand, the chord qualities of important events are nearly identical. Previous research manipulating chord hierarchy has found that higher-level chords are more stable and evoke weaker tension (Bigand et al., 1996; Bigand & Parncutt, 1999; Lerdahl & Krumhansl, 2007). Therefore, formal structure influences tension changes through its control of tonal structure. The similarity between Mozart' s and Beethoven' s sonatas in the structural positions and hierarchical levels of musical events affects tension development, creating similar overall tension patterns in both pieces.

Both model predictions and behavioral results revealed significantly higher tension in the development sections compared to the exposition and recapitulation. This may result from several factors: First, the development section contains more tonal deviations than the other sections. For instance, Beethoven' s devel-

opment moves through distant modulations to a minor and C major, whereas the exposition and recapitulation remain in the home key or closely related keys. Previous studies have found that chromatic chords or chords containing non-diatonic tones evoke higher tension (Bigand & Parncutt, 1999; Steinbeis, et al., 2006). Second, the development section includes more dissonant chords such as secondary dominant sevenths (DD7) and secondary leading-tone sevenths (DD 7), whose dissonance enhances tension (Bigand et al., 1996; Farbood & Finn, 2013; Toiviainen & Krumhansl, 2003; Williams, et al., 2011). Finally, increased melodic attraction between upper and lower voices in the development section also contributes to greater tension (Lerdahl & Krumhansl, 2007; Woolhouse & Matthew, 2009).

Listeners rated tension in the recapitulation higher than in the exposition, possibly due to emotional accumulation (Résibois et al., 2018; 张金璐, 吴莹莹, 杨晓虹, 杨玉芳, 2014). The tension increase in the development sections of both pieces does not dissipate immediately but accumulates into subsequent musical progression. Therefore, although the recapitulation' s tonal structure returns to that of the exposition, listeners' tension experience is not fully resolved. Similarly, our previous research found that each modulation in nested harmonic structures evokes increased tension that accumulates continuously, while tonal regression does not provide immediate relief (Sun et al., 2020). This aligns with our real listening experience: although the final tonic chord can resolve tension at the piece' s conclusion, listeners' emotional tension does not immediately subside.

The study also found that while correlations between model calculations and behavioral results were significant, the correlation levels were low, indicating that the tension model does not fully predict tension experience. This is because the model focuses primarily on tonal structure' s influence on tension, whereas behavioral ratings reflect listeners' actual experiences. Although tonal structure is an important means of evoking musical tension, numerous empirical studies have demonstrated that loudness, dynamics, tempo, timbre, and other factors also significantly influence tension (Farbood & Finn, 2013; Farbood & Price, 2017; Granot & Eitan, 2011; Ilie & Thompson, 2006; Misenhelter, 2001). In this study, listeners' tension ratings were also affected by these factors. For example, in Beethoven' s sonata between 36–45 seconds, analysis of the score reveals that the decrease in listeners' tension resulted from changes in musical texture rather than tonal structure.

4.2 Differences Between Mozart and Beethoven Sonatas

Although behavioral results revealed no overall difference in tension between Mozart and Beethoven, the continuous rating curves show that Mozart' s tension fluctuates through cycles of tension and release with gradual ascent or descent, whereas Beethoven' s patterns are more abrupt. This result relates to the composers' individual creative styles and historical contexts, aligning with traditional musicological perspectives.

Musicologists agree that Mozart' s music is melodically beautiful and songful, profound yet subtle, and refined and elegant (Eisen & Sadie, 2001; Rosen, 1997). Consequently, Mozart' s approach to building tension involves gradual progression through alternating tension and release. Beethoven' s music demonstrates clearer directionality and excited inner tension (Lockwood, 2005; Rosen, 1997), related to his tenacious and even somewhat obsessive personality (Suchet, 2020; Swafford, 2014). Thus, Beethoven' s approach to tension progression presents more direct, large-scale fluctuations. Notably, as a late Classical composer who synthesized and expanded the achievements of his predecessors, Beethoven greatly extended the use of various structural elements. Specifically regarding tension progression, he not only employed tonal structure but also enhanced tension' s drive and scope through expanded use of register, dynamics, tempo, rhythm, texture, and other elements, making his music more dramatic and conflicted.

References

Belkin, A. (2018). *Musical composition: Craft and art.* New Haven, CT: Yale University Press.

Berry, W. (1976). *Structural functions in music.* Englewood Cliffs, NJ: Prentice-Hall. (Reprinted New York: Dover, 1987).

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*(1), 125–141.

Bigand, E., & Parncutt, R. (1999). Perceiving musical tension in long chord sequences. *Psychological Research, 62*(4), 237–254.

Ding, X. (2010). On the conception of philosophical dialectic embodiment in developing of sonata form. *HuangZhong (Journal of Wuhan Conservatory of Music)*, (1), 50–62. [丁旭东. (2010, 1 月). 哲学辨证观念在奏鸣曲式发展中的体现. 黄钟(武汉音乐学院学报), (1), 50–62.]

Eisen, C., Sadie, S. (2001). Mozart, Wolfgang Amadeus. In S. Sadie & J. Tyrrell (Eds.), *The new Grove dictionary of music and musicians* (2nd ed., Vol. 17, pp. 276–296). London: Macmillan.

Farbood, M. M., & Finn, U. (2013). Interpreting expressive performance through listener judgments of musical tension. *Frontiers in Psychology, 4*, 993.

Farbood, M. M., & Price, K. C. (2017). The contribution of timbre attributes to musical tension. *Journal of the Acoustical Society of America, 141*(1), 419–427.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences.* Behavior Research Methods, 39*(2), 175–191.

