MUSIC THEORY AND PERCEPTION: AN EXPERIMENTAL COMPARISON

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AN EXPERIMENTAL COMPARISON

By

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ABSTRACT

The purpose of this thesis was to conduct three experiments in order to ascertain a perceptual account of Schenker's analysis of a Handel *Aria* and to test Lerdahl's premise that listeners experienced in Western tonal music perceive tension globally rather than locally. Data were obtained by recording perceptual judgements of tension, phrase structure, and pitch space at 83 stopping points across the *Aria* and three Schenkerian levels of analysis (background, middleground, and foreground). Of particular interest is viewing this data in the light of Schenker's *organicism* philosophy. Listeners in all three experiments are experienced musicians and university music students. In experiment 1, tension ratings correlate among listeners at all levels of analysis and perceived tension varies with stopping point. Thus, the experience of tension and relaxation requires minimal harmonic and melodic information. The phrase structure data obtained from experiment 2 demonstrates that more surface material is required in order to make judgements of phrase structure. Experiment 3, using Krumhansl's probe tone method, shows that even with the minimal information of Schenker's background level, listeners experienced in Western tonal music consistently perceive a hierarchical pitch space similar to Krumhansl's probe tone profile. The application of Lerdahl's *Tonal Pitch Space Theory* demonstrates a reliance of the experienced listener on local tension rather than on inherited tension in this short, completely diatonic piece.

To Dr. William Renwick, who captivated me with the marvels, mysteries and magic of Heinrich Schenker;

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INTRODUCTION

In the preface to his pioneering book, *Emotion and Meaning in Music*, Leonard Meyer declared, "if the aesthetics and criticism of music are ever to move out of the realms of whim, fancy, and prejudice, and if the analysis of music is ever to go beyond description which employs a special jargon, then some account of the meaning, content, and communication of music more adequate than at present available must be given." [1]

Music is an enigmatic medium of communication. In my experience, the approach of traditional music theory tends to be chord-by-chord analysis with little concern as to what the listener might hear and feel. Music perception research, on the other hand, is mostly concerned with discrete tones or short, simple tone patterns rather than complex or *real* music.[2, 3] Is it possible for these two diverse analyses and experiences of music to converge at the point of the listener's perception of *real* music? It is my desire to attempt to answer this nearly fifty-year-old plea. For the perspective of music theory, I turn to the writings and analyses of Schenker and his pupils, Salzer and Zuckerkandl. For perception of music perspective, I turn to the work of Handel, Huron, Krumhansl, Narmour, Schellenberg, Smith and Cuddy, and Trainor. My task, as stated by Meyer, is to discern whether music theory, with its jargon and analytical techniques, is able to describe what listeners perceived.

Schenker certainly believed that his method of music analysis graphically represented what the listener could hear in a given piece. "Now then, the artist has power enough so to order all these relationships [fifth-relationships] that only a few of them are perceptible in the foreground of the composition, while the others do their work more discretely in the background. Our ear is as able and willing to follow this gradation of effects."[4] "The meaning of these graphs lies in their ability to delineate and explain the function of each progression or each motion of the detail (foreground) in relation to the overall musical structure (middleground and background)."[5] The titles of Zuckerkandl's books *Sound and Symbol* and *The Sense of Music*, and Salzer's *Structural Hearing*, suggest that they also believe that Schenker's approach to music analysis is based on what a listener can hear.

In contrast, some perception psychology tends to analyse music for local information. Huron, for example, looks for the perceptual principles that lead to voice-leading rules. Narmour and Schellenberg's approach to the concept of melodic expectancy results in the implication-realization model. Krumhansl's development of an algorithm and a probe tone method for experimentation

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[1] Leonard Meyer, *Emotion and Meaning in Music* (Chicago: University of Chicago Press, 1956), viii.
[2] *Real*, in this context, refers to music that has been composed for the purpose of expressing ideas and emotions through sound. In other words, music that is available through recordings and live performance.
[3] Simple and complex, here, refer to the melody, rhythm and harmonic components. Thus, in this context, a monophonic folk song would be seen as "simple" while a piano sonata as "complex".
[4] Heinrich Schenker, *Harmony* (Chicago: University of Chicago Press, 1954), 138.
[5] Felix Salzer, "Introduction" from *Five Graphic Music Analyses* H. Schenker. (New York: Dover Publications Inc., 1969), 16.

address the listener's ability to perceive tonality and sense of key. Handel investigates principles that explain why some notes stream together while others do not. Trainor investigates age-related awareness of consonance and dissonance, key membership, and implied harmony. Finally, Smith and Cuddy conduct experiments in order to ascertain the listener's judgements of phrase structure, perceived key distances, temporal orientation, perceived tension, and judgements of consonance and dissonance.

The theories and graphs of Schenker are suitable analytical tools to employ in a comparison of music theory with perception theory due to his insistence that music is heard as more than a succession of tones and chords. For Schenker, intervals have power, tones have egotism, and these elements enliven music with power, energy, and drive. This line of thought coincides with perception theory, which, through experimentation, has demonstrated the hierarchy of tones and chords found in Western tonal music. The division of the octave (due to the basic constraint of working memory) into from five to seven unequal steps and the emphasis on consonant intervals are universal properties of scale structure. The asymmetric structure of the scales found in Western tonal music is perceptually advantageous. Due to this structure, each note of a scale forms a unique relationship with every other note of the scale. For example, the intervals or relationships between the tonic and every note of the scale are different from the intervals or relationships between the mediant and every note of the scale. This uniqueness of relationships accounts for the power and egotism of Schenker's intervals and tones.

Yet it is not solely the notes and chords themselves that generate expression and thus communicate to the listener, but the *context* in which they are placed, that embodies music's expressive character. According to Salzer, Schenker drew on context to differentiate *chord grammar* from *chord significance.* Chord grammar is employed in harmonic analysis and, by labelling triads, thereby breaks phrases into isolated chords. By contrast, chord significance reveals the structural purpose or the meaning of a chord within a phrase. Since one chord may play many different roles, chord grammar is an insufficient analytical tool when one wishes to discern the expressive qualities of music.

Krumhansl demonstrates that the listener does indeed hear the elements of music in relation to one another rather than as disconnected units and that individual tones and chords are perceived in terms of their functions in the broader context.[6] Through experiments that employ the probe tone method and require subjects to rate how well all twelve tones fit into a tonal musical context, Krumhansl arrives at a rating profile or tonal hierarchy of the tonal system. The results are, in descending order, tonic, dominant, mediant, subdominant, submediant, supertonic, leading tone followed by the chromatic notes. The same experimental method is employed with triads and the results are, in descending order, tonic, dominant, subdominant, submediant, supertonic, mediant, leading tone followed by the chromatic chords. Schenker's belief in the power of the fifth

[6] Carol Krumhansl, "Perceiving Tonal Structure in Music" *American Scientist* 73(1985), 371.

(dominant) over that of the third (mediant) [7] and his directive that "it is important to distinguish between C as the root tone of a triad and C as a scale-step"[8] and that "not all triads have the same weight and importance"[9] are demonstrated by the experiments of Krumhansl. Krumhansl clearly corroborates Schenker's belief in the existence of a tonal hierarchy and the unequal distribution of power among the tones and chords of tonal music; this same unequal distribution is responsible for the power, energy, and drive and thus the expressive character of music.

Schenker believed—and Krumhansl's work supports the assertion—that listening is not a passive occupation but rather requires the active participation of the listener. Schenker discusses this on a more limited scale than does Krumhansl; the impetus for both, however, is the same. In *Harmony*, Schenker makes many references to the abilities of the listener to discern vital information while listening to music. In one instance he explains how, while listening to a melody, the listener will instinctively connect notes to form triads. "Our ear will connect the first tone, G, with the B on the first quarter of measure 1 … it will connect that G with the D on the first quarter of measure 2 … For our ear will miss no opportunity to hear such triads, no matter how far in the background of our consciousness this conception may lie hidden."[10] Again, Schenker's theories are shown to be perceptually valid as Krumhansl concludes, based on her research, that "listeners continuously integrate and reinterpret musical events as the sequence progresses."[11]

Zuckerkandl's approach to the hierarchy of notes and their expressive power is more philosophical but equally compelling. Zuckerkandl refers to the dynamic quality or 'forces' found in the notes themselves and labels three components of sense perception as the physical, the psychic and, most importantly, the dynamic.[12] He describes the physical as the aspect of music that we can hear, while the psychic is our inner reaction. The most expressive component, the dynamic component, is comparable to the tonal hierarchy of Schenker and Krumhansl described above. Zuckerkandl's explanation, "the musical difference between two tones is not a difference of pitch but of position in the tonal system"[13], is the same as Schenker's intervallic power and tonal egotism, and Krumhansl's demonstration of a hierarchy among tones and chords.

Zuckerkandl's account of the contrasts between "meaning in music" and "meaning in language" is particularly valuable and effective. He recognizes that while words and tones both convey meaning, the word, and its meaning are independent things, while the tones themselves create the meaning.[14] His most effective elucidation occurs when he explains that the meaning of the tone is not to what it points, but *in the pointing itself.* The tone is an actual presence that has

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[7] Schenker, 26.
[8] Ibid, 139.
[9] Ibid, 152.
[10] Schenker, 133 - 34.
[11] Krumhansl, 378.
[12] Victor Zuckerkandl, *Sound and Symbol* (Princeton N.J.: Princeton University Press, 1956), 60.
[13] Ibid, 34.
[14] Ibid, 68.

completely absorbed its meaning into itself and subsequently discharges that meaning upon the listener.[15]

Zuckerkandl's discussion of the expressive character of the chord is also borne out in perception theory. He explains that the triad is more than its root and much more than the three notes from which it is formed and thus "something new radiates from their union."[16] Let us revisit Krumhansl's hierarchical lists of tones and triads.

Tones:	1, 5, 3, 4, 6, 2, 7
Triads:	I, V, IV, VI, II, III, VIII

If the power of the triad were found solely in its root, we would expect the two lists shown above to be the same. In fact, there are many differences, and more differences than similarities. Why there are some similarities at all is an interesting question. Why are 1 and I, 5 and V, and 7 and VII in the same positions as tones and as chords? While a definite answer cannot be given at this time, what is clear is that this hierarchy contributes to the emotional character of music as it sets up expectations of melody and harmony that have been investigated by music theorists and perception psychologists.

Schellenberg revisits Narmour's Implication-Realization Model for melodic expectancy with a view to simplifying the overly specific model without losing its predictive accuracy. Schellenberg condenses Narmour's five specific principles of registral direction, intervallic difference, registral return, proximity, and closure into the two more general principles of pitch proximity and pitch reversal. Narmour's *registral direction* rule states that movement of a small interval implies movement or realization in the same direction, while movement of a large interval (greater than a perfect fifth) implies a change of direction. The *intervallic difference* rule states that small implied intervals imply similarly sized realization intervals (from a perfect unison to major second) in the same direction, while larger implied intervals imply smaller realized intervals. The preference for the last tone of the realized interval to be close in pitch to the first tone of the implied interval is termed the *registral return* rule while the *pitch proximity* rule states that the implications are stronger for realized intervals that are smaller than a perfect fourth. Finally, the *closure* rule states that a sense of closure is stronger when the implicative and realized intervals are in different directions and also when the realized interval is smaller than the implicative interval.

Schellenberg simplifies these five rules into two very basic expectations that are universal across musical styles and systems. The *pitch proximity* principle states, "when listeners hear an implicative interval in a melody, they expect the next tone to be proximate in pitch to the second tone of the implicative interval."[17] Simply put, this rule states that the smaller the realized interval the more it is expected. Schellenberg's second rule was the *pitch reversal* rule, which states that there are no strong expectations for small implied intervals except that the listener does expect the realized interval to reverse direction and return close

[15] Ibid,68.
[16] Ibid, 107.
[17] Glenn Schellenberg, *Simplifying the Implication-Realization Model of Melodic Expectancy* Music Perception Spring 1997, Vol.14, No.3, 309.

to the first note of the implied interval. For large intervals, the listener has the strong expectation of a pitch reversal and also the expectation that the realized note will return close to the pitch of the first note of the implied interval.

Emotion in music is related to expectation. If the listener's expectations are met, there is little tension felt. If the expectations are not met or met later than anticipated, tension is achieved.

Narmour and Schellenberg develop rules and a predictive model for expectation in melody across musical systems and styles. Are there, then, perceptual bases for voice-leading rules of harmony? Huron assembles thirteen core voice-leading rules found in music theory texts and subsequently sought the perceptual principles that could support these rules. The core voice-leading rules are:

1. Registral Compass Rule: primary range from F_2 to G_5.
2. Textual Density Rule: harmony works best with 3 or more parts.
3. Chord Spacing Rule: separate the soprano and alto, alto and tenor by no more than an octave, tenor and bass can have more separation.
4. Avoid Unisons.
5. Common Tone Rule: pitches common to consecutive chords should be retained in the same voices.
6. Nearest Chordal Tone Rule: move to the nearest chord tone (i.e. use small intervals).
7. Conjunct Motion Rule: move by diatonic step.
8. Avoid Leaps.
9. Part-crossing Rule.
10. Part Overlap Rule.
11. Parallel Unison, Fifths and Octaves Rule.
12. Consecutive Unison, Fifths and Octaves Rule: if two voices form any of these intervals they should form none of them in the next chord.
13. Exposed Unison, Fifths and Octaves Rule.

Huron discovers six necessary and four optional corresponding perceptual principles. *Toneness* is the measure of pitches that are most clearly perceived by the listener and relates to Voice-leading rule 1(VLR-1) of Registral Compass. Toneness was found to be in the range of E_2 to G_5 and compares favourably with the range (F_2 to G_5) of VLR-1. The *Minimum Masking Principle*, which corresponds with VLR-3, states that in order to minimize auditory masking in chords, notes that sound simultaneously should be more widely spaced as the register descends and thus negate the tendency of one tone to obscure another. The *Tonal Fusion Principle*, which coincides with VLR-4, states that since it is more difficult to hear individual voices if the tones are fused it is best to avoid writing perfect unisons, octaves, and fifths. VLR-5, 6, 7, 8, 9, and 10 are expressed in the perceptual principle Huron calls *Pitch Proximity Rule* which states that a voice or pitch stream will remain coherent when successive tones are close in pitch. The tempo should be reduced if leaps are written. VLR-11, 12, and 13 can be explained by the *Pitch Co-modulation Principle* which states that positively correlated pitch movement and exactly parallel motion in particular leads to fusion of tones. The perceptual principles of *Onset Synchrony*, *Limited Density*, *Timbral Differentiation,* and *Source Location* are optional but do occur frequently in compositions. Huron thus concludes that the rules of voice-leading observed in Western tonal music can be derived from perceptual principles.

The bases for the expectations reinforced by voice-leading rules develop early in life. Trainor demonstrates that infants as young as 2 months prefer listening to consonant intervals over dissonant intervals and by age 5 years, children familiar with Western tonal music perceive key membership. The ability to perceive implied harmony develops by age 7.

Krumhansl, Narmour and Schellenberg, Huron and Trainor demonstrate that music theory exploits perceptual principles. Yet we are really no further ahead at discerning the basis of emotion in music than we were at the beginning of this paper. It is now apparent that, as listeners, we are consciously or unconsciously aware of a tonal hierarchy of both tones and triads. We have expectations of melody and we can hear many events in the harmony among the voices. Unfortunately, for the theories of Schenker, Zuckerkandl, and Salzer, we have explored music on a local rather than global perspective. While these perception psychologists demonstrate that listeners do perceive music on many levels, other than Krumhansl they do not demonstrate what listeners perceive and retain over time. Narmour and Schellenberg's implication-realization model refers to the immediate satisfaction of expectancies. Schenker purports that the listener is aware of deep level structures and maintains the information as a reference to and background for the ensuing events. According to Salzer, "[There is an] inborn tendency for structural hearing."[18] How can this statement of Salzer's, based on the theories of Schenker, be tested?

We have seen how Handel, Huron, Krumhansl, Narmour, Schellenberg, and Trainor have laid the groundwork that is necessary to answer Meyer's plea. Smith and Cuddy have struck off in a new and exciting direction. These perception psychologists are asking subjects to make judgements about complex music. These include judgements of phrase structure, perceived key distances, temporal orientation, perceived tension, and judgements of consonance and dissonance. These results combined with statistical analyses have demonstrated some very interesting aspects of Schenker's theories regarding intervallic power, tonal egotism, and the listener's awareness of music on the levels of foreground, middleground, and background. Lerdahl's *Tonal Pitch Space* theory, which builds upon his work with Jackendoff—*A Generative Theory of Tonal Music*—and also incorporates some Schenkerian concepts, provides an opportunity for calculating empirical values for sequential and hierarchical tension and relaxation that may offer insight into the listener's experience of tonal music. Through the application of rules delineating grouping structure, metrical structure, time-span

[18] Felix Salzer, *Structural Hearing* (New York: Dover Publications Inc., 1962), 30.

reduction, prolongational trees, and attraction values, predictions of tonal tension may be calculated.

Early perceptual experiments were limited by their use of small excerpts of music to look at one feature at a time. Due to this pioneering work, we are now at the point where psychological perceptual techniques can be applied to more complex music in an attempt to discover the interaction among the aspects of music that elicit an emotional response in listeners. The task set by Meyer fifty years ago, however, is a monumental undertaking. "While it is easy to recognize the psychological relationship between tones and emotions, it is much more difficult to find in them even as much as a trace of an order. And yet this very indefiniteness must be considered as a first groping step toward real art. It is one of the mystifying features of our art that its truth is not penetrated any more easily for having its roots in Nature!"[19]

Can Schenkerian analysis and/or Lerdahl's tonal pitch space theory reveal aspects of the listener's experience of tonal music? Can music theory and perception theory, two diverse analyses and experiences of music, converge at the point of the listener's perception of *real* music? What follows is an attempt to answer these questions. Chapter 1 explores Schenker's theory from a historical and philosophical perspective that gives a fresh insight into the motivation behind such concepts as *Ursatz, Urlinie, Bassbrechung*, prolongation, unfolding, foreground, middleground, and background. Chapter 2 introduces Lerdahl and Jackendoff's *A Generative Theory of Tonal Music* and Lerdahl's subsequent *Tonal Pitch Space* as they apply to the present study. An experiment designed to both discern what aspects of Schenker's theory may be perceived by the listener and test the predictive power of Lerdahl's tonal pitch space theory, including the subsequent data, interpretations, and conclusions, are the focus of chapter 3. The *Aria* from Brahms' *Variations on a Theme by Handel* Opus 24 was chosen for this perceptual analysis. I conclude with chapter 4 in which suggestions for further research are discussed.

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[19] Schenker (1954), 53.

CHAPTER 1 – SCHENKER AND ORGANICISM

BACKGROUND AND EDUCATION

Although Heinrich Schenker was a composer, teacher, music editor and arranger, music critic and essayist, history, until very recently, preserves him as a music theorist—a music theorist whose theories grew out of the philosophy of organicism. Two points requiring elucidation arise from my opening statement—the idea that "until very recently" the view of Schenker is limited to that of music theorist and the description of Schenker as organicist. The former is easily accomplished while the latter is surrounded by debate. Strangely, the two points are related, as the resolution to the question of Schenker as organicist has caused scholars to consider his music criticism as a source for illumination.

William Pastille tosses the pebble that starts the ripples as he writes his article "Heinrich Schenker, Anti-Organicist" [20]. His premise is that Schenker developed his organicist approach to music theory over time. He bases his conclusion on an article, "Der Geist der musikalischen Technik" ("The Spirit of Musical Technique") that Schenker wrote for the *Musikalisches Wochenblatt* (Leipzig). Schenker was to have written a series of seven articles to be published during May and June of 1895 but he did not complete the series or parts of it have been lost. Since the "subject matter of *Geist* ... is completely speculative, without the slightest hint of reportage" and due to the footnote by editor E. W. Fritzsch found in the first instalment[21], Pastille evaluates the tone of Schenker's article as theoretical. This is quite unlike Schenker's previous writings, which focus on specific composers, their works, and musical events.

In order to understand the significance of the *Geist* article, it is necessary to recall Schenker's background—birth, education, early journalistic writings and those critics and educators who exerted influence upon him. He was born in 1868, the fifth child, into one of many poor Jewish families in the province of Galicia, which is located in southeastern Poland. In 1772 most of the region was annexed and became part of Austria until 1861, at which time Galicia won limited autonomy, and was granted representation in the Austrian parliament. Schenker spent his childhood in Wisniowczyk (now in Ukraine) where his father, a surgeon, passed on to his children a keen intellectual curiosity. Schenker attended a German-language school in Lemberg (now Lvov), the capital of Galicia. His interest in music began at home, as he studied piano with Karol Mikuli who had been a pupil of Chopin and continued at school where he led the student orchestra. In 1884, at the age of 16, he enrolled at the University of Vienna to study law.

Eduard Hanslick taught at the University during this time and offered music appreciation courses that were open to all students from any field. It was not until his final semester that Schenker found time to take any electives, which still did not include music. Kevin Karnes suggests that it was Schenker's father

[20] William Pastille, "Heinrich Schenker, Anti-Organicist," *19th Century Music* VIII/I (1984),30.

[21] The footnote by *Musikalisches Wochenblatt's* editor E.W. Fritzsch indicates that this work was intended as a lecture for the Philosophical Society of the University of Vienna.

who was determining his course of study and that Schenker longed to study music.

> Life has already made me give up [my] beautiful dreams! ... Having grown up in poverty—poorly—and living in the most unharmonius conditions ... I had and still have, no teacher, and I fear not being able to get one because of my poverty ... I know that after the present examination, and after I have perhaps emerged from the most impoverished existence ... I, alone, will attempt to tackle the strange "theory" and the masterworks about which I know only very, very little. I understand that I need to work diligently, and perhaps I will succeed ... in learning something about this monumental theory.[22]

In fact, Schenker had already begun to compose—throughout his university days, his interest in music continued. Such was his enthusiasm that in 1887 he enrolled in a composition programme at the Vienna Conservatory. He continued at the Conservatory until 1889, when he graduated with his law degree. Besides studying composition, he studied piano with Ernst Ludwig, harmony with Anton Bruckner and he sang in the Conservatory choir. While Schenker did not complete his degree at the Conservatory, he did receive the highest grade and fellow students such as Carl Flesch, who became a world-famous violinist, commented that Schenker was the brightest student in the class.

Upon finishing his law degree, Schenker began to concentrate on his career in music as he corresponded with established musicians, such as Brahms, and some of the most promising artists of his generation.[23] He continued to compose and perform and in 1891, three years after his graduation from the University of Vienna, he began his decade of writing for newspapers and journals as a music critic.

From 1891-1901, he wrote 95 articles and concert reviews for 5 main newspapers and journals. In 1891–1896, he contributed seven articles to the *Musikalisches Wochenblatt* (Leipzig) in which he discussed newly published music, Brahms, and presented the *Geist* article on music theory and aesthetics. Music historian Oscar Paul founded the *Musikalisches Wochenblatt* in 1870 "as an Organ for Musicians and Musical Enthusiasts."[24] Three months later Wilhelm Fritzsch became editor and remained so for over three decades. Fritzsch liked Schenker's analytical reviews and often placed them on the front page.

In 1892, he began writing articles in which he discussed new music, various performers, and the new Italian school of opera for *Die Zukunft* (Berlin). In total, he wrote eighteen articles in six years for editor Maximilian Harden.

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[22] Kevin Karnes, *Heinrich Schenker and Musical Thought in Late Nineteenth-Century Vienna* (Ph.D. diss., Brandeis University, 2001), 38.
[23] The biographical information on Schenker is taken from Karnes, 33-43.
[24] Ibid, 48.

Although Fritzsch actually gave Schenker his start as a music critic, it was Harden whom he credited with "[paving] the way toward a better future [for me]."[25] Harden began the journal in 1892 "as an independent forum for talented writers on cultural or political topics … who have the courage to proclaim the truth here unreservedly."[26] Schenker, with the enthusiastic support of Harden, wrote eighteen essays over the next five years. By 1894, Schenker and Harden began to have differences—with Schenker supporting composers such as Karl Goldmark whom Harden did not and being critical of composers like Humperdinck whom Harden did support—and by 1897 Harden terminated their professional relationship.

Schenker's most varied concert reviews and technical articles were published in the Austrian *Neue Revue* for the five years beginning in 1894. This monthly journal was begun in 1890 by Arnold Bauer who wanted to educate the Austrian public regarding new books by Austrian authors. Upon his death in 1893, Heinrich Osten and Edmund Wengraf, co-editors, expanded the scope of the journal and employed some of the most prominent names in Austrian cultural criticism.[27] Schenker, who published twenty-nine articles there, wrote most of the music criticism for this weekly journal. Schenker's association with this journal ceased when it stopped publishing in 1898. "Osten wrote to Schenker in order to express his 'warmest gratitude' … for his many 'first-rate essays, which have been a credit to our paper.'"[28]

During 1895 and 1896, he also wrote concert reviews and the occasional technical article for the Viennese newspaper *Die Zeit*. This was the "most well known and widely respected journal for which Schenker wrote."[29] During the year in which he wrote for this journal, Schenker contributed forty-six articles, which is nearly half of his total critical output.[30]

Nearly fifty years before Schenker began writing music criticism, Eduard Hanslick penned his first concert *feuilleton* for *Wiener Zeitung* (Vienna), a writing style that subsequently dominated music criticism for some time to come. The term *feuilleton* springs from the nineteenth century practice in French newspapers of inserting an article, which is ruled off from the rest of the page, on the front page of the newspaper and placing it at the bottom. The subject was traditionally a criticism of some type of art and this placement afforded some prominence to artistic subjects.

Schenker's first *feuilleton* appeared in *Neues Weiner Tagblatt*. It was also his last. Sandra McColl explains that a *feuilleton* should be written "in a conversational tone, chatty, light … witty … entertaining" and should have "amusement value, and a good punch-line."[31] These are not characteristics one readily associates with Heinrich Schenker! Schenker's "*feuilleton*" discusses his

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[25] Ibid, 51.
[26] Ibid, 52.
[27] Ibid, 58.
[28] Ibid, 60.
[29] Karnes, 62.
[30] Ibid
[31] Sandra McColl, *Music Criticism in Vienna 1896-1897: Critically Moving Forms* (Oxford: Clarendon Press, 1996), 1-3.

research into the life and work of Bedřich Smetana and displays none of the required *feuilleton* characteristics as his writing was opinionated and reflected his musical interests while presenting progressive and controversial ideas.

Schenker's analytical, legal mind is readily evident in his writing. Who influenced his musical thought? The answer lies with some of his teachers and with other music journalists at the time.

A good place to begin is with Eduard Hanslick (1825-1904) since he sat firmly in both fields of influence in Vienna. Besides being an influential music critic, Hanslick was Professor of the History and Aesthetics of Music at the University of Vienna and also taught at the Conservatory while Schenker was in attendance. While Schenker did not study with Hanslick, Hanslick was an important professional contact for Schenker and responded enthusiastically to much of Schenker's critical writing. Hanslick wrote an important and widely read book entitled *Vom Musikalisch-Schőnen* in which he argues that structure or form was the most significant characteristic of a musical work. Hanslick also discusses musical coherence and the nature of the creative process[32]—two concepts similarly important in Schenker's theories.

Friedrich von Hausegger (1837-1899) was another lawyer turned music theorist and critic. He taught music history and theory at Graz University, published *feuilleton* and other forms of criticism, and participated in the raging debate on musical meaning and beauty. Hausegger claims that his approach to the communication of feeling through music was objective and scientific. He believes that properties of music such as dynamics, accents, tempo, and metre correspond to the natural processes of the human body. As with Hanslick, these ideas were highly controversial.[33] Alan Keiler believes that this theory of Hausegger significantly influenced Schenker's thinking[34] with Hausegger proclaiming,

> Our immediate task, then, will be to go back to the very beginning of our art, so as to know out of what elements it was formed, what in essence has remained constitutive and vital, what has been brought to it from the outside, what, therefore is to be recognized as its characteristic attributes, what must be separated as irrelevant, how its essence has been intensified, enriched, deepened, and how it has become altered, impaired and endangered.[35]

There is a clear Darwinian influence in Hausegger's writing that is not found in Schenker's writings, yet I find his influence to be apparent. Rather than adopting an evolutionary perspective, Schenker turned to Goethe and organicism

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[32] Karnes, 21-22.
[33] Karnes, 23-24.
[34] Allan Keiler, "The Origins of Schenker's Thought: How Man Is Musical," *Journal of Music Theory* 33n2 (1989), 293-294.
[35] Keiler, 293.

to find the "essence" of music and the "elements" from which it is formed and how "they remained constitutive and vital."

GOETHE AND ORGANICISM

From the discussion of Schenker's education, his music teachers, and fellow journalists, we can locate Schenker in the midst of the vibrant intellectual life of late nineteenth-century Vienna. Schenker was most productive as a journalist between 1894 and 1897 with 1895 as the year in which he wrote the *Geist* article. Keiler states that this "is a complicated essay in the philosophy and aesthetics of music in the tradition of Hanslick, Ambros, Hausegger and others, and thus stands out, both in content and significance, from his [Schenker's] other writings."[36] According to Pastille,

> one essay stands out for a number of reasons: it is the earliest published statement of Schenker's musical philosophy; it touches on many subjects that concerned him in later life; it presents a view of organicism radically different from that found in his later works; and it leads us to conclusions that may cause some fundamental changes in our conception of Schenker's musical thought.[37]

While Keiler and Pastille disagree concerning the timing of Schenker's conversion to organicism, they do agree that Schenker's theories were influenced by this ancient view.

> The notion that human history, society, and experience may be viewed and described in organic terms has been a pervasive one in Western culture. The use of the organism and its life as metaphors specifically for works of art can be traced back at least as far as Plato and Aristotle, and has recurred periodically in the history of philosophy and aesthetics but its most recent incarnation can be thought of as belonging quintessentially to the critical language of the late eighteenth and nineteenth centuries.[38]

Aesthetic organicism consists of two main precepts: "(1) the parts of the work are in keeping with each other and with the whole and (2) alteration of a part will bring with it alteration of the whole."[39] Organic form, also termed inner

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[36] Keiler, 277.
[37] Pastille (1984), 29.
[38] Ruth Solie, "The Living Work: Organicism and Musical Analysis." *19th-Century Music* IV/II (1980), 147.
[39] G. Orsini, "Organicism" *Dictionary of the History of Ideas*. October 10, 2004 http://etext.lib.virginia.edu/cgi-local/DHI/dhi.cgi?id=dv3-52, 1.

form, refers to development from within, and contrasts with mechanical form, in which form is imposed from the outside. Organicism became popular with German idealist philosophers during the late eighteenth century as "biology was gradually replacing mechanics as the central paradigm."[40] This paradigm was more than a metaphor to the German philosophers, more than referential language. Each school of philosophy, while seeing unity in inorganic forms, asserted its own unique position, yet with common threads existing.

Leibniz (1646-1716) asserts, "every small thing mirrors the whole universe,"[41] as he tries to explain how concrete bodies (such as music) could be expressive. Kant (1724-1804) emphasizes the "transcendental aspect of idealism … the existence of a mystical relationship of parts and whole in the universe."[42] Hegel (1770-1831) believes that *Idea* comes from nature and that the closest union between *Idea* and objective reality produces the highest beauty.[43]

Schenker, as organicist, is evident as much of his theorizing relates directly to the above philosophical positions. The contribution of Leibniz's philosophy can be found in Schenker's *Ursatz* —the background structure to all tonal music, consisting of the *Urlinie* and the *Bassbrechung*.[44] Schenker explains the influence of Leibniz,

> All transformations presume a final unalterable nucleus: in man, it is character, and in composition it is the Urlinie.
>
> Just as there is only one line, there is only one consummation of it. The Urlinie is, to employ a concept of Leibniz, the pre-stabilized harmony of the composition.[45]

Kant's influence is found in Schenker's insistence upon unity. Schenker looks at each piece of music as a unified whole with mystical relationships of parts and wholes. This is seen in his use of terms such as *Auskomponierung*, *Diminution* and *Prolongation*. Schenker also stresses that music's origin was in nature in the major triad found in the overtone series. "Even the octave, fifth, and third of the harmonic series are a product of the organic activity of the tone as subject, just as the urges of the human being are organic."[46]

Pastille and Keiler believe that it was Goethe, however, who exerted the greatest influence on Schenker's thinking. As both scholars arrived at their conflicting opinions regarding the arrival of Schenker's organicist thinking from evidence ascertained from Schenker's *Geist* article, a general discussion of

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[40] Solie, 148.
[41] Harold Osborne, *Aesthetics and Criticism* (London, 1955), p. 193 in Ibid, 150.
[42] Ibid, 149.
[43] Ibid, 149.
[44] See Appendix I on page 67.
[45] Solie, 151.
[46] Schenker (1977), 9.

Goethe's influence will be followed by a detailed examination of the Pastille/Keiler debate.

There seems to be no doubt that Schenker's theories were influenced by Goethe as "What educated, German-speaking person born in the nineteenth century did not learn about Goethe's writings, his life, and his achievements while in school?"[47] More tangible evidence can be found in Schenker's fondness for quoting Goethe as "[of] 116 non-musical quotations occurring in Schenker's published writings just between 1904 and 1924, 57 (approximately 49%) are from Goethe."[48] It was not Goethe's musical talent, however, that impresses Schenker but his scientific works. Of particular import were Goethe's *Metamorphosis of Plants* (1790) and *Theory of Colour* (1810). Goethe began his scientific research with nature resulting in *Metamorphosis of Plants*, in which he elucidates his "comprehensive world view that he called "morphology".[49] He generates terminology, such as *Urphänomen* (type), *Anschauung* (seeking), *aperçu* (sudden insight), and four principles: holism, polarity, intensification, and metamorphosis to explain morphology.

Goethe considers *Urphänomen* as present and perceivable in all forms, and common to all existing forms or classes of creatures, objects, or phenomena.[50] *Urphänomen* is perceived in the physical world through painstaking observations undertaken concurrently with meticulous investigation that elucidate consistencies for which empirical rules may be obtained. Through *Anschauung, aperçu* is achieved. For Goethe, obtaining this enlightened level of perception was extremely important as a*perçu* goes beyond surface level perception of the physical to the inner spiritual. It is the interaction and linking of the physical and spiritual, along with diligent work, that allows for heightened perception of the underlying *Urphänomen*.

Next we must ask how *Urphänomen* is discernible in the concrete sense, how it becomes real, observable. Here Goethe sets out the four principles mentioned above: holism, polarity, intensification, and metamorphosis. *Holism* comes directly from organicist philosophy and concerns the "mystical relationship" between the parts and the whole, where the parts are subordinated but not subsumed by the whole and one cannot change a part without changing the whole. Goethe does not see this as a static relationship but a "dynamic equilibrium with a vibrant, dynamic continual shifting and realigning of opposing forces."[51] He identifies this interaction of parts and whole as *polarity*. The balancing interplay of polarity would result in endless repetition if it were not for the third principle of *intensification*. Through *intensification,* new forms are created, as is a higher level of organization. Goethe classified this creation of new forms as *metamorphosis*. In this manner, *holism* subordinates the parts to the whole; *polarity* at once repels and reunites; *intensification* produces states that combine into something new and unexpected; *metamorphosis* continues to

[47] William Pastille "Music and morphology: Goethe's influence on Schenker's thought." In *Schenker Studies*. Ed. Hedi Siegel. Cambridge: Cambridge University Press, 1990. 29
[48] Ibid, 29.
[49] Ibid, 30.
[50] Ibid, 31.
[51] Ibid, 32.

generate new forms but is held in check by the unifying power of the organic whole.[52]

The ruminations of Goethe and Schenker are quite similar but whether there is a link between Goethe's morphological approach and Schenker's theories may be a bit more difficult to ascertain. It is in searching Schenker's published theoretical works that we find an acceptance of *Urphänomen*, *Anschauung*, and *aperçu*. In the second issue of his *Der Tonwille* (1922), Schenker quotes Goethe's poem "Typus" (type),

> There is nothing on the skin
> That is not in the bones.
> Everyone is repelled by a misshapen figure,
> For it hurts the eyes.
>
> What pleases everyone, then? To see flowering
> That is already well formed from within.
> Externally, it may be smooth or dappled.
> That has been destined from the start.[53]

Here we see Schenker comparing *Urlinie* and the human skeleton. Perhaps we might assume that Schenker is speaking metaphorically. We find, however, in this analysis he wrote in *Kontrapunkt I* (p.314-315), that he uses the same language as Goethe. Schenker's original words are placed in round brackets.

> Consequently, however—and precisely this is the result inaccessible to superficial perception—even the second eighth note, the passing tone approached by leap, embodies nothing but the original form (*Urtypus*) of the passing tone itself! One sees, then, how one and the same basic phenomenon (*Urphänomen*) manifests itself in so many forms, yet without completely losing its identity in any of them! However much a given variant may conceal the basic form (*Urtypus*), it is still the latter alone that occasions and fructifies the new manifestation. But to reveal the basic form (*Urtypus*) together with its variants, and [thereby] to uncover only prolongations of a fundamental law even where apparent contradictions hold sway-this alone is the task of counterpoint.[54]

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[52] Ibid, 33.
[53] Ibid, 34.
[54] Pastille (1990), 35.

In this quotation we observe Schenker's use of Goethe's terminology and the similarity in their concepts. Schenker's theory identifies the *Urphänomen* as the strict counterpoint that he believes is at the core of free composition. In the following quotation found in *Free Composition* (1935), we see Schenker's concurrence with Goethe's concept of *Anschauung* as he quotes Goethe's *Theory of Colour*.

> Sometimes a most curious demand is made: that one should present experiences and perceptions without recourse to any kind of theoretical framework, leaving the student to establish his conviction as he will. But this demand cannot be fulfilled even by those who make it. For we never benefit from merely looking at an object. Looking becomes considering, considering becomes reflecting, reflecting becomes connecting. Thus, one can say that with every intent glance at the world we theorize. To execute this, to plan it consciously, with self-knowledge, with freedom, and to use a daring word-with irony-requires a considerable degree of skill, particularly if the abstraction which we fear is to be harmless and if the empirical result which we hope to achieve is to be alive and useful.[55]

Pastille presents one more quotation from Schenker's work. Schenker says, in *Harmonielehre* (1906), "In music, it is important, very important, to attend to each occurrence – even the smallest – and to hear every single detail – even the tiniest – together with its proper cause."[56] By "attend to each occurrence – even the smallest" Schenker is speaking of *Anschauung* and diligent searching. Schenker brings to mind a*perçu* and heightened perception when he says, "to hear every single detail – even the tiniest."

We now see that Schenker embraces Goethe's doctrine both as metaphor and as concept. Can we go one step further and link Goethe's four principles of holism, polarity, intensification and metamorphosis to Schenker's theories? Schenker called his last theoretical work, *Free Composition*, a "grammar of tones". Pastille suggests that this, then, is a morphology of the masterwork in the same way that Goethe's *Theory of Colour* is a morphology of colour.

Ruth Solie presents a skilful argument for Schenker's acceptance of the organic quality, *holism*. She postulates that his monistic approach, his creation of models and procedures for treating a musical composition not as separate parts but as a whole, was Schenker's most significant achievement. His identification of the *Ursatz* with its constituent *Urlinie* and *Bassbrechung* as "elemental stuff,

[55] Ibid, 36.
[56] Ibid.

mystical/musical protoplasm,"[57] demonstrates his "passionate commitment to a holistic view."[58] Schenker's theoretical writings are bursting with examples that demonstrate his "holistic view."

> This characteristic is determined solely by the invention of the parts out of the unity of the primary harmony – in other words, by the composing out of the fundamental line and the bass arpeggiation.[59]
>
> The hands, legs, and ears of the human body do not begin to grow after birth; they are present at the time of birth. Similarily, in a composition, a limb which was not somehow born in the middle and background cannot grow to be a diminution.[60]
>
> The origin of every life, whether of nation, clan, or individual, becomes its destiny … The inner law of origin accompanies all development and is ultimately part of the present. Origin, development, and present I call background, middleground, and foreground; their union expresses the oneness of an individual, self-contained life.[61]

The above quotations represent a very small sampling of the multitude of references Schenker makes to Goethe's principle of *holism.*

Polarity can be found in Schenker's description of *Ursatz* in which the two opposing forces of harmony and melody become the linear progression and the scale degree. While *polarity* holds each in check, the principle of *intensification* allows for the creation of new forms. For Schenker this becomes levels of increasing complexity resulting finally in the *Vordergrund* (foreground), in Schenker's classification, or metamorphoses, in Goethe's categorization.

Pastille makes one further connection between Goethe and Schenker with his reference to a*perçu*. Recalling that in Goethian terms, a*perçu* describes the sudden insight or heightened perception that accompanies *Anschauung*, Pastille suggests that this principle explains why it is difficult to hear Schenker's graphs. The "graphs do not record perceptions of normal hearing …, but an elevated sense of hearing that has been trained by *Anschauung* to recognize underlying models and ultimately *Urphänomen.*"[62] This belief was held by Schenker himself as he noted in *Das Meisterwerk II* (pg.11) that any listener not trained in the terms of his principles has never heard music at all.[63]

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[57] Solie, 151.
[58] Ibid.
[59] Schenker (1968), 166.
[60] Schenker (1977), 6.
[61] Schenker (1977), 3.
[62] Pastille (1990), 42
[63] Ibid, 42.

"DER GEIST DER MUSIKALISCHEN TECHNIK" ARTICLE

While there appears to be no doubt that Schenker was significantly influenced by organicist philosophy, in general and Goethe's philosophy of morphology more specifically, debate rages over the timing of the adoption. Pastille argues that "the view of musical organicism presented in *Geist* is precisely the opposite of that expressed in Schenker's later works. He [Schenker] firmly denies that music can be organic."[64] While Keiler rebuts,

> this interpretation is achieved by the utter disregard of the complicated meaning of the essay from which the evidence is drawn, by the disregard of any other of Schenker's writings during the period, and by the disregard of the many contemporary works of musical historical and theoretical scholarship that must have played a crucial role in Schenker's thinking during the last decade of the nineteenth century.[65]

The *Geist* article is divided into two main sections, *The Materials of Music* and *Aesthetic Elements of Music*. Below is a table outlining the seven sections of the article as set out by Pastille. The terms placed in square brackets are Schenker's originals. Keiler, without employing a detailed outline, identifies eight parts, where the first four "discuss musical parameters and the second four, various questions of formal organization and aesthetic meaning."[66]

A. The Materials of Music

[I. Melody]

- 1. Melody
  - a. The origin of tone in humans
  - b. Three musical principles derived from singing
  - c. The emergence of melody

[II. Repetition]

- 2. Repetition
  - a. The development of repetition
  - b. The antiquity of instrumental music
  - c. Historical interaction between word and tone

[III. Polyphony]

- 3. Counterpoint
  - a. The origin of counterpoint in polyphony
  - b. Counterpoint as training in musical accuracy
  - c. Counterpoint in the act of creation
  - d. Counterpoint in the act of interpretation

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[64] Pastille (1984), 31.
[65] Keiler, 275.
[66] Ibid, 277-278.

e. Counterpoint and harmony as explanatory disciplines

[IV. Harmony]

4. Harmony
   - a. The ancient meaning of harmony
   - b. The effect of polyphony on the idea of harmony
   - c. The modern meaning of harmony
   - d. The function of harmony

B. Aesthetic Elements of Music

[V. Moods, Forms, and the Organic]

1. Musical moods
   - a. How music generates moods
   - b. The composer's dilemma in communicating moods
   - c. The listener's solution to perceiving moods
   - d. Moods in texted works
2. Artifice
   - a. The emergence of artifice
   - b. The composer's subtlety in hiding artifice
   - c. The fallacy of organicism
   - d. The true organic in music
3. Musical content and musical form
   - a. The vitality of content
   - b. Evaluating derivative composers
   - c. Rejection of the term formalism
   - d. Content versus form
   - e. The superficial examination of form[67]

In the first section, Schenker is part historian, part philosopher, and part evolutionist as he discusses the emergence of music and language as universal and innate, and the eventual emancipation of music from language. It "is a teleological and entirely organic portrayal, in which Schenker attempted to locate in the native human capacity for music a series of stages which are prefigured from the very beginning."[68]

The last section, in which Schenker positions himself opposite to Hanslick in the form versus content debate and reveals himself to be an anti-formalist, does not follow the evolutionary plane but instead presents a number of issues of concern. It is from this section that Pastille draws the following quotation and uses it to conclude that Schenker began as an anti-organicist but had converted by the time he wrote *Harmonielehre* in 1906.