Hindemith, P. (1937). *The craft of musical composition* (Vol. 1). New York: Belwin-Mills.

Ilie, G., & Thompson, W. (2006). A comparison of the acoustic cues in music and speech for three dimensions of affect. *Music Perception: An Interdisciplinary Journal, 23*(4), 319–330.

Granot, R. Y., & Eitan, Z. (2011). Musical tension and the interaction of dynamic auditory parameters. *Music Perception: An Interdisciplinary Journal, 28*(3), 219–246.

Kerman, J., Tyson, A., Burnham, S. G., Johnson, D., Drabkin, W. (2001). Beethoven, Ludwig van. In S. Sadie & J. Tyrrell (Eds.), *The new Grove dictionary of music and musicians* (2nd ed., Vol. 3, pp. 74–115). London: Macmillan.

Lerdahl, F., & Jackendoff, R. (1983). *A generative theory of tonal music*. Cambridge, MA: MIT Press.

Lerdahl, F., & Krumhansl, C. L. (2007). Modeling tonal tension. *Music Perception, 24*(4), 329–366.

Lehne, M., Rohrmeier, M., Gollmann, D., & Koelsch, S. (2013). The influence of different structural features on felt musical tension in two piano pieces by Mozart and Mendelssohn. *Music Perception, 31*(2), 171–185.

Lockwood, L. (2005). *Beethoven: The music and the life*. New York: W. W. Norton & Company.

Misenhelter, D. (2001). An investigation of music and nonmusic majors' responses to musical tension and dynamics in Beethoven' s Symphony No. 7. *Missouri Journal of Research in Music Education, 38*, 56–67.

Résibois, M., Rotgé, J.-Y., Delaveau, P., Kuppens, P., Van Mechelen, I., & Fossati, P., et al. (2018). The impact of self-distancing on emotion explosiveness and accumulation: An fMRI study. *PLOS ONE, 13*(11).

Rosen, C. (1997). *The classical style: Haydn, Mozart, Beethoven* (Exp. Ed.). New York: W. W. Norton & Company, Inc.

Steinbeis, N., Koelsch, S., & Sloboda, J. A. (2006). The role of harmonic expectancy violations in musical emotions: Evidence from subjective, physiological, and neural responses. *Journal of Cognitive Neuroscience, 18*(8), 1380–1393.

Suchet, J. (2020). *Beethoven: The man revealed* (Rev. ed.). London: Elliott & Thompson Ltd.

Sun, L., Feng, C., & Yang, Y. (2020). Tension experience induced by nested structures in music. *Frontiers in Human Neuroscience, 14*, 210.

Swafford, J. (2014). *Beethoven: Anguish and triumph*. London: Faber & Faber.

Toiviainen, P., & Krumhansl, C. L. (2003). Measuring and modeling real-time responses to music: The dynamics of tonality induction. *Perception, 32*(6), 741-766.

Webster, J. (2001). Sonata form. In S. Sadie & J. Tyrrell (Eds.), *The new Grove dictionary of music and musicians* (2nd ed., Vol. 23, pp. 687-701). London: Macmillan.

Williams, L. R., Fredrickson, W. E., & Atkinson, S. (2011). Focus of attention to melody or harmony and perception of music tension: An exploratory study. *International Journal of Music Education, 29*, 72-81.

Woolhouse, M. (2009). Modelling tonal attraction between adjacent musical elements. *Journal of New Music Research, 38*(4), 357-379.

Yang, Y. (2017). Beethoven's piano sonata: The "Triple Jump". *Piano Artistry*, (10), 4-10. [杨燕迪. (2017, 10 月). 贝多芬钢琴奏鸣曲: 风格演进与精神成长的"三级跳". 钢琴艺术, (10), 4-10.]

Zhang, J., Wu, Y., Yang, X., & Yang, Y. (2014). The influence of topic structure on emotional accumulation in discourse context. *Journal of Psychological Science, 37*(6), 1282-1290. [张金璐, 吴莹莹, 杨晓虹, 杨玉芳. (2014). 话题结构对语篇情绪累加的影响. 心理科学, 37(6), 1282-1290.]

Zou, Y. (2018). Beethoven' s first piano sonata in F minor (Op.2/1): Analysis of themes in its historical context. *The Art of Music*, (1), 62-75. [邹彦. (2018, 3 月). 历史语境中的贝多芬《f 小调第一钢琴奏鸣曲》(Op.2/1) 的主题分析. 音乐艺术 (上海音乐学院学报), (1), 62-75.]

The influence of tonal structure on tension experience in sonata pieces by Mozart and Beethoven

CHE Xinchun[1],[2]; SUN Lijun[1]; YANG Yufang[1]

[1]CAS Key Laboratory of Behavioral Science, Institute of Psychology, Chinese Academy of Sciences, Beijing 100101, China
[2]School of Music, Nanchang Hangkong University, Nanchang 330063, China

Abstract: Musical tension is the basis of musical listening. In this study, we calculated tension values based on Tonal Tension Model and conducted behavioral experiment to explore the influence of tonal structure on tension experience in sonata compositions by Mozart and Beethoven. The sonata form is composed of three parts: exposition, development and recapitulation. Our results revealed that both of the tension values and tension experience in development were higher than that in exposition and recapitulation, and higher in recapitulation than in exposition. This might be due to the differences of the distance and frequency on tonal modulations in the three parts. Our study investigated the influence of tonal structure on musical tension in large-scale music works, providing evidence and new perspectives for the study of musicology.

Key words: tonal structure; tension; sonata form; Mozart; Beethoven