> In reality, musical content is never organic, for it lacks any principle of causation. An invented melody never has a determination so resolute that it

[67] Pastille (1984), 31.
[68] Keiler, 281.

> can say, "Only that particular melody may follow me, none other." Rather, as part of the labor of building content, the composer draws from his imagination various similarities and contrasts, from which he eventually makes the best choice.[69]

Pastille states that Schenker identified two objections in this passage that represent his belief, at this time, that music cannot be organic—the "lack of any principle of causation"[70] and subjective influence as "the composer draws from his imagination".[71] Lack of causation denies the polar forces of growth, with its notion of unfolding, and unity, which implies holism, that are essential to a belief in the organic character of music.

According to Pastille, Schenker was studying musical growth as a horizontal phenomenon, perceiving music from the beginning of the piece until its end. By 1906, Schenker began looking in another direction, behind the surface of the music. *Harmonielehre* was just the beginning of Schenker's conversion to organicism and as Schenker researched more and more his conversion became complete. How did Schenker counter his second objection—the will of the composer? He answered this with the concept of *genius*.

> A great talent or a man of genius, like a sleepwalker, often finds the right way, even when his instinct is thwarted by one thing or another or ... by the full and conscious intention to follow the wrong direction. The superior force of truth – of Nature, as it were – is at work mysteriously behind this consciousness, guiding his pen, without caring in the least whether the happy artist himself wanted to do the right thing or not.[72]

Keiler agrees with much that Pastille suggests except that Schenker can be viewed as an anti-organicist in *Geist*. Keiler insists that the above remark must be put in context and the context is not as an anti-organicist but as an anti-formalist opposing Hanslick. In *Vom Musikalisch-Schőnen*, Hanslick describes the form of music as organic while Schenker believes it was the content that was organic—content that occurs during the compositional process—and it is this context in which Keiler believes Schenker was speaking in *Geist*. Keiler bolsters his argument by referring to several articles written by Schenker at this time in which he clearly asserts the organicists' position. He does this particularly with respect to the "coherent works of the German tradition in comparison with the contrived works of the composers of program music."[73]

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[69] Pastille (1984), 31.
[70] Heinrich Schenker in *Musikalisches Wochenblatt*, 309 cited in Ibid.
[71] Ibid.
[72] Schenker (1980), 60.
[73] Keiler, 290.

Keiler concludes by stating that it is absurd to assert that Schenker was ever an anti-organicist. Careful reading of articles written around the same time as the *Geist* article speaks of the coherence and organic qualities found in musical content. From his earliest education and his intellectually stimulated background, he was familiar with the writings of Goethe, Kant, Hegel, and Schiller. While not referring, specifically, to these German idealist thinkers until his later works, their influence on Schenker's organic approach can be found in many contexts. The first section of the *Geist* article is clearly organic in philosophy and the second section follows in the long tradition of debating, in public, the issues raised by Hanslick's famous book.

CONCLUSION

Schenker's theories, whether as an organicist from the beginning or an evolved organicist, are firmly in the tradition of German idealism. His description of the constituents of tonal music - *Ursatz*, *Urlinie*, *Bassbrechung*, the triad arising from nature, prolongation, unfolding, foreground, middleground and background, to name a few – see their origin in the principles of Göethe— *Urphänomen* (type), *Anschauung* (seeking), *aperçu* (sudden insight), holism, polarity, intensification, and metamorphosis. His emphasis on unity and growth comes from the organicists' philosophy. As Solie says, "Schenker is the organicist *par excellence*."[74] Accordingly, Schenker says, "I here present a new concept, one inherent in the works of the masters; indeed, it is the very secret and source of their being: the concept of organic coherence."[75]

[74] Solie, 151.
[75] Schenker (1977), xxi

CHAPTER 2: LERDAHL AND TONAL PITCH SPACE

A GENERATIVE THEORY OF TONAL MUSIC

In order to appreciate Lerdahl's *Tonal Pitch Space* theory (TPS) we must begin with his and Jackendoff's *A Generative Theory of Tonal Music* (GTTM). GTTM, published in 1983, is a structural description of a listener's experience of tonal music. In GTTM, Lerdahl and Jackendoff identify four components of tonal music whose constituent elements are pitch and rhythm and whose interaction is the foundation of the listener's experience. The components of this musical grammar, which are akin to the linguistic generative-transformational grammar of Noam Chomsky, are *grouping structure*, *metrical structure*, *time-span reduction,* and *prolongational reduction.* (Figure 1 is a representation of the interaction of these elements.) Each component is governed by rules of well-formedness (WFR)—which "establish the strict hierarchical organizations of each component"—, of preference (PR) —which "establish which formally possible structures correspond to a given musical surface"—and of transformation (TR)—which "permit modifications on musical surfaces so that certain hierarchically ill-formed phenomenon, such as grouping overlaps, can be treated as well formed."[76]

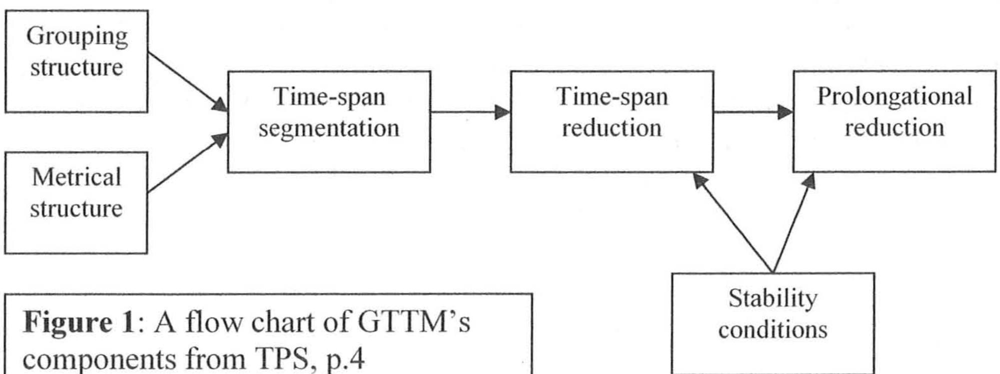

Figure 1: A flow chart of GTTM's components from TPS, p.4

GROUPING STRUCTURE

Grouping structure refers to the hierarchical manner in which listeners parse music into groups such as motives, themes, phrases, and sections. Jackendoff and Lerdahl's five well-formedness rules (GWFR) and seven preference rules (GPR)[77] are presented, in Italics, followed by their implications concerning the *Aria* from Brahms' *Variations on a Theme by Handel*, Opus 24 (see Appendix VIII, pg.76).

> GWFR 1: *Any contiguous sequence of pitch-events, drum beats, or the like can constitute a*

[76] Fred Lerdahl, *Tonal Pitch Space* Oxford, New York: Oxford University Press (2001), 6.
[77] The rules listed for grouping structure, metrical structure, time-span reduction and prolongational reduction are found in Fred Lerdahl and Ray Jackendoff, *A Generative Theory of Tonal Music* Cambridge Mass., London England: The MIT Press (1983) pages 345-352.

group, and only contiguous sequences can constitute a group.

The *Aria*, then, is comprised of all the notes between and including mm.1-1 and 8-3.

GWFR 2: *Any piece constitutes a group.*

The *Aria* is a group and as such is a structural unit.

GWFR 3: *A group may contain smaller groups.*

The eight-measure *Aria* can be heard as two four-measure phrases, four two-measure phrases or eight one-measure phrases. GPR 1 prohibits a group of thirty-one one-beat groups.

GWFR 4: *If a group G_1 contains a smaller group G_2, then it must contain all of G_2.*

In the *Aria*, at its lowest grouping level (*a*), mm.1 and 2 each form a group. At the next higher level (*b*), all—not part of—m.1 and m.2 form a group.

GWFR 5: *If a group G_1 contains a smaller group G_2, then it must be exhaustively partitioned into smaller groups.*

The *Aria* cannot contain only one group of four measures. If it contains one group of four measures, the other 4 measures must form a group.

GPR 1: *Avoid analyses of very small groups—the smaller, the less preferable.*

The smallest group in the *Aria* occurs at the first level (*a*) between mm.1-1 and 1-3. It would not be preferable to consider each beat as a group as this analysis would violate the first grouping preference rule.

GPR 2: *(Proximity) Consider a sequence of four notes n_1 n_2 n_3 n_4. All else being equal, the transition between n_2-n_3 may be heard as a group boundary if*

a. *(Slur/Rest) the interval of time from the end of n_2 to the beginning of n_3 is greater than that from the end of n_1 to the beginning of n_2 and that from the end of n_3 to the beginning of n_4, or if*

b. *(Attack-Point) the interval of time between the attack points of n_2 and n_3 is greater than that between the attack points of n_1 and n_2 and that between the attack points of n_3 and n_4.*

Both of these rules suggest a preference for a group boundary between beats 3 and 4 in mm.1-7.

GPR 3: *(Change) Consider a sequence of four notes n_1 n_2 n_3 n_4. All else being equal, the transition between n_2-n_3 may be heard as a group boundary if*

a. *(Register) the transition n_2-n_3 involves a greater intervallic distance than both n_1 - n_2 and n_3 - n_4, or if*
b. *(Dynamics) the transition n_2-n_3 involves a change in dynamics and n_1 - n_2 and n_3 - n_4 do not, or if*
c. *(Articulation) the transition n_2-n_3 involves a change in articulation and n_1 - n_2 and n_3 - n_4 do not, or if*
d. *(Length) n_2 and n_3 are of different lengths and both pairs n_1, n_2 and n_3, n_4 do not differ in length.*

Register, dynamics, and articulation are not of concern in our presentation of Handel's *Aria* as the lines move mostly by step and, as the MIDI recording used for the experiments employs equal key velocity, all dynamic levels and articulation were constant. The exceptions to the stepwise motion of the melody and which may give rise to group boundaries are the interval of the 3rd which occur at mm.1 and 3, connect mm.6 with 7 and 7 with 8, and the descending 5th between m.4-3 and 4-4.

The adjacent melody note values in mm.1-4, and 7 are quarter note, thirty-second, sixteenth, and eighth notes. Since the pairs, n_1, n_2 and n_3, n_4, do differ in length there is no suggestion of group boundaries. Although the adjacent melody note values in mm.5, 6, and 8 are in a somewhat different arrangement, there is no suggestion of group boundary here either. The left hand chords reveal a different situation as they consist of either three quarter notes, an eighth rest and eighth note or three quarter notes and a quarter rest. In the first case, n_1 and n_2 are of equal length while n_3 and n_4 are not thus giving rise to a group boundary. In the second case, n_1, n_2 and n_3, n_4 are of equal length while indicating no group boundary. There is, however, a group boundary in m.4 where the second case occurs, due to the change in register in the melody.

> GPR 4: *(Intensification) Where the effects picked out by GPRs 2 and 3 are relatively more pronounced, a larger-level group boundary may be placed.*

The change in register found in the left hand moving from m.3 to 4 would intensify this group boundary and make it into a large-level group boundary.

> GPR 5: *(Symmetry) Prefer grouping analyses that most clearly approach the ideal subdivision of groups into two parts of equal length.*

In this way we find the grouping of the *Aria* "is from beat 1 to beat 3 in the first measure after which the grouping is consistently from beat 4 of one measure to beat 3 of the next. Larger grouping levels are symmetrical (2 + 2 + 2 +2; 4 + 4)."[78]

> GPR 6: *(Parallelism) Where two or more segments of the music can be construed as parallel, they preferably form parallel parts of groups.*

Parallelism is noticeable in the *Aria* as each group contains a parallel rhythmic structure – the main exception being m.4 where a larger-level group boundary occurs. Jackendoff and Lerdahl place a great deal of "importance of parallelism in musical structure [which] cannot be overestimated. The more parallelism one can detect, the more internally coherent an analysis becomes."[79] Parallelism is important to Schenker as for him it signifies organic unity. This facet of his theory with respect to the *Aria* will be presented in some detail in a succeeding chapter.

> GPR 7: *(Time-Span Reduction and Prolongational Reduction Stability) Prefer a grouping structure that results in more stable time-span and/or prolongational reductions.*

While it is possible for the time-span and prolongational reductions to be in conflict with the grouping structure, Jackendoff and Lerdahl suggest that an attempt be made to arrive at a grouping structure that aligns with the time-span and prolongational reductions. The result will be more stable reductions.

Lerdahl proclaims grouping structure "the most difficult component to treat in quantitative terms ... They are hard to quantify because the factors involved in determining grouping boundaries vary continuously over any given dimension and interact with one another in complex ways ... grouping is

[78] Personal communication from Fred Lerdahl to D. Henry November 2, 2004.
[79] Lerdahl and Jackendoff, 52.

susceptible to the influence of performance nuances."[80] Fortunately, Handel's *Aria* offered little resistance to devising a clear grouping structure (see Appendix II, pg.70).

METRICAL STRUCTURE

The influence of the rhythmic nature of music on the listener's perception is not restricted to the grouping structure alone. One must account for the metrical structure as well (see Appendix III, pg.71). GTTM, with four well-formedness rules (MWFR) and ten preference (MPR) rules, describes the metrical structure of a passage to be "the regular, hierarchical pattern of beats to which the listener relates musical events."[81] They are as follows:

> MWFR 1: *Every attack point must be associated with a beat at the smallest metrical level present at that point in the piece.*

This rule indicates that every note heard, whether it is the length of a quarter note or a thirty-second notes as in the *Aria*, has some metrical strength.

> MWFR 2: *Every beat at a given level must also be a beat at all smaller levels present at that point in the piece.*

This rule is similar to GWFR 4 and indicates that there are beats at the tactus level, the subtactus, and supertactus. The beats at the subtactus level are part of the beats at the tactus and supertactus levels.

> MWFR 3: *At each metrical level, strong beats are spaced either two or three beats apart.*

In the *Aria*, the strong beats are two beats apart since the time signature is common time.

> MWFR 4: *The tactus and immediately larger metrical levels must consist of beats equally spaced throughout the piece. At subtactus metrical levels, weak beats must be equally spaced between the surrounding strong beats.*

The weak beats of 2 and 4 are equally spaced between the stronger beats of 1 and 3.

> MPR 1: *(Parallelism) Where two or more groups or parts of groups can be construed as*

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[80] Lerdahl, 7.
[81] Lerdahl and Jackendoff, 17.

parallel, they preferably receive parallel metrical structure.

Given that the rhythm pattern of the *Aria* is basically the same throughout, each group should receive a parallel metrical structure. The rhythm of the left hand, with the exception of mm.4 and 8, is three quarter notes, eighth rest and eighth note. The rhythm of the right hand is slightly less consistent with mm.1, 2, 3, and 7 being exactly the same and mm.4, 5, and 6 being variations of m.1. This leads us to apply the same metrical structure to all the measures.

MPR 2: *(Strong Beat Early) Weakly prefer a metrical structure in which the strongest beat in a group appears relatively early in the group.*

The metrical structure for the *Aria* follows this preference rule. At the lowest level (*a*), the first beat of group 1 is a strong beat. From that point onward, the strong beat is the second beat of the group. This anacrusic pattern continues through the levels of metrical structure.

MPR 3: *(Event) Prefer a metrical structure in which beats of level L_i that coincide with the inception of pitch-events are strong beats of L_i.*

This rule applies in the *Aria* when we find the rest in the left hand on beat 4 in all measures except 4 and 8. There is no "inception of pitch-events" here but at the same time MWFR 3 indicates that beats must be evenly spaced. Thus, the best analysis is to indicate the metrical structure at the eighth rest rather than the eighth note.

MPR 4: *(Stress) Prefer a metrical structure in which beats of level L_I that are stressed are strong beats of L_I.*

This preference rule is not really applicable to the *Aria,* as Handel does not indicate any accents or stresses in the music. He does, however, by his use of trills, remove stress from beat 2. The eighth rest in the left hand on beat 4 also removes stress from this beat. Thus, beats 1 and 3, while not stressed with accents, are made more evident by de-stressing beats 2 and 4.

MPR 5: *(Length) Prefer a metrical structure in which a relatively strong beat occurs at the inception of either*

a. *a relatively long pitch-event,*
b. *a relatively long duration of a dynamic,*
c. *a relatively long slur,*

d. *a relatively long pattern of articulation,*
e. *a relatively long duration of a pitch in the relevant levels of the time-span reduction, or*
f. *a relatively long duration of a harmony in the relevant levels of the time-span reduction (harmonic rhythm).*

In the *Aria*, the quarter note (a "relatively long pitch-event") at the beginning of each measure carries through to the various levels of the metrical structure while the eighth notes, which occur at the subtactus level, do not. As stated previously, dynamics, slurs, and articulation do not play a role in this presentation of the *Aria.*

MPR 6: *(Bass) Prefer a metrically stable bass.*

This rule was addressed above but it is worth restating that as the bass is more metrically stable than the treble in the *Aria*, MPRs 3, 4, and 5 are given extra weight.

MPR 7: *(Cadence) Strongly prefer a metrical structure in which cadences are metrically stable; that is, strongly avoid violations of local preference rules within cadences.*

This rule states that, where there may be conflict regarding the preferred metrical structure, the metrical structure of the cadence plays the deciding role. No such conflict arises in the *Aria*.

MPR 8: *(Suspension) Strongly prefer a metrical structure in which a suspension is on a stronger beat than its resolution.*

We find this in the metrical structure in m.2 of the *Aria*, in which the I^6_4 occurs on the strong beat—beat one—of m.2. This preference rule dictates that, in the metrical structure, it is on a stronger metrical beat than V, its resolution.

MPR 9: *(Time-Span Interaction) Prefer a metrical analysis that minimizes conflict in the time-span reduction.*

The *Aria* is not rhythmically, harmonically or tonally complex and thus there is little opportunity for conflict between the metrical analysis and the time-span reduction to occur.

MPR 10: *(Binary Regularity) Prefer a metrical structure in which at each level every other beat is strong.*

This preference rule addresses irregular metre and is not applicable to the *Aria*. Due to a time signature of common time, the metrical structure of the *Aria* does follow this rule and we find, at all levels, every other beat is a strong beat.

TIME-SPAN REDUCTION

Once the grouping and metrical structures are determined, we can proceed to the time-span reduction (see Appendix IV, pg.72). This reduction is a prediction of which events in the music are perceived to be structurally important. "The time-span reduction evaluates the importance of events within the framework of the time-span segmentation."[82] It is at this point, while explaining the efficacy of GTTM's approach over that of Schenker's, that Lerdahl admits a link with Schenkerian analysis. While identifying areas of structural importance is central to both Schenker and GTTM, Lerdahl and Jackendoff believe their "rule based" theory is an improvement on Schenker's "informal" approach. This reduction, in which we can detect clearly Schenker's influence, is hierarchical in nature with the "head" being the most stable and other events considered elaborations of that head. The head of one level of the reduction, chosen primarily because of its harmonic stability, then proceeds to the next level. GTTM describes two segmentation rules, four well-formedness rules and, nine preference rules.

Segmentation Rule 1: *Every group in a piece is a time-span segmentation of the piece.*

This first rule indicates, as with the previous first rules, that every note or group of the music must be included; nothing can be left out.

Segmentation Rule 2: *In underlying grouping structure,*

a. *each beat B of the smallest metrical level determines a time-span T_B extending from B up to but not including the next beat of the smallest level,*
b. *each beat B of metrical level L_i, determines a regular time-span T_B, which is the union (or sum) of the time-spans of all beats of level L_{i-1} (the next smaller level) from B up to but not including*

[82] Lerdahl, 10.

(i) the next beat B' of level L_i or
(ii) a group boundary,
whichever comes sooner, and

c. *if a group boundary G intervenes between B and the preceding beat of the same level, B determines an* <u>*augmented time-span*</u> *T'_B, which is the interval from G to the end of the regular time-span T_B*

Each beat at each level must be considered in a sequential manner. In higher levels some of the lower level beats are subsumed by the more structurally important beats. The next level beats cannot cross group boundaries and must also move in a sequential fashion, neither omitting nor rejecting any beats.

> TSRWFR 1: *For every time-span T there is an event e (or a sequence of events e_1e_2) that is the* <u>*head*</u> *of T.*

Every time-span includes the structurally significant events for that level. Furthermore, the head at the highest level will necessarily be a head at each previous level.

> TSRWFR 2: *If T does not contain any other time-span (that is, if T is at the smallest level of time-spans), then e is whatever event occurs in T.*

At the lowest level, before reduction occurs, there is no head but a series of events from which the heads, once chosen, will move to the next level.

> TSRWFR 3: *If T contains other time-spans, let $T_1, \ldots, T_n$ be the (regular or augmented) time-spans immediately contained in T and let $e_1, \ldots e_n$ be their respective heads. Then:*
>
> a. *(Ordinary Reduction) The head of T may be one of the events $e_1, \ldots e_n$.*

This simply means that one of the events at one level may become the head at the next higher level.

> b. *(Fusion) If $e_1, \ldots e_n$ are not separated by a group boundary ("locality" condition), the head of T may be the superimposition of two or more of $e_1, \ldots e_n$.*

The following rules are found also in Schenker's theory, occur at relatively local levels, and suggest that one need not move only the exact notes, as they occur, from one level to another. As is often the case with Alberti bass, two notes not separated by a group boundary, may form a head that is a combination of the notes of e_1 and e_2 and in this manner a more structurally sound head is formed. This phenomenon, related to auditory stream segregation, does not occur in the *Aria*.

c. *(Transformation) If $e_1, \dots e_n$ are not separated by a group boundary, the head of T may be some mutually consonant combination of pitches chosen our of $e_1, \dots e_n$.*

This rule, similar to Schenker's "implied" notes, allows the head of one time-span to be a hypothetical chord that is "composed out of two mutually consonant fragments of the …events in the time-span."[83] An example of this phenomenon occurs in m.8 as we move from level *a* to level *b*. We find the melodic C of the ii^6 chord replaces the melodic A of the V chord.

d. *(Cadential Retention) The head of T may be a cadence whose final is e_n (the head of T_n – the last time-span immediately contained in T) and whose penult, if there is one, is the head of a time-span immediately preceding T_n, though not necessarily at the same level.*

It is the normal practice, when moving from one level up to the next, to take only the head. The exceptions to this rule are the full and deceptive cadences since they are, by design, two-chord structures. The same does not occur with the half cadence. In this case, only the final is moved to the next higher level.

TSRWFR 4: *If a two-element-cadence is directly subordinate to the head e of a time-span T, the final is directly subordinate to e and the penult is directly subordinate to the final.*

This rule indicates how a cadence should be represented hierarchically in the time-span reduction when you move to a higher level reduction.

The question of how to choose the head of each time-span is answered with the following preference rules that fall into three categories – local, nonlocal and structural accent rules. "*Local rules* attend exclusively to the rhythmic

[83] Lerdahl and Jackendoff, 135.

structure and pitch content of the events within the time-span itself. *Nonlocal rules* bring into play the pitch content of other time-spans (essentially considerations of voice-leading and parallelism). *Structural accent rules* involve articulation of group boundaries."[84]

> TSRPR 1: *(Metrical Position) Of the possible choices for head of time-span T_1, prefer a choice that is in a relatively strong metrical position.*

We find this to be the case, with a few exceptions, in the time-span reduction of the *Aria*. The first exception is found in m.4 at level *c*. The head of this measure is the V chord found on beat 3. Beat 3 is still a metrically strong beat but not as strong as beat 1. In this case, however, the V chord is the best choice for the head because it is more structurally stable than the I^6 that occurs on the first beat of that same measure. The other reason for preferring the V chord will be discussed in TSRPR 7: *(Cadential Retention)*. The second occurrence is found in m.6 of the same level. V^6 on the weak beat at the end of the measure is the most likely chord to move from level *b* to level *c* as it is the most harmonically stable chord in this measure. The intervening chords between the V on m.5-1 and the V^6 on m.6-4 "can be treated as a neighboring function within the V prolongation."[85]

> TSRPR 2: *(Local Harmony) Of the possible choices for head of time-span T_1, prefer a choice that is*
>
> a. *relatively intrinsically consonant,*
> b. *relatively closely related to the local tonic*

These preference rules have been met in the time-span reduction of the *Aria*. All choices in all levels are consonant and more often than not, are the local tonic. The choices other than the tonic chord are the dominant and the predominant (ii) chords. As there is no modulation or tonicization in the *Aria*, B^b major is the local tonic throughout.

> TSRPR 3: *(Registral Extremes) Of the possible choices for head of time-span T_1, weakly prefer a choice that has*
>
> a. *a higher melodic pitch,*
> b. *a lower bass pitch.*

A good example of choosing a higher melodic pitch can be found in m.1 as we move from level *b* to level *c* (see Appendix IV, pg.72). It is difficult to

[84] Ibid, 159.
[85] Personal communication from Fred Lerdahl, November 2, 2004.

decide which chord to move to the next level as they both have the same bass note; the first chord is more harmonically stable and is on the stronger beat while the second chord is melodically higher. I have chosen to follow this preference rule over 1 and 2.

> TSRPR 4: *(Parallelism) If two or more time-spans can be construed as motivically and/or rhythmically parallel, preferably assign them parallel heads.*

This rule is particularly valuable as, in the *Aria*, both motivic and rhythmic parallels are found existing simultaneously. Mm.1, 3 and 6 are motivic and rhythmic parallels as are mm.2 and 7. Mm.2 and 7 are treated identically in the time-span reduction while preference rules conflict when analyzing mm.1, 3 and 6 resulting different heads.

> TSRPR 5: *(Metrical Stability) In choosing the head of a time-span T, prefer a choice that results in more stable choice of metrical structure.*

This rule suggests that while choosing the head of a time-span reduction it is advisable to consider the effects your choice will have on the metrical preference rules and attempt to arrive at a reduction that does not conflict with the metrical preference rules. My time-span reduction is not in conflict with the metrical preference rules.

> TSRPR 6: *(Prolongational Stability) In choosing the head of a time-span T, prefer a choice that results in more stable choice of prolongational reduction.*

The time span-reduction of the *Aria* agrees with the prolongational reduction except for the beginning where the prolongational reduction prefers m.1-1 to m.1-3 found in the time-span reduction.

> TSRPR 7: *(Cadential Retention) If the following conditions obtain in a time-span T, then label the progression as a cadence and strongly prefer to choose it as head;*
>
> *i.* *There is an event or sequence of two events* $(e_1)e_2$ *forming the progression for a full, half, or deceptive cadence.*
>
> *ii.* *The last element of this progression is at the end of T*

or is prolonged to the end of T.

iii. *There is a larger group G containing T for which the progression can function as a structural ending.*

There are two structural cadences in the *Aria*, m.4-2→ m.4-3, and m.8-2→ m.8-3, which both follow this preference rule. Note that this preference rule causes us to ignore preference rule 1 by choosing both the metrically weak beats of m.4-2 and m.8-2.

> TSRPR 8: *(Structural Beginning) If for a time-span there is a larger group G containing T for which the head of T can function as the structural beginning, then prefer as head of T an event relatively close to the beginning of T (and hence to the beginning of G as well).*

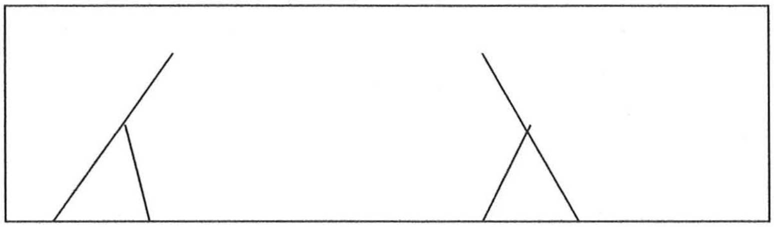
This preference rule is followed such that the structural beginning of phrases one and two of the *Aria* are found at all levels of the time-span reduction.

> TSRPR 9: *In choosing the head of a piece, prefer the structural ending to the structural beginning.*

Since the structural ending of a piece is more stable than its goal-driven structural opening, the structural ending is the preferred choice for the head of the piece. GTTM states that this may not always be the case; it is for the *Aria*.

PROLONGATIONAL REDUCTION

GTTM's grouping, metrical, and time-span reduction rules may convey areas of local tension, such as the rhythmic tension of syncopation whose opposite is lack of tension. A different mode of analysis is required to communicate areas of tension whose opposite is relaxation. In goal-directed tonal music, areas of tension are often found at phrase openings while areas of relaxation are often found at phrase endings and areas of maximal tension at the climax of the phrase or piece. In order to qualify levels of tension and relaxation, GTTM designates three types of motion or relationships between events as weak prolongation, strong prolongation, or progression. The direction of branching (right or left) between superordinate and subordinate events is also an indication of areas of tension or relaxation. Right branching signifies an area of tension while left branching signifies an area of relaxation (see Figure 2, pg.37).



tension→ relaxation→

Right branching Left branching

Figure 2: Branching

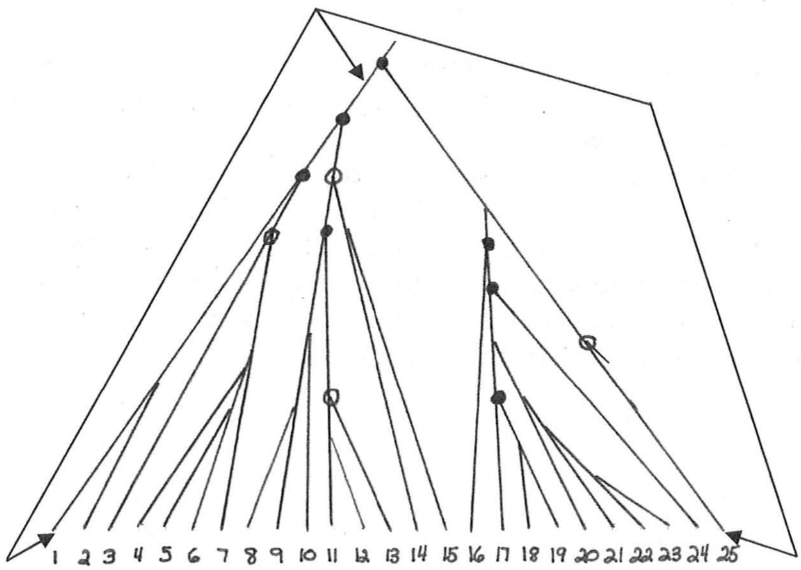


Figure 3: Right Branching in *Aria*

In Figure 3 (shown above) we find an example of a right branching structure in the *Aria* between time points 1 and 25. Lerdahl predicts that the listener will experience a sense of tension as the melody moves from the tonic B^b to the mediant D while supported by the same tonic chord in the same root position.

Figure 4 (shown below) depicts a left branching structure through time points 28→29→30→31. Lerdahl predicts that the listener will experience a sense of relaxation as the chords move from IV^6→ii^6→V→I arriving on a tonic melody note supported by a root position tonic chord.

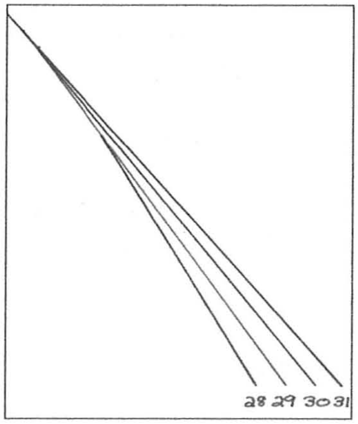


Figure 4: Left Branching in *Aria*

In order to construct a prolongational tree (see Appendix V, pg.73), it is necessary to decide which event is the most important in the various "hierarchically related regions."[86] For this, Lerdahl and Jackendoff prescribe four well-formedness rules and six preference rules with which they refer to both direct and recursive elaborations. Direct elaborations result when an event terminates on another event that is not, itself, a branch of a third event. The latter case would be a recursive elaboration. In Figure 5, an example of a direct elaboration can be found between time points1 and 2 at **A**. At **B** (time points 5→6→7→3→1) is an example of recursive elaborations.

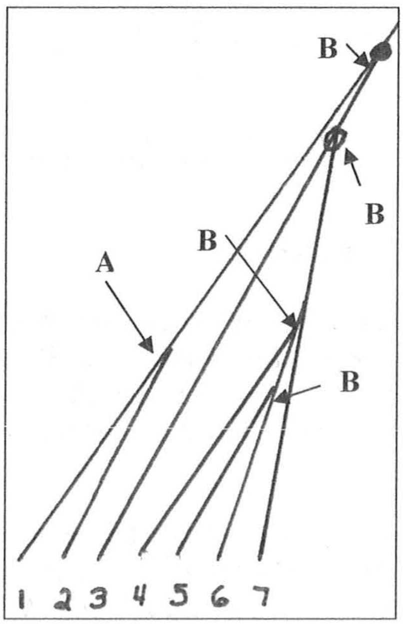


Figure 5: Examples of Direct (**A**) and Recursive (**B**) Elaboration in *Aria*

[86] Lerdahl and Jackendoff, 216.

PRWFR 1: *There is a single event in the underlying grouping structure of every piece that functions as prolongational head.*

In the *Aria,* this single event is the tonic chord in root position and with $\hat{3}$ in the melody.

PRWFR 2: *An event e_i can be direct elaboration of another event e_j in any of the following ways:*

a. *e_i is a strong prolongation of e_j if the roots, bass notes and melodic notes of the two events are identical*

An example of a strong prolongation can be found between m.1-1 and m.8-3.

b. *e_i is a weak prolongation of e_j if the roots of the two events are identical but the bass and/or melodic notes differ.*

An example of a weak prolongation can be found between m.1-1 and m.7-1.

c. *e_i is a progression to or from e_j if the harmonic roots of the two events are different.*

An example of a strong prolongation can be found between m.8-2 and m.8-3.

PRWFR 3: *Every event in the underlying grouping structure is either the prolongational head or a recursive elaboration of the prolongational head.*

Every event must be indicated in the prolongational structure as a right or left branch.

PRWFR 4: (No Crossing Branches) *If an event e_i is a direct elaboration of an event e_j, every event between e_i and e_j must be a direct elaboration of either e_i, e_j, or some event between them.*

Any subordinate events that occur between two superordinate events are linked to the superordinate events and as such must be branched between rather than outside of the two superordinate events. An example of this may be found between m.1-3 and m.2-3 where the intervening chords are branched between these two events.

Determining the regions in the time-span reduction absolutely relies on the interaction of the grouping and metrical structure. Such is not the case with the prolongational regions. Here we often find regions in the prolongational reduction that cross group boundaries. Lerdahl and Jackendoff explain that the main difference between the grouping/metrical/time-span reduction approach and the prolongational reduction approach is that "the grouping, metrical, and time-span structures are built from the smallest units up, … [while] the prolongational structure must be constructed from the top down, starting with the head of the piece and dividing the piece into progressively smaller regions until all events are included."[87]

Before discussing the prolongational reduction preference rules we must consider characteristics of the prolongational head and the prolongational region. The prolongational head must be a point of maximal relaxation and is most often the end of the piece. Thus, in the *Aria*, the prolongational head will be m.8-3. GTTM defines a prolongational region as "a sequence of events (e_i-e_j), (#-e_j), or (e_i-#) such that all events within the sequence are recursive elaborations of either e_i or e_j"[88] As # represents the boundaries of a piece, the prolongational regions would be #- e_i, e_i – e_j, e_j - #.

Prolongational reduction preference rules 1 and 2 address the relationship between "prolongational reduction and time-span reduction."[89]

> PRPR 1: (Time-Span Importance) *In choosing the prolongationally most important event e_k of a prolongational region (e_i-e_j), strongly prefer a choice in which e_k is relatively time-span important.*

This is indeed the case as m.1-1 is chosen as the prolongational head as it is a root position chord with the tonic in the melody and occurs on the first beat of the first measure.

> PRPR 2: (Time-Span Segmentation) *Let e_k be the prolongationally most important event in a prolongational region (e_i-e_j). If there is a time-span that contains e_i and e_k but not e_j, prefer a prolongational reduction in which e_k is an elaboration of e_i; similarly with the roles of e_i and e_j reversed.*

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[87] Ibid, 216.
[88] Ibid, 219.
[89] Ibid, 220.

An example of this can be seen in the prolongational tree where e_k is m.3-1, e_i is m.1-1, e_j is m.7-1, and e_k is a prolongation of e_i and not e_j. This preference rule addresses the attachment but not the choice of e_k.

> PRPR 3: (Prolongational Connection) *In choosing the prolongationally most important event e_k in a prolongational region (ei-ej), prefer an e_k that attaches so as to form a maximally stable prolongational connection with one of the endpoints of the region.*

M7-1 is the event e_k in the prolongational region in which e_i is m.1-1 and e_j is m.8-3.

At this point in the prolongational reduction preference rules, Lerdahl and Jackendoff attempt to categorize the relative stability of prolongational connections. It is this aspect in particular and the subsequent interaction principle that Lerdahl revisits in *Tonal Pitch Space*. As they stand here, the stability conditions require no elucidation.

Stability Conditions for Prolongational Connection:

1. (Branching condition)
   a. *Right strong prolongations are more stable than right weak prolongations, which in turn are more stable than right progressions.*
   b. *Left progressions are more stable than left weak prolongations, which in turn are more stable than left strong prolongations.*
2. (Pitch-collection condition)
   A connection between two events is more stable if they involve or imply a common diatonic collection.
3. (Melodic condition)
   a. (Distance) *A connection between two events is melodically more stable if the interval between them is smaller (with the exception of the octave, which is relatively stable.)*
   b. (Direction) *An ascending melodic progression is most stable as a right-branching structure; a descending is*

most stable as a left-branching structure.

4. (Harmonic Condition)
    a. (Distance) *A connection between two events is harmonically more stable if their roots are closer on the circle of fifths.*
    b. (Direction) *A progression that ascends along the circle of fifths is most stable as a right-branching structure; one that descends along the circle of fifths or produces a subdominant-to-dominant relationship is most stable as a left-branching structure.*

PRPR 4: (Prolongational Importance) *Let e_k be the prolongationally most important event in a region (e_i-e_j). Prefer a prolongational reduction in which e_k is an elaboration of the prolongationally more important endpoints.*

Like PRPR2, this preference rule is a "relatively weak principle"[90] and may in fact override PRPR2. Like PRPR2, it is more concerned with the attachment and not the choice of e_k.

PRPR 5: (Parallelism) *Prefer a prolongational reduction in which parallel passages receive parallel analyses.*

This preference rule is followed in the prolongational reduction of the *Aria* with the passing chords between I and I^6 graphed in the same manner. The passing chord is graphed as a right branching progression within the right branching prolongation.

PRPR 6: (Normative Prolongational Structure) *A cadenced group preferably contains four (five) elements in its prolongational structure:*

a. *a prolongational beginning*
b. *a prolongational ending consisting of one element of the cadence*

[90] Ibid, 226.

> c. *(a right –branching prolongation as the most important direct elaboration of the prolongational beginning)*
> d. *a right-branching progression as the (next) most important direct.*

The prolongational reduction of the *Aria* follows this preference rule.

> INTERACTION PRINCIPLE: *In order to make a sufficiently stable prolongational connection, e_k must be chosen from the events in the two most important levels of time-span reduction represented in $(e_i\text{-}e_j)$.*

The purpose of the interaction principle is two-fold – it attempts to allow both flexibility and restriction at the same time. This principle permits flexibility in choosing the most important prolongational event by allowing the event to be chosen from the two highest time-span reduction levels. It does restrict the choice and thus does not permit "unimportant detail from playing too great a role at any particular stage of prolongational analysis."[91]

TONAL PITCH SPACE THEORY

GTTM made great strides in its attempt to qualify both local and global events in music. It teases apart constituents of tonal music, assigning each its own level of analysis, hierarchical levels—grouping structure, metrical structure, time-span reduction, and prolongational reduction—and recombines them in the prolongational analysis. Lerdahl, in *Tonal Pitch Space*, continues to rely on the expressive mode of tension and relaxation as he refines and quantifies these same constituents while addressing the concern of stability conditions that are ignored in GTTM.

Let us begin by looking at the changes made to the prolongational tree and follow this discussion with a presentation of the new concepts regarding the calculations of surface dissonance and pitch space that define the stability conditions.

Lerdahl formulates rules for *prolongational good form*[92] that adapt and supersede those of GTTM (see: PRPR6) as follows:

> PROLONGATIONAL GOOD FORM
> (1) *Normative prolongational structure*: For cadenced groups, prefer to include:
> (a) a structural beginning and a cadence

[91] Ibid, 228.
[92] Lerdahl, 28.

(b) optionally, a right-branching prolongation that is the most important direct elaboration of the structural beginning
(c) a right-branching progression that, except for (b), is the most important direct elaboration of the structural beginning
(d) a left-branching progression that is the most important direct elaboration of the first element of the cadence.

(2) *Balance constraint*:
At any level, for events e_2 and e_3 immediately subordinate within the strong or weak prolongation e_1-e_4, prefer the attachment of e_2 to e_1 and e_3 to e_4.

(3) *Recursion constraint*:
At any level, for events e_j and e_k subordinate to e_i, prefer, if e_j directly attaches to e_i, the direct attachment of e_j to e_k: both subject to the conditions that
(a) e_j and e_k are both to the left or to the right of e_i
(b) e_i, e_j, and e_k form all progressions or all prolongations
(c) e_i, e_j, and e_k are all either harmonic events within a region or events located in different regions.

The prolongational tree of the *Aria* (see Appendix V, pg.73) demonstrates prolongational good form as it does not conflict with any of the above rules. The overall structure corresponds to normative prolongational structure (a) while (b) is found at m.7-1 where I is the right-branching prolongation that is the most important direct elaboration of the structural beginning. An example of (c) can be found where I in m.3-1 is the most important direct elaboration of the structural beginning, except for (b). A left-branching progression described in (d) can also be found in the prolongational tree of the *Aria* at $ii^6 \rightarrow V \rightarrow I$ of the final cadence (m.8-1→8-3).

An example of the balance constraint can be found between m.4-2 (e_1) and m.5-1 (e_4) where m.4-3 (e_2) attaches as a progression to e_1 and m.4-4 (e_3) attaches as a prolongation to e_4. The recursive constraint is exploited many times in the prolongational tree of the *Aria*. The final cadence (m.8-1→8-3), following the left-branching condition, where e_i is I, e_j is V and e_k is ii^6 is one such example. A right-branching example occurs between mm.5-4 and 6-2 where e_i is I^6, e_j is ii^6 and e_k is iii^6.

While further clarification of the normative prolongational structure is enlightening, it is Lerdahl's attempt to quantify the tension perceived by the listener that is of particular appeal. Lerdahl links perceived tension to the tonal hierarchy present in the pitch space of Western tonal music. For him,

> tonal hierarchy ... corresponds to GTTM"S stability conditions and embodies the hierarchical relations that accrue to an entire tonal system beyond its instantiation in a particular piece. Such a hierarchy is atemporal in that it represents more or less permanent knowledge about the system rather than a response to a specific sequence of events. This knowledge arises from listening experience ... Exposure to music is a prerequisite for internalizing a tonal hierarchy.[93]

Like Schenker, Lerdahl believes that it is the tonal hierarchy present in Western tonal music that is the bearer of the tension perceived by listeners. These listeners, as also instructed by Schenker, must be experienced listeners but here 'experienced' is defined as 'familiar with' rather than as 'educated in the theory'.

Lerdahl describes two types of tension in music—sequential and hierarchical—as "[l]isteners understand music both sequentially and hierarchically. They inevitably hear one event after another; they also organize the surface in terms of structural events and their elaborations."[94] He further proposes that experienced listeners, in contrast with naïve listeners, hear hierarchically. I will not discuss sequential tension, as the subjects of this experiment were experienced listeners and, by Lerdahl's classification, hear hierarchically.

The ultimate result of the calculations presented in TPS is the *global total.* The global total is composed of the *local total* plus the *inherited* values. The local total is comprised of values of *surface dissonance* and *pitch space distance*. The pitch space distance is also used to determine the inherited values. All values are calculated using both the music score and the prolongational tree.

Surface dissonance is perhaps the easiest place to begin this discussion. It is a measure of the tension created by three variables—the scale degree in the melody and the bass (inversion) as well as nonchord tones—regardless of any relationship to sequential or hierarchical chords. Surface dissonance, in other words, can be calculated out of context. Lerdahl instructs that, if the melodic note is a chord tone but not the root, a value of 1 be added to represent the increase in tension perceived when the $\hat{3}$, $\hat{5}$ or when a melody note on $\hat{1}$ is in an upper octave which results in a change in tessitura. The placement of $\hat{3}$ or $\hat{5}$ in the bass results in an addition of 2 for both of these inversions. Nonchord tone diatonic 7ths

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93 Ibid, 41.
94 Ibid, 143.

result in an addition of 1; diatonic nonchord tones – 3; chromatic nonchord tones – 4. Thus, the *surface tension rule* is written as,

> $T_{diss}(y)$ = scale degree + inversion + nonchord tones; where $T_{diss}(y)$ is the surface tension associated with the chord y.

Pitch space distance renders the tension created by the interplay among the chords related by or connected through the prolongational tree. It describes chord distance and consists of three variables—*i*, *j*, and *k*—that are calculated in the context of the prolongational tree. The chord distance rule states the distance between two chords is equal to *i*+ *j*+ *k* where *i* is the change in the number of sharps and flats in the key signature found during tonicization and modulation, *j* is the shortest distance between the two chord roots along the circle of fifths, and *k* is the number of distinct pitch classes found in chord y compared to chord x. The chord distance rule states,

> $\delta(x \rightarrow y) = i + j + k$, where $\delta(x \rightarrow y)$ is the distance between chord x and chord y.

There is no need, in the present study, to address the calculation of an *i* value since the *Aria* is completely diatonic with no tonicizations or modulations. Figure 6 shows example calculations of *j*,figure 7 calculations of *k*.

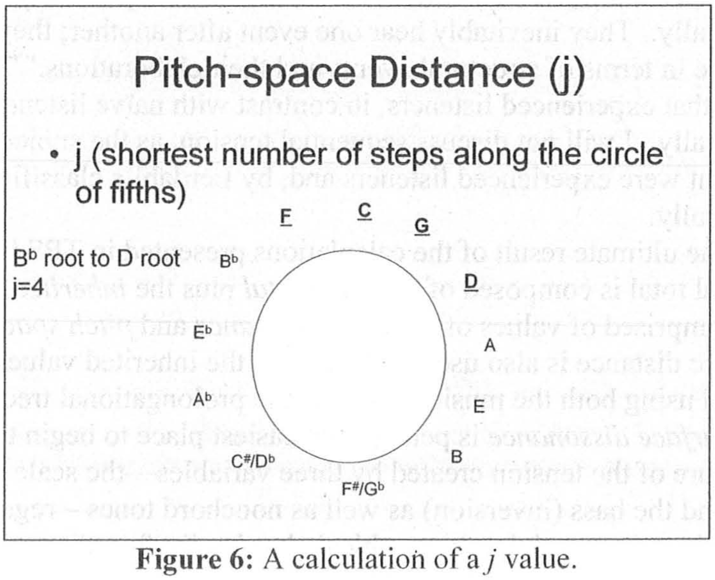

Figure 6: A calculation of a *j* value.

Pitch-space example (k)

- *C* chord (*CEG*) **D** chord (**DFA**)

e: *C* **D**
d: *C* **D** *G* **A**
c: *C* **D** *E* **F** *G* **A**
b: C D E F G A B
a: C,C#,D,D#,E,F,F#,G,G#,A,A#,B
k = 6

Figure 7: Calculation of *k* value.

Figure 7 is an example of the chord of I progressing to the chord of ii in a C^+ piece. At the a or chromatic level, both chords have the same member notes. At the diatonic or b level, both chords have the same member notes. It is at the triadic (c), fifth (d) and root (e) levels that the member notes differ. At the triadic level, the ii chord has 3 member notes (D, F, and A) that differ from the I member notes C, E, and G. D and A are different from C and G at the fifth level and D is different than C at the root level. Thus, a progression from I to ii in any major key results in a *k* value of 6.

We now have enough information to calculate the hierarchical tension found between two chords joined on the prolongational tree as either a progression, a weak prolongation or a strong prolongation.

Hierarchical Tension Rule:

$T_{loc}(y) = T_{diss}(y) + \delta(x \rightarrow y)$, where $T_{loc}(y)$ is the local tension perceived at y, $T_{diss}(y)$ is the surface dissonance at y, and $\delta(x \rightarrow y)$ is pitch space distance between x and y.

Lerdahl is not finished yet since local tension does not take into account the multiple levels of branching found in a prolongational tree. Another value – global tension – must also be considered. Global tension addresses the tension inherited by subordinate branches that attach both directly and indirectly to superordinate branches. Global tension is not a concern when there is but a single superordinate branch as is the case between mm.7-1 and 1-1 in the *Aria* prolongational tree. It does become essential, however, at places like m.6-3, which has five superordinate branches from which to inherit tension. The subordinate branch inherits only its superordinates' pitch space distance and not the surface tension values. Thus, the final version of the hierarchical tension calculation is as follows,

$T_{glob}(y) = T_{loc}(y) + T_{inh}(x_{dom})$,
where $T_{glob}(y)$ is the global tension value, $T_{loc}(y)$ is the local tension value ($T_{diss}(y) + \delta(x \rightarrow y)$), and $T_{inh}(x_{dom})$ is the pitch space distance ($\delta(x \rightarrow y) = i + j + k$) from all superordinate branches.

The calculations, for the *Aria*, of surface dissonance, pitch space distance, local total and global total can be found in Appendix VII (pg.75) with stopping points found at Appendix VI (pg.74).

Lerdahl and Jackendoff's *A Generative Theory of Tonal Music* and Lerdahl's subsequent *Tonal Pitch Space*, with their attending rules, may appear, at first, less intuitive than Schenker's approach. While in certain respects this is true, a person with little experience of Western tonal music and its rules of harmony would not be able to render a satisfactory analysis by following the numerous rules as one might follow a recipe. Nor, not surprisingly, do the abundant rules necessarily result in one defining analysis of any particular piece of music, as musical intuition remains a part of this analysis.

In TSP, Lerdahl attempts to integrate principles of music perception and cognition with his hierarchical analysis of a music score to quantify patterns of tension and relaxation. While he admits that many aspects of the theory remain unfinished and some points, like the seemingly arbitrary values assigned for surface tension, require further development, Lerdahl is clear in his motive. "I attempt to make my proposals precise enough to be testable."[95]

The following chapter describes such an experiment. The subjects are presented with three tasks, one of which is to judge perceived tension at various stopping points in Handel's *Aria*. These judgments are subsequently compared to the values obtained by an application of Lerdahl's tonal pitch space theory.

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[95] Lerdahl, vii.

CHAPTER 3: THE EXPERIMENTS

INTRODUCTION

Heinrich Schenker and Fred Lerdahl each developed theories and corresponding graphic notation concerning the perception of music by the "experienced listener." This study focuses on a particular piece of music—an *Aria* composed by Handel and used by Brahms as the basis for 21 variations for piano in his Opus 24[96]—for the purpose of comparing the perceptual experience of the listener as characterized by the two theories. The methodology is based on the previous work of Smith and Cuddy.

Determining the best piece of music for the present study presents a number of challenges. In order to test Schenker's theory - with its emphasis on the *organic* quality of music - the necessary qualities of the selection are that it be structurally complete, self-contained, and tonal. As Lerdahl's theory primarily concerns Western tonal music and also emphasizes a background structure, the requirements to test his theory concur. In addition, the music selection must be rhythmically and harmonically 'interesting' and unknown to the subjects. Furthermore, the selection must be originally composed for piano since the stimuli are presented using piano timbre. Finally, due to the rigour of the tests, the piece must be short.

It quickly became apparent, after many hours of searching though piano scores of the Baroque, Classical, and Romantic repertoire, that finding one piece that met all the criteria was challenging. (The keyboard works of the Baroque period were included since much of that repertoire is performed, today, on the piano.) The main difficulty is finding an excerpt that is short enough yet structurally sound. Much of the Romantic repertoire is harmonically and melodically interesting but requires a long excerpt before a self-contained structure can be ascertained. Narrowing the focus to themes/arias employed as the basis for sets of variations expedites the situation.

Eventually, eight possibilities were identified. These were three by Brahms (on themes by Haydn, Handel and Paganini), one by each of Field, Heller (on a theme by Beethoven), Felix Mendelssohn, W.A. Mozart and Schubert. Each of these themes underwent Schenkerian and traditional harmonic analysis as an aid for the identification of points of perceptual interest. In the end, the Handel Aria, as used by Brahms in his Opus 24, was considered the best choice for this study for the following reasons:

- brevity (8 measures totalling 24 seconds)
- structural completeness
- self-contained
- tonality is unambiguous
- diatonic harmonic language different from the highly modulatory harmonic language found in Beethoven's *Waldstein* sonata used by Smith and Cuddy
- rhythmically interesting

[96] See Appendix VIII (pg.74).

· Brahms use of the aria was for piano
· unlikely to be known to subjects (when compared to the other possible choices)
· Schenker has written extensively on this work. (This writing is from his later period when his theory was well developed.)

One aspect of interest absent from the *Aria* is that of modulation and tonicization as this piece is clearly in B^b major throughout. However, this characteristic also contrasts with the work of Smith and Cuddy where the tonality of the excerpt from Beethoven's *Waldstein* sonata was highly ambiguous.

The next step was to translate Schenker's graphic notation into traditional notation while maintaining the integrity of his analysis[97]. Initially, Schenker's levels *a, d, e, g* and the *Aria* were chosen for testing. During the initial sessions, however, it became apparent that the experiment was extraordinarily long and one level would need to be removed. I decided to remove level *e* since *a*, as the background, was necessary as was the *Aria* itself. Level *g* was retained, as it is basically the *Aria* without the confounding surface detail. I was left with choosing to remove either level *d* or *e*. The decision, made initially on constraint of time, was to eliminate *e*. In this manner, then, I could collect data on the subtle changes at the two extremes—the background and the foreground.

As stated above, Schenker analysed the Handel *Aria* in B^b because it served as the basis for Brahms' Opus 24 variations. To aid in his discussion of the *Aria*, Schenker uses eight graphs—labelled *a* to *g* and *Aria*—which move from the background to the foreground, identify significant structures, and depict the relationships between the notes. Thus, the testing in this study follows this same sequence. Through this approach, Schenker emphasizes the fundamental structure upon which the surface material may interact. This was of significant import as he notes, "While the power of the imagination retains this *Ursatz*, all sorts of melodic unfoldings, diminutions, motives, and the like appear."[98]

In graph *a*, Schenker outlines the fundamental structure identifying the fundamental line ($\hat{5}$, $\hat{4}$, $\hat{3}$, $\hat{2}$, $\hat{1}$) and the bass arpeggiation (I-V-I-ii-V-I). This describes a prolongation of I with F in the melody over a B^b bass that begins in m.1 and remains until a change in the bass to F in the middle of m.4 making a V chord. In m.5, Schenker indicates E^b over the bass F, creating a V^7 chord. The melodic E^b descends to D as the bass F rises to B^b resulting in I in m.7. The D of the melody moves to C in m.8 as the bass descends first to E^b, forming ii^6, and then to F creating V. The final descent of both lines to B^b creates a solid final I.

[97] See Appendix IX, pg.75-78.
[98] William Renwick (trans.) "Brahms's Variations and Fugue on a Theme by Handel, Op.24" in *Der Tonwille Pamphlets/Quarterly Publication in Witness of the Immutable Laws of Music Volume II by Heinrich Schenker*, ed. William Drabkin. (Oxford, New York: Oxford University Press, 2005), 77.

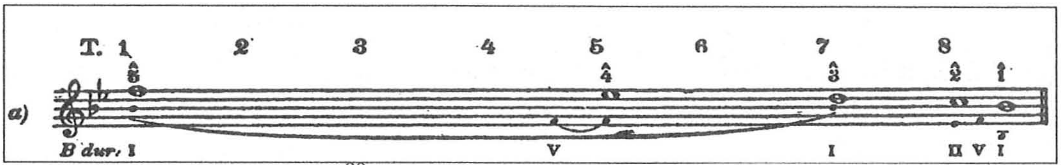

Figure 8: Graph a)[99]

In graph *d*, Schenker details the unfolding of I from m.1-4 and adds new detail concerning the last 4 measures. Immediately apparent is the motive of the rising 3rd. Over the first two measures, the initial ascent begins with B^b moving a 3rd, by way of a passing note C, to D. The subsequent two measures show another rising 3rd movement of D to F through E^b. Schenker indicates a similar event occurring in the bass—B^b to D, D to F—without the inclusion of the passing notes. During mm.5 and 6, the harmony changes to V with the rising 3rd movement evident here as well. While the bass remains on the F, the melody rises from C, through D, to E^b. The melody of the last two measures is a mirror of the first two, as the ascent from B^b to D has now become a descent from D to B^b. The bass line also descends in 3rds, from B^b to G and then to E^b before the final 5th descent in the bass, which is the condensed version of the stepwise 5th descent of the melody. With the addition of more notes comes the elaboration of the chord structure to that of I-V//V-I-vi-ii-V-I.

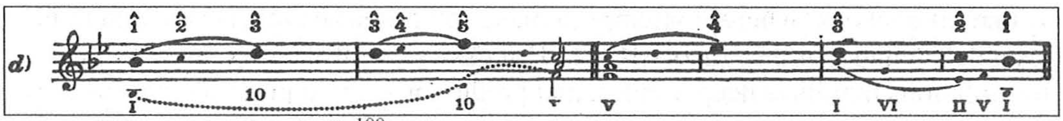

Figure 9: Graph d) [100]

Bar lines corresponding directly to those found in the *Aria* are introduced in graph *g*. This graph is also written with metrical accuracy not previously encountered. Schenker adds more surface detail, still from a voice-leading and chordal perspective, outlines the basic harmony, and identifies the important neighbour notes (Nbn). While outlining the basic harmony, Schenker readily identifies the background I-V//V-I-IV-ii-V-I by placing the less structurally important chords in round brackets. It is important to note that while on the surface the music appears to be different—melody and bass notes have changed resulting in some chord renaming and non-chord notes have been added—the background fundamental structure remains unchanged in both the structure and location of the chords. As in graph *d*, we find the recurring identification of the rising 3rd motive. The inclusion of trills, mordents, and chord completion to level *g* bring us to the *Aria*.

[99] William Renwick (trans.) "Brahms's Variations and Fugue on a Theme by Handel, Op.24" in *Der Tonwille Pamphlets/Quarterly Publication in Witness of the Immutable Laws of MusicVolume II by Heinrich Schenker*, ed. William Drabkin. (Oxford, New York: Oxford University Press, 2005), 77.
[100] Ibid.

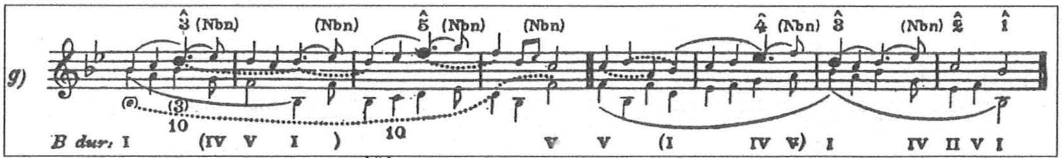

Figure 10: Graph g)[101]

While the fundamental structure remains constant through the graph levels and up to the *Aria*, much does not. The *Aria*, as in all the graphs, begins on I. It is the melody note that changes from B^b, in the *Aria*, to D in *d* to F in the background. Moving from the *Aria* toward the background again, we find the C (*Aria*, *g* and *d*) in m.5-1 becoming an E^b in the background. The representation at level *a* suggests greater tension resulting in a stronger need to resolve and thus a stronger forward temporal orientation. This same event in the *Aria* actually takes place at m.6-2 and, while the resolution occurs on m.7-1 as in all the levels, it is delayed by a rising sequence of first inversion chords. The harmonic function of the rising sequence is to increase the feeling of tension. The question that arises, then, is whether Schenker is merely indicating the beginning of the tension in the background graph or whether, to him, this is the location of ultimate tension.

That the determination concerning issues of this nature are of interest to Lerdahl is revealed in the *Preface* to his book, *Tonal Pitch Space*, where he says that his new theory is "an integrated theory of music cognition and an associated system of analysis [where] I attempt to make my proposals precise enough to be testable"[102] and that the "theory [GTTM] seeks to be sufficiently precise in its formulations that its concepts, rules, and predictions can in principle be tested by the methods of experimental psychology."[103]

Fred Lerdahl, in TPS, both accepts and rejects Schenker's theory as he acknowledges when he says,

> "[conversations] with William Rothstein in the late 1980's sharpened my understanding of the relationship of my work to Schenkerian analysis"[104] while taking exception with "Heinrich Schenker's (1935/1979) well-known approach to reduction [that] has both a metaphysical and an aesthetic basis, depends on an a priori construct (the *Ursatz*) that has a pervasive top-down influence on an analysis, is informal in its application, and emphasizes voice-leading features. GTTM's, in contrast, has a psychological aim, has no metaphysical givens, proceeds by rule, and emphasizes rhythmic and harmonic features. In

[101] Ibid.
[102] Lerdahl, vi – vi.
[103] Ibid, 4.
[104] Ibid, ix.

> both approaches, structural importance is a question not of surface salience but of syntactic stability."[105]

While the theories of both men revolve around the "experienced listener", the definitions of "experienced" are quite different. We recall from the discussion of the Goethian term, a*perçu* that describes the sudden insight or heightened perception that accompanies *Anschauung* (seeking), which, according to Pastille, explains why it is difficult to hear Schenker's graphs. The "graphs do not record perceptions of normal hearing ... but an elevated sense of hearing that has been trained by *Anschauung* to recognize underlying models and ultimately *Urphänomen* [type]."[106] Schenker himself held this belief as he notes in *Das Meisterwerk II* (pg.11) that any listener not trained in the terms of his principles has never heard music at all.[107] A more precise description of Schenker's "experienced listener" comes from his pupil, Felix Salzer who writes,

> Understanding of tonal organisms is a problem of hearing; the ear has to be systematically trained to hear not only the succession of tones, melodic lines and chord progressions but also their structural significance and coherence. Thus a systematic approach evolved, starting from simple and short examples and leading, in gradual stages, to large and complex organisms. This approach I call "Structural Hearing."[108]

In his description of "Exercises in prolongation-Structural ear training"[109], Salzer explains the importance of playing the music, in successive stages, from the background to the foreground while maintaining an awareness of the significance of the prolongations and their relationship to the work as a whole. This approach offers another confirmation of our decision to present the subjects with material that started at the background and moved toward the foreground. Salzer further instructs the student engaged in "structural ear training" that, although the graphs are not in a definite rhythmic form, they, especially the graphs that "most closely approximating the actual composition ... be played so as to suggest more definitely the rhythm of the actual composition."[110] As mentioned above, this study followed that directive.

Lerdahl's definition of "experienced listener" is more generous. "GTTM assumes an 'experienced listener.' In reality no two listeners are exactly alike, nor are any two hearings by the same listener. Given familiarity with an idiom, however, the ways in which a piece is understood are highly constrained."[111]

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[105] Ibid, 10.
[106] Pastille (1990), 42
[107] Ibid (1990), 42.
[108] Salzer, xvi.
[109] Ibid, 144.
[110] Ibid
[111] Lerdahl, 5.

Lerdahl, while concentrating primarily on the idiom of Classical diatonic tonal music, also attempts to model the musical mind with rules that apply universally. "The term "universal" is meant not in a geographical or historical sense but in a psychological one. "To assert that a rule is universal is to claim that it represents a natural propensity of the musical mind."[112]

We can identify, from this introduction, converging and diverging approaches to the "experienced listener's" perception of music in the theories of Schenker and Lerdahl. The focus of this study was to evaluate the predictive aspects of each through subject's judgments of tension/relaxation, phrase structure, and probe tones[113].

EXPERIMENTS 1-3: GENERAL METHOD

- **Participants.** Eleven listeners (7 female and 4 male), music students from McMaster University and Wilfred Laurier University participated in the same three experiments over three sessions without remuneration. The mean age was 25.6 years (*SD* = 11.53). The mean years of musical training was 16 years (*SD* = 8.56), either primarily, or substantially, on the piano. 3.05 (*SD* = 1.62) was the mean hours per day spent listening to music. Four were pursuing a Bachelor of Music degree at either McMaster University or Wilfred Laurier University and 7 a Master's of Music Criticism at McMaster University. All reported normal hearing, none with absolute pitch. Upon completion of the experiment, none reported a previous knowledge of the *Aria* by Handel.

Listeners were first presented with a training session that required judgments of tension/relaxation, phrase structure, and probe tones after the presentation of a three-chord (I-V-I) cadence played in appropriate keyboard style in C Major using the same piano timbre as the experiments. The purpose of the training session was to acclimatize the participants to the testing procedure and to provide a test whereby the experimenter could determine the ability of the participant to make accurately the required judgments.

- **Materials and Apparatus.** The musical materials consisted of an *Aria*, chosen by Brahms from Handel's *Lessons for the Harpsichord* and used as the basis for 21 variations. Schenker's graphs *a*, *d*, and *g* were transcribed into traditional notation using *Finale2000b* (see Appendix IX, pg.77-80). All musical materials were created in MIDI format (80 bpm) with equal key velocity on all notes. The probe tones, created in the same manner, were comprised of a five-note unison chord that spanned the range of the *Aria* (e.g. C2, C3, C4, C5, C6). The MIDI files were then rendered as digital sound files (sampling rate = 44.1 kHz) using the Grand Piano timbre in Apple's Garage Band application. I

[112] Ibid, 4.

[113] The probe tones used in this experiment can be found at Appendix XV (pg. 90). They consist of a 5-note unison chord that spanned the range of the *Aria*. In the experiment, the musical excerpt is played, followed by a 2 s silence and a 1s probe tone after which time listeners are prompted to make their judgments. There are 12 probe tones representing the 12 chromatic pitches found in the octave.

presented them using custom-made software developed in MAX/MSP running on an Apple G5, the output of which was amplified by a NAD C352 Stereo Integrated Amplifier and Sennheisser HAD 200 headphones. Participants were able to control the volume of the sounds presented to them through the headphones. Three differently coloured screens, with a range of coloured buttons (labelled with numbers 1 - 7 and text identifying the amount of tension, type of phrase structure or fit of probe tones), were shown to the listener during the presentation of the excerpt. The listener clicked a mouse on the corresponding rating.

- **Experimental Sessions.** The first session began with the training session and proceeded directly into the 7 time points on Schenker's *a* graph and the 15 of the *d* graph. Session 2 proceeded directly to the 30 time points of the *g* graph. The third session required judgments of 31 time points of the *Aria*. After each judgment, the music would begin at the beginning and stop at the same time point until all 14 judgments (1 for tension/relaxation; 1 for phrase structure; 12 for probe tones) were made. The music would begin again at the beginning of the selection and proceed to the next stopping point and the process would continue in this manner until all judgments were made at all stopping points (see Appendix IX pg.77-80). Each session lasted approximately 2 - 2.5 hours.

EXPERIMENT 1: TENSION/RELAXATON

In this first experiment, I was interested in acquiring ratings of perceived tension at each stopping point in all Schenker's levels in order to discern how the addition of auditory cues through these levels changes the perception of tension and relaxation. Stopped time judgments were preferred to continuous judgments made with a slider mechanism due to the time lag encountered in the latter instance and its associated difficulties in data analysis.

METHOD

The listeners were instructed to make judgments on the perceived amount of tension or relaxation at each stopping point. They were presented with a screen (see Appendix X, pg.80) which reminded the listener of the required judgment, prompted the listener when to listen and when to make the judgment, and allowed the listener to replay the selection. The ratings were made on a seven-point scale, with "7" representing a strong sense of tension, and "1" a strong sense of relaxation. After each time point, the listeners provided a rating by clicking a mouse on the corresponding rating.

RESULTS AND DISCUSSION

Intersubject correlations (Level *a*: r (5) = .77, $p < .05$; Level *d*: r (13) = .66, $p < .01$; Level *g*: r (28) = .61, $p < .001$; *Aria*: r (29) = .59, $p < .001$) demonstrate that, at each level, listeners were largely in agreement in their rating with the strength of the correlations appearing to weaken as we approach the surface. This may due to the additional musical material allowing for more varied interpretations and suggests that tension resulting from deeper structures is experienced more similarly than tension arising from more surface structures. A factor in the experience of tension (and phrase structure) may also be the mechanical presentation of the stimulus; that is the lack of expressive timing in a computer-generated stimulus. As discussed below, surface detail heightens the perception of tension and thus as surface detail arises, expressive timing may be required for a more consistent rating by experienced listeners.

A one-factor repeated measures ANOVA (Level *a*: $F(6,70) = 35.93, p < .0001$; Level *d*: $F(14,149) = 18.90, p < .0001$; Level *g*: $F(28, 289) = 11.97, p < .0001$; *Aria*: $F(29,299) = 8.27$, $p < .0001$) shows that significant differences in tension were found across stopping points for all levels. These values indicate that listeners experienced a shifting sense of tension and relaxation at each level. The graphs of tension for each level, found in Appendix XII (pg. 83-84) and those of the LS Means Plot in Appendix XIII (pg.85-88) reveal that, the point of least tension/most relaxation, at m.8-3, remains consistent through all levels while the points of highest tension do not.

The tension in level *a* is rated highest for the V^7 at m.6-4 followed by the the V in m.8-2 and the pre-dominant ii^6 in m.8-1. The mean rating confirming the sense of relaxation perceived by the resolution of the V^7 at m.6-4 to the $I\hat{3}$ of m.7-4, although not considered honestly significantly different, is superseded by that felt by the arrival the $I\hat{1}$ of m.8-3. A higher tension rating for $I\hat{3}$ than for $I\hat{1}$ appears to support Lerdahl's assertion that melody chord notes other than the root add to the perception of surface dissonance and thus the perception of tension.[114] This will be addressed in more detail shortly when the middleground and foreground are discussed.

The pre-dominant vi found in m.7-4 of level *d* is perceived as having the highest sense of tension followed by the equally perceived tension, as demonstrated by the mean ratings, of V^7 (m.6-4), V (m.8-2), nonchord tone in m.1-4 between the I of m.1-2 and I of m.3-2, and the nonchord tone in m.5-4 between the V of m.5-2 and V^7 of m.6-4. Here again, we find an instance where Lerdahl's theory appears to be confirmed. The mean tension rating at *d*1-2 is not honestly significantly different from that of *d*3-2 but the passing note that moves between these two points is.[115] We also find the I^6 in m.4-1 is honestly significantly higher than that of I in m.8-3. This appears to support Lerdahl's theory in that a chord in inversion (add 2) embodies more tension than does a root position chord with a melody note that is not the root (add 1). However, context, for which Lerdahl has not accounted, plays a role. This is demonstrated when the opening $I\hat{1}$ is perceived as having more tension than the $I\hat{3}$ of m.3-2 while the reverse case occurs between the rating given $I\hat{3}$ found at m.7-2, after a V^7, and the final $I\hat{1}$.

As more surface detail is added through *g* and *Aria* and the music becomes more complex, it is more difficult to draw conclusions about the absolute cause of the mean ratings with complete certainty. We can formulate some interesting inferences. The point of highest tension, in *g*, is shared by the V^7 of m.2-4 and

[114] Lerdahl indicates that a value of 1 be added to the calculation of surface dissonance if any chord note other than the root appears in the melody.

[115] Lerdahl indicates that a value of 3 be added to the calculation of surface dissonance if any diatonic nonchord note appears in the melody.

the auxiliary chord of m.3-4. At least two factors are behind these high tension ratings; one is the chord itself and the other is the rhythm. Lerdahl considers the V^7 chord to be a V chord with a diatonic nonchord note and adds 1 to the surface dissonance calculation where it should, but does not in this case, embody less surface dissonance than the V^6 chord (add 2) of m.6-4. Thus, surface dissonance alone cannot explain the hierarchy of tension ratings. The highest tension ratings, which are associated with several different chords (vii, V, V^7, I), positions (root, first inversion, second inversion) and various nonchord notes and functions (passing, auxiliary), occur on the offbeat. It appears that, here, rhythm plays a role in the perception of tension. As predicted by Lerdahl, the tension rating for the I^6 chord (add 2) is generally higher than the ratings for I$\hat{3}$ (add 1).

At the *Aria* level, we again find the interaction of chord function and rhythm. The highest tension ratings occur on chords that are functioning as dominants (V, V^6, V^7, vii^6) and are also decorated with groups of 𝅘𝅥𝅯 composed of alternating chord and nonchord notes. We can see, by comparing the ratings for m.1-2 and m.7-2, that context or perhaps temporal orientation play a role in perceived tension. The chords, although identical in composition and function (as decorations of I), are honestly significantly different in their perceived tension. The importance of context is equally well demonstrated when comparing the honestly higher ratings of I$\hat{1}$ as found at m5-2 (where it functions as a passing chord between two V chords) and the same chord found at m.8-3 (where it functions as the goal of the perfect cadence).

Tension ratings change at stopping points as a function of context, function, chord composition, and rhythm. In the tension perceived by our experienced listeners, we find some support for Lerdahl's theory of surface dissonance and perhaps inherited tension in the guise of context.

The mean tension values obtained for each level indicate that only level *g* correlated with the aria (Level *a*: $r\ (5) = 0.62$, *ns*; Level *d*: $r\ (13) = 0.44$, ns; Level *g*: $r\ (28) = 0.61, p<.001$), demonstrating that only at the *g* level was tension experienced similarly to that of the *Aria*. However, a problem with this interpretation arises from the increasing degrees of freedom, and therefore power, with increasing levels of structure. Therefore, the correlation results (levels to Aria) were recalculated using only the 6 stopping points common to all levels (Level *a*: $r\ (4) = .62$, *ns*; Level *d*: $r\ (4) = .95, p<.01$; Level *g* $r\ (4) = .84, p<.05$). Interestingly, middleground levels *d* and *g* correlated more strongly with the *Aria* than did the background level *a*, suggesting that the added detail changed perception even at the points represented in the background. This can be seen as a confirmation of Schenker's theory, based on the organic nature of music, in which the foreground *unfolds* from the background.

While it is not surprising that the minimal information at level *a* does not allow for a significant correlation with the tension experienced at the surface at these 6 stopping points, it is curious that a stronger correlation is found at level *d* than at level *g*. The following chart (Table 1, pg.58) displays the chords at each level and stopping point. (Chords in common across levels are displayed in *italicized* type while chords common with the *Aria* are in **boldface** type.)

Stopping Point	Level *a*	Level *d*	Level g	*Aria*
m.4-4	$\mathrm{V^F}$	V^C	V^C	$\mathrm{V^A}$
m.6-4	V^7	V^7	$\mathbf{V^6}$	$\mathbf{V^6}$
m.7-4	I	vi	$\mathbf{IV^6}$	$\mathbf{IV^6}$
m.8-1	$\mathbf{ii^6}$	$\mathbf{ii^6}$	$\mathbf{ii^6}$	$\mathbf{ii^6}$
m.8-2	V^C	V^C	V^C	$\mathrm{V^A}$
m.8-3	$\mathbf{I^{Bb}}$	$\mathbf{I^{Bb}}$	$\mathbf{I^{Bb}}$	$\mathbf{I^{Bb}}$

Table 1: Chords at 6 common stopping points

We can see that other than m.7-4, all levels infer the same general chords with level *g* having 4 out of 6 chords in common with the *Aria* and level *d* having only 2 in common with the *Aria*. One explanation might be the found in the experimental design. Levels *a* and *d* were rated in the same session while *g* and *Aria* were in two different, separate sessions. Subjects may have rated the tension experienced in *d* higher when compared to that experienced immediately prior in *a*. Level *g* was run after a rest of several days at which time the comparison to the previous session may not have been a factor, resulting in a more accurate rating of tension.

The mean ratings of tension, as perceived by our experienced listeners, appear to support some aspects of the theories of Schenker and Lerdahl. From the data, it may seem reasonable to say that level *a* is the background to the *Aria* and that the *Aria* unfolds about the structure of the background as Schenker indicates through his working of levels *d* and *g*. We can see how, as Lerdahl prescribed, that the surface detail of melody note and chord position can affect the perception of tension.

EXPERIMENT 2: PHRASE STRUCTURE

In this experiment, listeners made judgments concerning phrase structure at each stopping point in all Schenker's levels in order to discern how the addition of auditory cues through these levels changes the perception of phrase structure.

o METHOD

Listeners were instructed to make judgments of the perception of the opening and closing of music phrases at each stopping point. They were presented with a screen (see Appendix XI, pg.82), which reminded the listener of the required judgment, prompted the listener when to listen and when to make the judgment, and allowed the listener to replay the selection. The ratings were made on a seven-point scale, with "7" representing a strong sense of phrase opening, and "1" a strong sense of phrase closing. After each time point, the listeners provided a rating by clicking a mouse on the corresponding rating.

o RESULTS AND DISCUSSION

Intersubject correlations (Level *a*: $r\,(5) = 0.54$, *ns*; Level *d*: $r\,(13) = 0.50$, *ns*; Level *g*: $r\,(28) = 0.45, p < .02$; *Aria*: $r\,(29) = 0.47, p < .01$) demonstrate that only in level *g* and *Aria* were listeners in agreement in their ratings. These correlation values suggest that phrase structure is more difficult to identify with little information than is the experience of tension.

A one-factor repeated measures ANOVA shows that significant differences in phrase structure were found across stopping points for all levels; that is, listeners experienced areas of phrase opening and phrase closure at all levels—(Level *a*: $F(6,69) = 12.80, p < .0001$; Level *d*: $F(14,149) = 9.02, p < .0001$; Level *g*: $F(29,299) = 8.61, p < .0001$; *Aria*: $F(29,299) = 12.51, p < .0001$; m.8-3 was excluded from this test as all subjects gave the same rating for this final cadence.).

The mean phrase value correlations between each level and the aria were Level *a*: $r\ (5) = 0.40$, *ns*; Level *d*: $r\ (13) = 0.51$, *ns*; Level *g*: $r\ (28) = 0.62, p<.001$. This increase in correlation with structural level demonstrates that listeners appear to have a clearer sense of phrase structure as more information is given. This result is not surprising when one looks closely at the scores for the various levels. One would expect a sure sense of phrase closure at m.8-3 of level *a* from the harmonic progressions. Surely Schenker's notation of level *a* is that of one long descending, closing phrase. Schenker's graph of level *d* suggests a sense of phrase opening to m.4-1, a slight sense of closure between mm.4-2 and 4-4, a sense of opening to m.6-4 and phrase closure to the end. Indeed, the graphs of tension and phrase across each level (see Appendix XII, pg.83-84) appear to support these inferences from Schenker's graphs. Furthermore, as phrase structure correlated strongly and significantly with tension at all levels (Level *a*: $r\ (5) = .897, p<.02$; Level *d*: $r\ (13) = .838, p<.0005$; Level *g*: $r\ (28) = .90, p<.0005$; *Aria*: $r\ (29) = .849, p<.0005$) we may conclude that Schenker's graphs notate a listener's experience of tension as well.

The correlation results (levels to Aria) obtained using only the 6 stopping points common to all levels (Level *a*: $r\ (4) =.47$, *ns*; Level *d*: $r\ (4) =.76$, *ns*; Level *g* $r\ (4) = .63$, *ns*) reveal no significant correlation with the sense of phrase structure found in the *Aria*. Given that even level g is not significant with only 6 stopping points it would appear that the surface detail is necessary for some sense of phrase structure in the *Aria*. This is not really surprising, as Schenker is not concerned with phrase structure per se but in notating the unfolding of the surface material from the background and through the middleground and not simply removing extraneous surface material while at the same time maintaining the integrity of the phrase structure.

EXPERIMENT 3: PROBE TONE

The purpose of this experiment was to ascertain the listener's perception of pitch space at each stopping point in all Schenker's levels in order to discern how the addition of auditory cues through these levels changes the perception of pitch space. I expect this experiment to address several questions, the first of which concerns the amount of information required before the listener has a secure sense of pitch space. The subsequent question necessarily asks how the addition of information, as the experiment proceeds through the levels, changes the perception of pitch space.

The probe tone method as described by Krumhansl and Shepard (1979) was adopted in order to answer these questions. Following this method, listeners are presented with one of each of the twelve tones of the chromatic scale (equal-tempered tuning) after first listening to a music excerpt.

- **METHOD**

The listeners were presented with a music excerpt followed by a 2 s silence and a 1 s probe tone, after which time they were prompted by a message on the screen (see Appendix XIV, pg.91). The probe tones consist of a 5-note unison chord that spanned the range of the *Aria* (e.g. B^b2, B^b3, B^b4, B^b5, B^b6) for the purpose of presenting the listener with a specific pitch chroma without an unambiguous pitch height (See Appendix XV, pg.90). The listeners were ask to rate the "fit" of the probe tone on a rating scale where "1" was very well and "7", very poorly. The probe tones were presented in a random order and thus were different for each block of trials and each participant.

- **RESULTS AND DISCUSSION**

The probe tone results correlated extremely strongly with the Krumhansl probe tone profile (Level *a*: $r(10) = .88, p<.0002$; Level *d*: $r(10) = .94, p<.0001$; Level *g*: $r(10) = .94, p<.0001$; *Aria*: $r(10) = .94, p<.0001$) across all levels. This suggests that at all levels listeners had a secure sense of B^b major pitch space.

A two-factor repeated measures ANOVA was performed on each level to determine the variance in probe tone ratings that could be attributed to differences in probe tone ratings at different stopping points. The two factors were the probe tone (12 levels) and stopping point (7 -level *a*, 15 -level *d*, 30 -level *g* or 31 - *Aria*).

The results indicate that there was no interaction between stopping point and probe tone suggesting that the perceived key did not change across the level (Level *a*: $F(66,839) = 0.76$, *ns*; Level *d* $F(154,1799) = 1.12$, *ns*; Level *g* $F(319,3599) = 0.95$, *ns*; *Aria* $F(330,3719) = 0.83$, *ns*). While this result is different from that found by Smith and Cuddy, it is not surprising as their excerpt, from Beethoven's *Waldstein* sonata, was highly modulatory while the Handel *Aria* is strongly diatonic with no modulation or tonicization.

The main effect of probe tone was significant at each level (Level *a*: $F(11,839) = 25.86, p < .0001$; $F(14,1799) = 7.33, p < .0001$; $F(29,3599) = 4.51, p < .0001$; *Aria*: $F(11,3719) = 284.67, p < .0001$) demonstrating that, some pitches are identified as more stable than are others. The details of which pitches are rated more highly is discussed later in this section.

At each level, the main effect of stopping point was also significant (Level *a*: $F(6,839) = 6.05, p < .0001$; Level *d*: $F(11,1799) = 112.43, p < .0001$; Level *g*: $F(11,3599) = 303.58, p < .0001$; *Aria*: $F(30,3719) = 3.96, p < .0001$) indicating that all probe tone fit the context better at some stopping points than at others. However, the lack of interaction detailed above suggests that listeners did not experience a sense of modulation.

The mean probe tone values obtained for each level, correlated with those of the aria (Level *a*: $r\ (5) = 0.74, p<.0571$, *ns*; Level *d*: $r\ (13) = 0.87, p<.0005$; Level *g*: $r\ (28) = 0.93, p<.0005$), except for level *a*, demonstrating that even though the listeners are presented with minimal information when compared to the *Aria*, they are able to discern pitch space to a significantly high degree. Even at level *a*, the correlation approaches the conventional level of statistical significance of .05. One wonders, when confronted with the small sample size, what factors are either strengthening the correlation towards that which is significant or weakening it below the level of significance. A clearer picture emerges when the data is subjected to a Tukey HSD (Honestly Significant Difference) test where the ratings for each pair of probe tones are compared. In the tables below (Tables 2-6,pgs. 61-62) probe tones identified as being rated not honestly significantly different are given the same letter rating. The column identified as *Level* refers to the probe tone pitch. The next columns (ranging from A→F) indicate which pitches are considered honestly significantly different by the listeners. The third column, *Least Sq Mean*, is the mean rating calculated from the experimental data.

LSMeans Differences Tukey HSD

Alpha= 0.050 Q= 3.27731

Level						Least Sq Mean
Bb	A					6.0389610
F		B				5.1688312
Eb		B	C			4.3636364
C			C	D		3.9350649
B			C	D	E	3.6363636
D				D	E	3.4155844
G				D	E	3.4155844
Db				D	E	3.3896104
Gb				D	E	3.3376623
E				D	E	3.3116883
A				D	E	3.1948052
Ab					E	3.0389610

Table 2: Level *a*

The B^b probe tone is the only probe tone given an A rating and is thus considered honestly significantly different from all the other pitches. The F and E^b share a B rating while the E^b shares a C rating with the supertonic (C). This data demonstrates the relative strength of the tonic (B^b) and dominant (F) and, to a lesser degree, the subdominant (E^b) and the supertonic (C). These pitches are followed by a mixture of diatonic and chromatic notes. We can conclude from the table that, with the minimal information presented in level *a*, subjects are able to discern key accurately. What might be of surprise to Schenker, with his belief in the 'chord of Nature'—the triad—and in comparison to the Krumhansl probe tone profile, is the rating of the E^b before the D in level *a*.

The question that comes to mind, then, concerns the purpose of the surface material. What, other than adding a significant factor of interest, does the surface material contribute to the sense of pitch space? Certainly, phrase structure is more readily perceived with more information as is the sense of tension and relaxation. Comparison of Tukey HSD for each level shows an interesting trend. It appears that the addition of more material produces a firmer sense of chord and key and allows the listener to distinguish more clearly among important diatonic notes lesser diatonic notes and chromatic notes exemplifying the power and egotism of Schenker's intervals and tones.

LSMeans Differences Tukey HSD

Alpha= 0.050 Q= 3.27731

Level						Least Sq Mean
Bb	A					6.0389610
F		B				5.1688312
Eb		B	C			4.3636364
C			C	D		3.9350649
B			C	D	E	3.6363636
D				D	E	3.4155844
G				D	E	3.4155844
Db				D	E	3.3896104
Gb				D	E	3.3376623
E				D	E	3.3116883
A				D	E	3.1948052
Ab					E	3.0389610

Table 3: Level *a*

LSMeans Differences Tukey HSD

Alpha= 0.050 Q= 3.27235

Level							Least Sq Mean
Bb	A						6.4363295
F		B					5.1939052
Eb		B					4.7514810
C			C				4.2302689
D				D			3.7151174
G				D	E		3.5817840
A					E	F	3.1939052
B					E	F	3.1155272
Ab					E	F	3.1029961
Db						F	3.0060265
Gb						F	2.8302689
E						F	2.7939052

Table4: Level *d*

LSMeans Differences Tukey HSD

Alpha= 0.050 Q= 3.27018

Level								Least Sq Mean
Bb	A							6.5818182
F		B						5.5696970
Eb			C					5.0212121
C				D				4.5363636
D					E			3.6909091
G					E	F		3.6090909
A						F		3.2909091
Ab							G	2.7666667
Gb							G	2.6696970
Db							G	2.6666667
B							G	2.6636364
E							G	2.5787879

Table5: Level *g*

LSMeans Differences Tukey HSD

Alpha= 0.050 Q= 3.27011

Level							Least Sq Mean
Bb	A						6.4046921
F		B					5.5425220
Eb			C				4.7302053
C			C				4.4134897
D				D			3.4662757
G				D	E		3.1876833
A					E		3.0351906
Gb						F	2.5278592
E						F	2.5278592
B						F	2.5249267
Db						F	2.5249267
Ab						F	2.4838710

Table 6: *Aria*

It is evident from this comparison that the tonic is rated significantly different at all levels in comparison to the other pitches. The dominant and the subdominant, along with the chromatic notes, are differentiated above level *d*. The overlap of some diatonic and chromatic notes found in levels *a* and *d* is clearly separated by level *g* and *Aria*. Surprisingly, C (supertonic) approaches the level of E^b (subdominant) with more context. This may be explained by the pitch count of C moving from that of 4.36 in level *a* to 13.375 *Aria* but as Table 7 (pg.63) demonstrates, a high pitch count is not necessarily reflected in a high mean rating.

	Level *a*		Level *d*		Level *g*		*Aria*	
PITCH	MEAN	COUNT	MEAN	COUNT	MEAN	COUNT	MEAN	COUNT
Bb	6.04	**17**	6.04	18	6.58	**8.5**	6.41	18
F	5.17	**22**	5.17	12	5.57	9	5.54	19
Eb	4.36	5	4.36	7	5.02	6	4.73	**8.5**
C	3.94	2	3.94	**8**	4.54	8	4.41	**13.375**
D	3.42	4	3.42	**15**	3.69	**8.5**	3.47	15
G	3.42	0	3.42	2	3.61	2.5	3.19	4.4
A	3.19	0	3.19	0	3.29	2.5	3.04	9.1

Table 7: Mean Probe tone rating and pitch count

We also find that D (mediant) and G (submediant) are not rated as highly significantly different at any level. The graphs (Figures 11-14, pg.63-64) of these results also show this ability to separate pitches hierarchically.

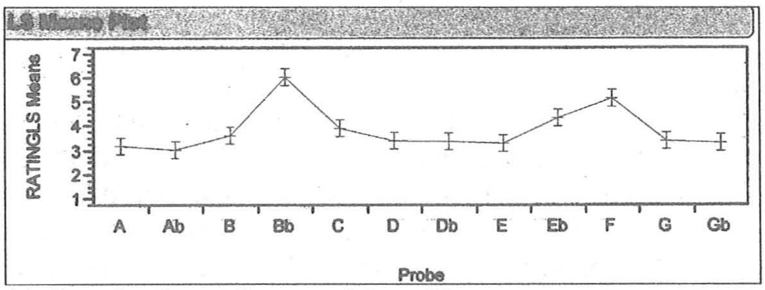


Figure 11: Level *a* Least Squares Mean Plot

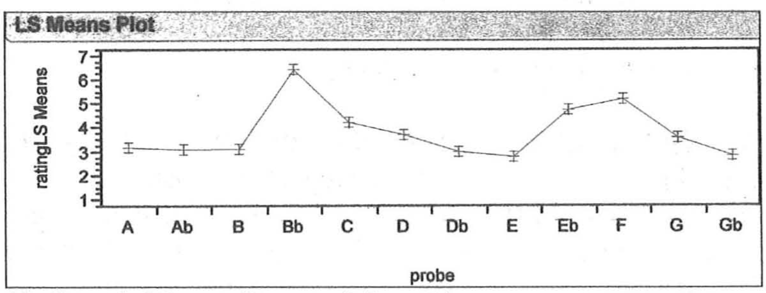


Figure 12: Level *d* Least Squares Mean Plot

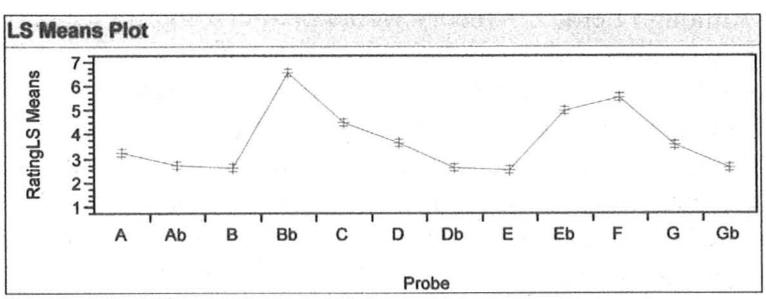


Figure 13: Level *g* Least Squares Mean Plot

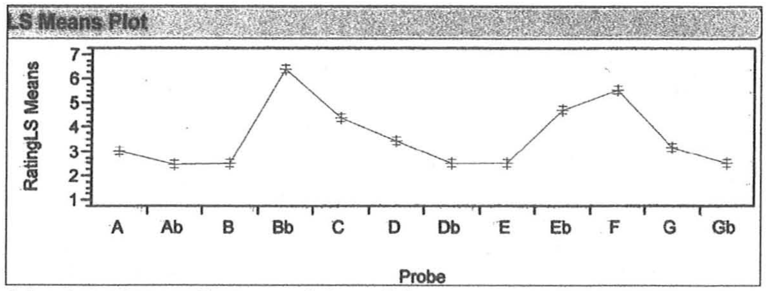


Figure 14: *Aria* Least Squares Mean Plot

This interpretation is further supported by the intersubject correlations (Level *a*: *r* (5) = 0.28, *ns*; Level *d*: *r* (13) = 0.45, *ns*; Level *g*: *r* (28) = 0.52, $p<.01$; *Aria*: *r* (29) = .51, $p<.01$) which show good agreement between listener's ratings at level *g* and *Aria* but not so with the minimal information found at levels *a* and *d*. These results are consistent with the suggestion that listeners can consistently agree on the diatonically more important notes – such as tonic, dominant and subdominant with minimal information. At the background level, more uncertainty appears about remaining notes that take on more differentiation as the surface is approached.

In summary, results from 11 experienced musicians rating levels of tension/relaxation, phrase open/phrase close and probe tones at stopping points in a Handle *Aria* and 3 Schenkerian levels suggest that in a short, strongly diatonic piece listeners were able to provide similar ratings across various levels of information. The sense of phrase structure requires more information than tension. The sense of pitch space, as exemplified by the significantly different ratings of the tonic and dominant, seems to require minimal information, although the listeners do require more information in order to arrange the remaining diatonic and chromatic notes hierarchically.

AN APPLICATION OF TONAL PITCH SPACE THEORY

Recall that the above one-factor repeated measures ANOVA (*Aria*: $F(29,299) = 8.27$, $p < .0001$) shows that significant differences in tension were found across stopping points in *Aria*. Appendix VII (pg.75) shows the table of calculations for surface dissonance, pitch-space distance, local total, inherited value, and global total for *Aria* following Lerdahl's directions in *Tonal Pitch Space*. Although Lerdahl's theory would predict a significant correlation between the observed values and the global calculations of tension (see Appendix XVI, pg.91 and XVII, pg.92), this was not the case in our experiment (Global *r* (29) = 0.35, *ns*; Local *r* (29) = 0.55, $p<.01$; Inherited *r* (29) = 0.14, *ns*). It is the local tension values that show good agreement with mean of the observed values. Squaring the correlation value shows that Local accounts for 29% of the variance and inherited 2%, for a total of 31%. Thus, the observed values are predicted well by the local tension with some influence of inherited tension, but not by the global tension. The contribution of local tension, correlates significantly with inherited tension($r(29) = .454$, $p<.01$), overlapping by 21%. This finding indicates that both contribute to the overall sense of tension in some related manner. It does not seem likely that the simple equally weighted relationship suggested by Lerdahl for the calculation of global tension values capture how listeners perceive tension.

Multiple regression analysis reveals an unequal weighting in the proportions of:

Predicted Perceived Tension = (local x 0.201) + (inherit x -0.007) + 4.14.

Use of this formula results in a correlation ($r(29) = .55, p<.01$) between observed and predicted values which is no different than the correlation between Lerdahl's local and observed. The coefficients suggest that, for the *Aria*, the inherited value is near zero indicating its lack of effect on perceived tension.

The *Aria* is strongly diatonic and, as the chart in Appendix XVIII (pg.93) shows, the inherited value for over half of the stopping points (20 out of 31) is zero. This may explain the general lack of impact of the inherited value for this example. Lerdahl's model, if correct, should be able to account this occurrence. One other interpretation is that experienced listeners hear only locally and not globally as suggested by Lerdahl.

CONCLUSIONS

Schenker and Lerdahl move beyond the local approach of a side-by-side chordal analysis of music to a global perspective in order to discern what experienced listeners perceive in Western tonal music. Both recognize the hierarchical relationships that exist in tonal music and seek a means to articulate this concept. Schenker chose a graphic notation that resulted from years of work as a composer, pianist, teacher, and analyst to convey his belief in the power and ego of the tones and intervals from which music is composed. Lerdahl builds upon Schenker's theories and incorporates elements of linguistic analysis so as to arrive at a theory that can be tested empirically.

The results of these three experiments demonstrate that elements of both theories have a basis in the perception of listeners experienced in Western tonal music. The data demonstrates the sparse auditory information of the background results in statistically similar perceptions of pitch space and tension across our population. The probe tone data suggests that a rudimentary understanding of the pitch space is perceivable from the background structure alone. The hierarchical arrangement of pitches in pitch space becomes more clearly delineated as listeners are presented with more information. This goes some way to support Schenker's assertion regarding the presence of a background structure from which the piece itself is 'composed out'. It further suggests some validity in the theory of prolongation and its attendant structurally significant chords, whose consequence is the hierarchical tension espoused by Lerdahl. The present data does not unequivocally demonstrate Schenker's belief that "While the power of the imagination retains this *Ursatz*, all sorts of melodic unfoldings, diminutions, motives, and the like appear."[116] It does suggest, however, that the "power of the imagination" does perceive the sense of pitch space as exemplified by the *Ursatz.*

Lerdahl's hypothesis in which local and inherited tension values receive equal weighting can account for a minimal amount of variance between the observed tension and the calculated global tension, as it models Handel's *Aria.* The inherited tension appears to have a negligible effect on the listener's perception of tension. Lerdahl's model should be able to account for the many inherited values of zero in the harmonically uncomplicated *Aria.* Since the local tension was able to explain only 30% of the variation in tension ratings other aspects must be involved. *Tonal Pitch Space* theory is an intriguing concept that begs further perceptual investigation.

[116]*(William Renwick (trans.) "Brahms's Variations and Fugue on a Theme by Handel, Op.24" in Der Tonwille Pamphlets/Quarterly Publication in Witness of the Immutable Laws of Music Volume II by Heinrich Schenker, ed. William Drabkin. (Oxford, New York: Oxford University Press, 2005), 77.*

CHAPTER 4: REMARKS

Analysis of data obtained from experiments requiring experienced subjects to rate levels of perceived tension, phrase structure, and pitch space through the use Krumhansl's probe tone method reveals some new information regarding the perception of pitch space and of global tension. The results obtained from experimentation on Handel's *Aria* demonstrate that perceived tension is a function of both local and inherited tension but not equally weighted as per Lerdahl's dictum. While Lerdahl's model does predict that perceived tension includes both local and inherited tension in some relationship, it seems that revision is required in order to arrive at the correct proportions of their influence. Lerdahl does not differentiate among diatonic, chromatic and modulating music; his theory treats them all in the same manner. He does addresses this issue with non-chord tones at the level of surface dissonance and with the *i* values of pitch space distance but one model may not be able to predict global tension across all styles of tonal music. It appears that the arbitrary values Lerdahl chose for surface dissonance may require re-evaluation, as does the manner in which the inherited value is calculated. Perhaps, rather than taking the whole inherited value without regard for the number of superordinate branches, the inherited value may need to be graduated dependent upon the distance from the subordinate branch. In this manner, I postulate that the gradation would retain the highest inherited value for the most superordinate and decrease the inherited value as you approach the subordinate branch. While Lerdahl's model should predict values that correlate significantly with observed values for a harmonically uncomplicated piece, perhaps a selection with more harmonic controversy where the inherited value may have more impact would yield more significant correlations than found in Handel's *Aria*..

Although not a concern of this experiment, as the sounds were presented as computer-generated, piano-tone MIDI files, Lerdahl does not address essential elements of musical tension such as timbre and dynamics. A complete model for perceived tension should include these variables. Schenker does not concern himself with timbre either, instead relying on the voice-leading and harmony irrespective of sound colour.

While both theories consider phrase structure as a caveat for reduction, it may be superseded at any time in preference of tension and pitch space. We have seen that while listeners perceived areas of phrase opening and phrase closure at all levels, they were in agreement only at level *g* and *Aria*. Thus, it may not be necessary to test for phrase structure at levels far from the foreground in the future.

This set of experiments was extremely long, requiring three sessions totalling 7.5 hours for each subject in order to obtain data on a 24-second piece of music. The experiments, for studying pitch space, can now be streamlined so that longer pieces could be used and since it is the relationship between the background structure and the surface material that is of particular interest, testing on the middleground could be eliminated. Several approaches to further this study are the following.

The first approach builds upon the data obtained from this study. One method could be to manipulate the background and another, the *Aria*. The *Aria* is harmonically uncomplicated with its diatonic harmony and its predominance of I and V chords. It would be quite simple to "doctor" this music by applying secondary dominants and comparing these results with the "undoctored" background. According to Schenkerian theory, however, this approach is unlikely to yield any significant differences when compared to the original version. Changing the background by having it consist of a random series of chords may yield results that are more informative. As our understanding of the relationship between the background and the surface material grows, longer and more tonally challenging repertoire could be tested.

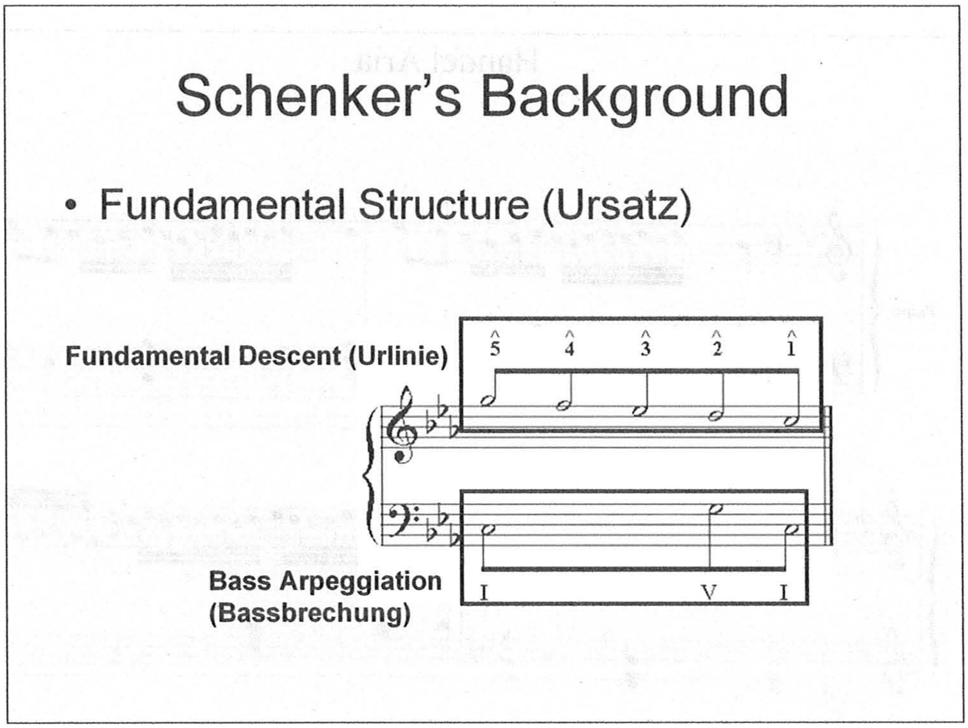
Lerdahl's tonal pitch space theory discusses the attraction value that he also relates to the perception of pitch space and of tension. It sounds very much like Zuckerkandl's dynamic forces where the meaning of the tone is not to what it points but *in the pointing itself.* This area of interest, not addressed by this study, would prove a valuable direction to pursue.

Schenker's theory encompassed many factors of which only the question of the fundamental structure was broached in this study. The issue of prolongation, in the Schenkerian tradition and tonal pitch space of Lerdahl, are of particular interest. As the Tukey HSD analysis shows, the tonic probe tone rating remains significantly different across all levels. A different approach, however, is required to address the prolongation question. The anecdotal evidence, obtained while de-briefing the subjects of my experiments, suggests that listeners found "context" a difficult concept in some ways. They report rating a probe tone highly, not always because it sounded good with what they had heard immediately prior to the probe tone, but either because it fit with what they had just heard or because it fit with what they expected to come next.

An investigation into the prolongation phenomenon would add immeasurably to our understanding of tonality and pitch-space as it would appear that Lerdahl and Schenker were correct in their reliance upon a structural background that is hierarchical in nature with some notes and chords functioning as decoration, resulting in the prolongation of the structurally significant chords. It is with this important information that much new work can be done. Smith and Cuddy calculated *temporal orientation*, which would be an invaluable tool for examining the theory of prolongation of both Schenker and Lerdahl. The hope here would be that the direction and strength of the temporal orientation at the time points could demonstrate the existence of (or lack of) a background perceived by the listener upon which the entire piece unfolds.

Schenker's theories of the structural background and prolongation and Lerdahl's tonal pitch space theory are fertile grounds for experiments in music perception and for forging a link between music analysis and music perception.

APPENDIX I: Fundamental Structure[117]



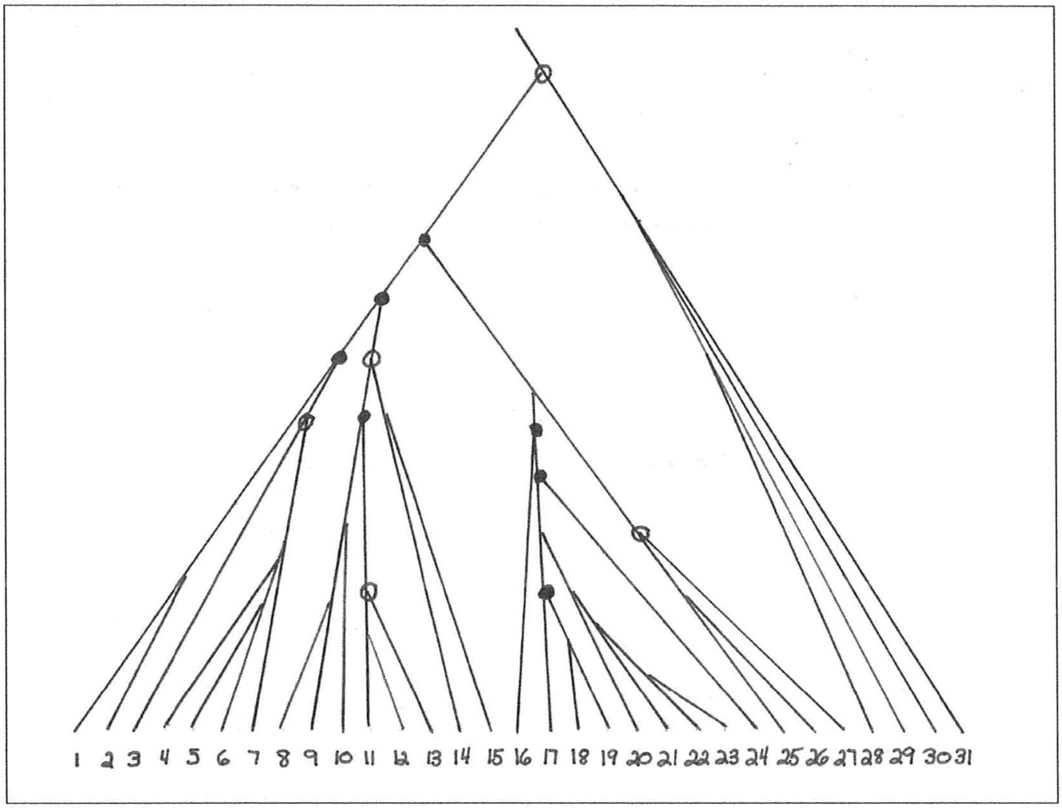
[117] Tom Pankhurst, "Schenker Guide" http://www.schenkerguide.com/, March 14, 2005.

APPENDIX II: Grouping Structure

APPENDIX III: Metrical Structure

APPENDIX IV: Time-span Reduction

APPENDIX V: Prolongational Tree



APPENDIX VI: *Aria* with Stopping Points Numbered

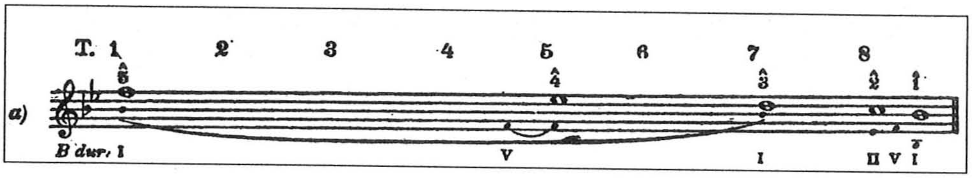
APPENDIX VII: *Aria* Hierarchical Tension

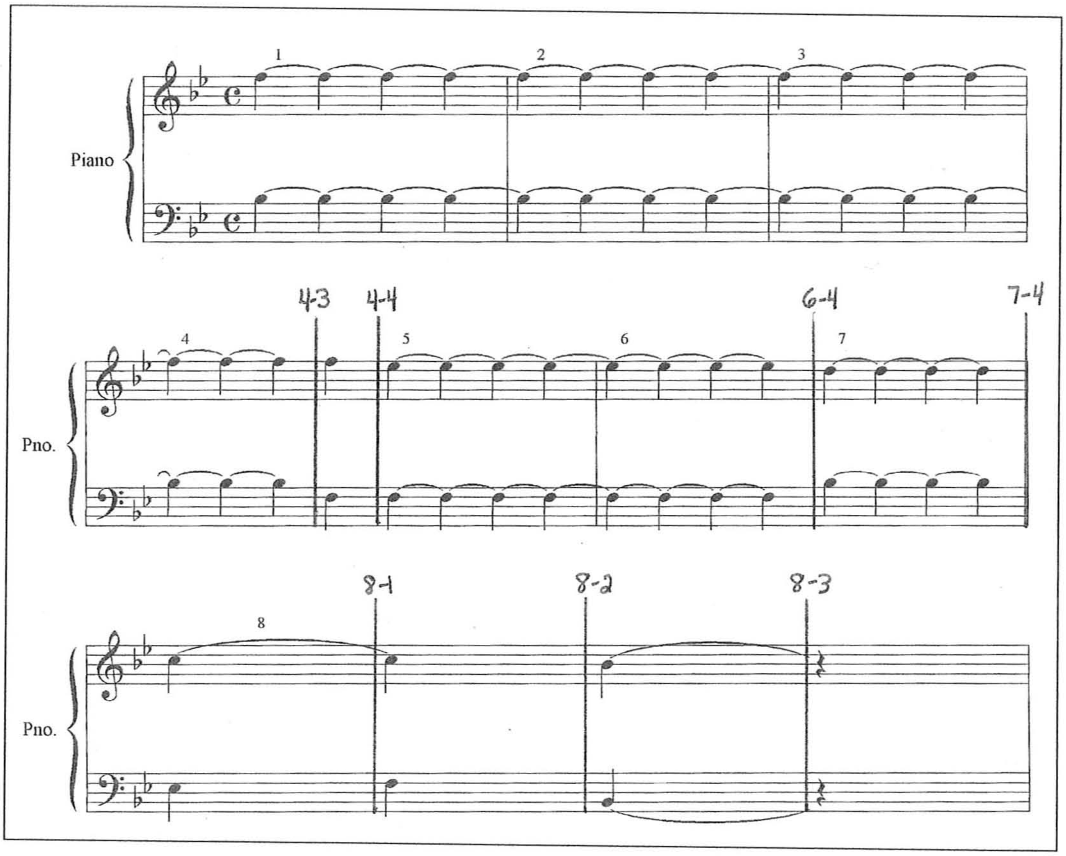
	Surface Dissonance			Pitch-space Distance			Local Total	Inherited Value	Global Total
Stopping Point	Scale Degree (1)	Inversion (2)	Nonharmonic Tones (3,4/7ths=1)	*i*	*j*	*k*			
31-**1**	0	0	0	0	0	0	0	0	0
31-1-3-**2**	1	2	0	0	1	4	8	0	8
31-1-**3**	0	0	3	0	0	0	3	0	3
31-1-3-7-6-**4**	0	2	0	0	2	6	10	5	15
31-1-3-7-6-**5**	1	2	0	0	1	4	8	5	13
31-1-3-7-**6**	1	0	0	0	1	4	6	0	6
31-1-3-**7**	0	0	3	0	0	0	3	0	3
31-1-9-**8**	0	0	1	0	1	4	6	0	6
31-1-**9**	1	0	0	0	0	0	1	0	1
31-1-9-**10**	1	2	0	0	5	6	14	0	14
31-1-9-**11**	0	2	3	0	0	0	5	0	5
31-1-9-**12**	0	2	1	0	5	6	14	0	14
31-1-9-**13**	1	2	0	0	0	0	3	0	3
31-1-9-**14**	0	0	3	0	0	0	3	0	3
31-1-9-**15**	1	0	0	0	1	4	6	0	6
31-1-25-17-**16**	0	0	3	0	0	0	3	5	8
31-1-25-**17**	1	0	0	0	1	4	6	0	6
31-1-25-17-19-**18**	1	0	0	0	1	4	6	5	11
31-1-25-17-**19**	0	0	3	0	0	0	3	5	8
31-1-25-17-**20**	0	22	0	0	1	4	7	5	12
31-1-25-17-20-**21**	0	2	3	0	2	6	13	5	18
31-1-25-17-20-21-**22**	0	2	3	0	2	6	13	18	31
31-1-25-17-20-21-22-**23**	0	2	3	0	5	6	16	26	42
31-1-25-17-**24**	0	2	0	0	0	0	2	5	7
31-1-**25**	1	0	0	0	0	0	1	0	1
31-1-25-**26**	1	2	0	0	1	4	8	0	8
31-1-25-**27**	0	0	3	0	0	0	3	0	3
31-30-29-**28**	0	2	0	0	3	4	9	10	19
31-30-**29**	0	2	0	0	1	4	7	5	12
31-**30**	1	0	0	0	1	4	6	0	6
31	0	0	0	0	0	0	0	0	0

APPENDIX VIII:

APPENDIX IX: Transcriptions and Stopping Points[118]

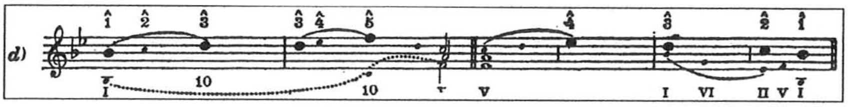
Level *a*





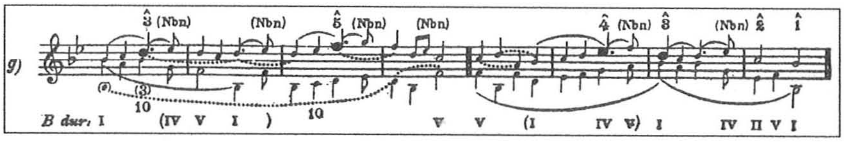
[118] The Schenker graphs (*a*, *d*, and *g*) are from William Renwick (trans.) "Brahms's Variations and Fugue on a Theme by Handel, Op.24" in *Der Tonwille Pamphlets/Quarterly Publication in Witness of the Immutable Laws of MusicVolume II by Heinrich Schenker*, ed. William Drabkin. (Oxford, New York: Oxford University Press, 2005), 77.

Level *d*


d)
10
10
V
I VI
II V I


1-2
1-4
3-2
3-4
Piano
4-1
4-2
4-4
5-2
5-4
6-4
7-2
7-4
Pno.
8-1
8-2
8-3
Pno.

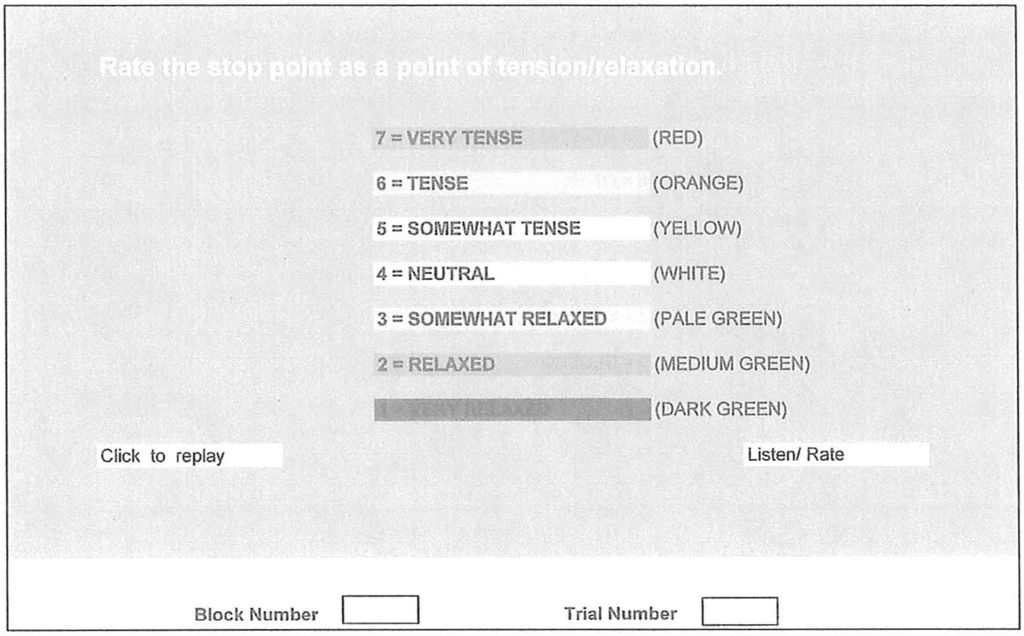
Level *g*


g)
(Nbn)
(Nbn)
(Nbn)
(Nbn)
(Nbn)
(Nbn)
10
10
B dur: I (IV V I) V V (I IV V) I IV II V I

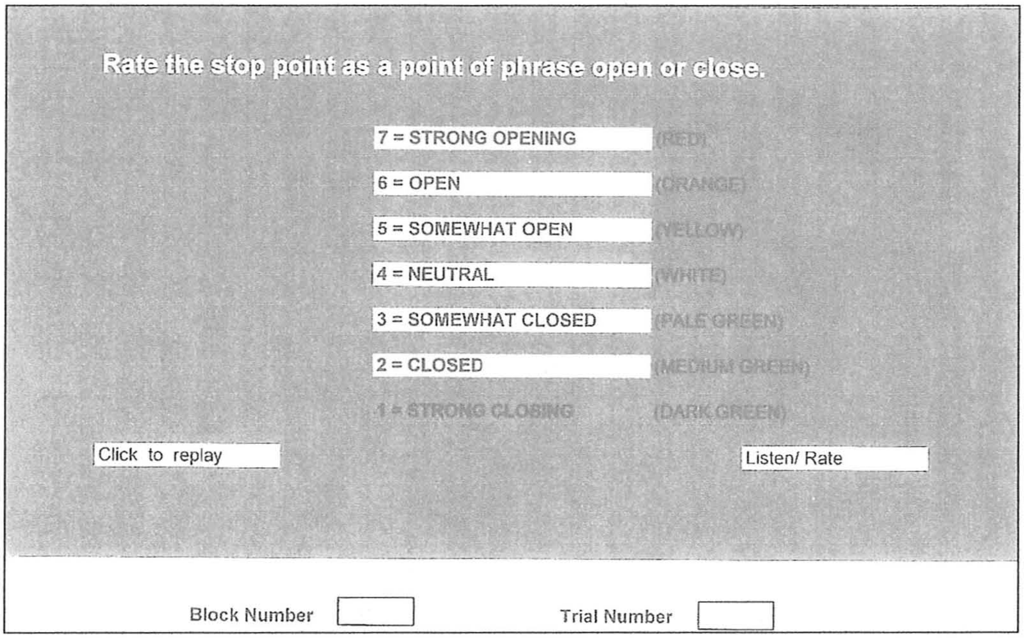

1-1 1-2 1-3 1-4 2-1 2-2 2-3 2-4 3-1 3-2 3-3 3-4
Piano
4-1 4-2 4-4 5-1 5-2 5-3 5-4 6-1 6-2 6-3 6-4 7-1 7-2 7-3 7-4
Pno.
8-1 8-2 8-3
Pno.


Handel Aria
1-1 1-2 1-3 1-4 2-1 2-2 2-3 2-4
Piano
3-1 3-2 3-3 3-4 4-1 4-2 4-3 4-4
Pno.
5-1 5-2 5-3 5-4 6-1 6-2 6-3 6-4
Pno.
7-1 7-2 7-3 7-4 8-1 8-2 8-3
Pno.

APPENDIX X: Tension Screen (Pink)

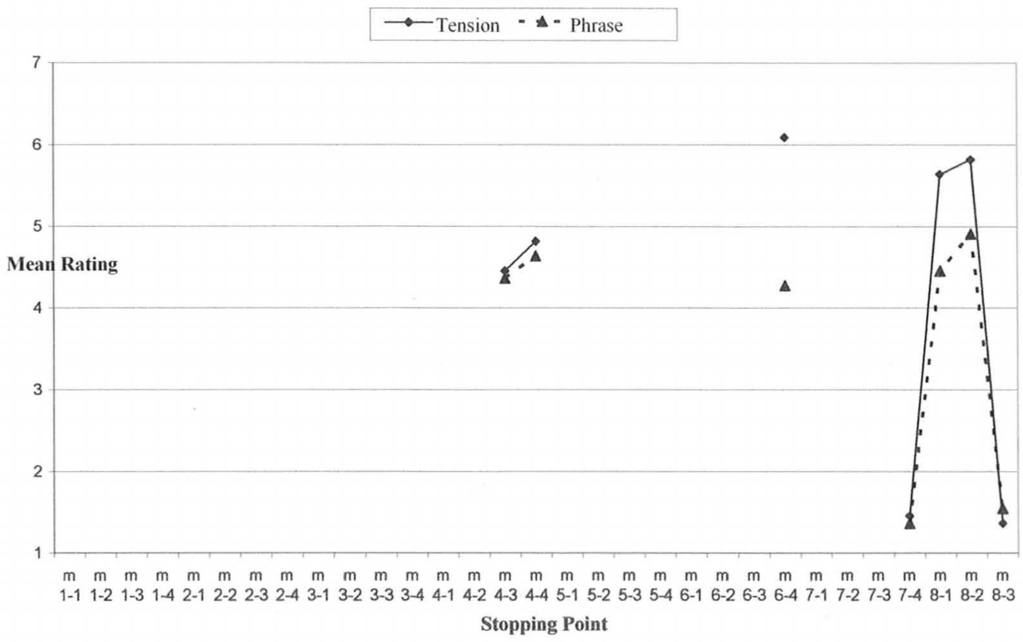


APPENDIX XI: Phrase Screen (Brown)

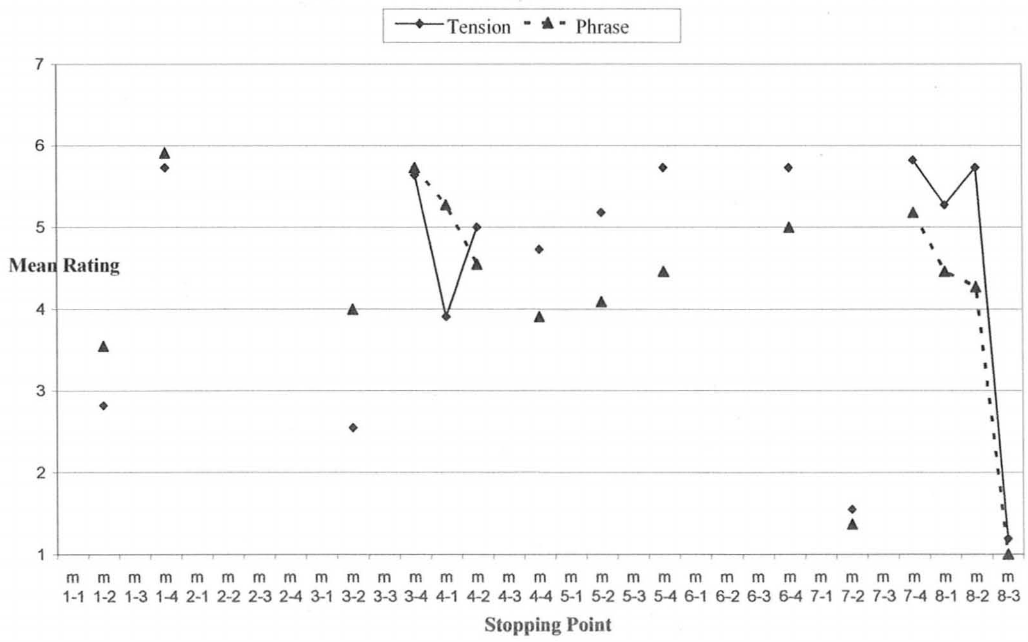


APPENDIX XII: Mean Tension and Phrase

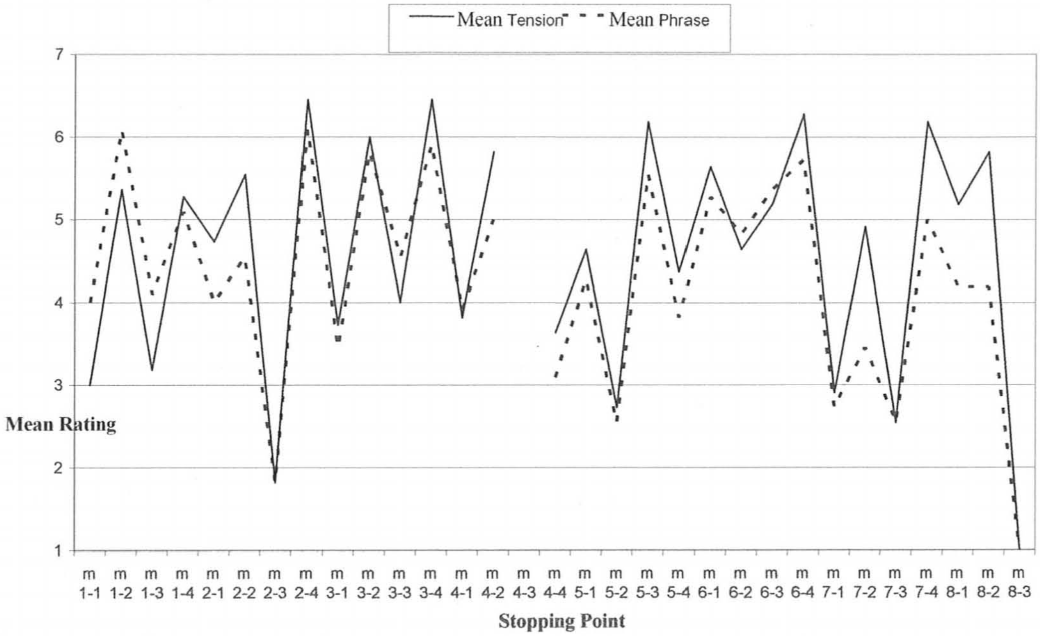
MEAN TENSION AND PHRASE - a



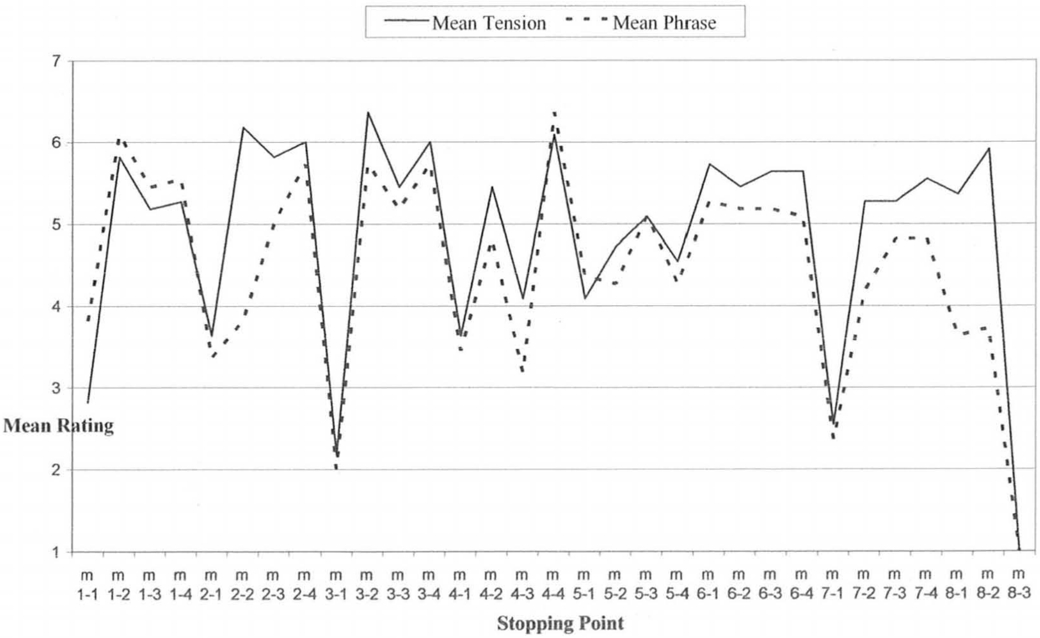
MEAN TENSION AND PHRASE - d



MEAN TENSION AND PHRASE-g



MEAN TENSION AND PHRASE-Aria



APPENDIX XIII: LS Means Plot and Tukey HSD Table

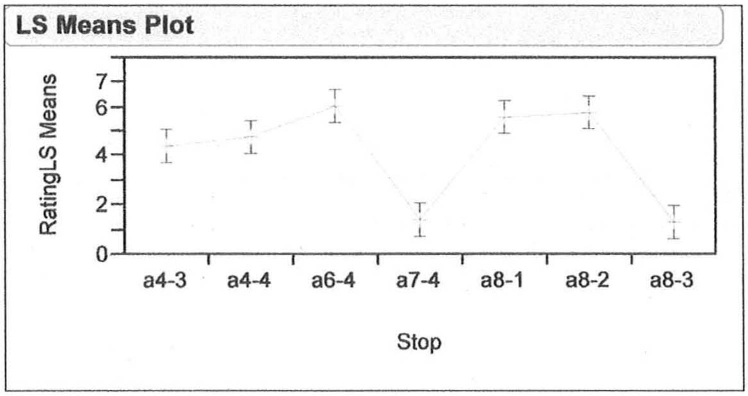
Level *a*:

LSMeans Differences Tukey HSD

Alpha= 0.050 Q= 3.03701

Level				Least Sq Mean
a6-4	A			6.0909091
a8-2	A	B		5.8181818
a8-1	A	B		5.6363636
a4-4	A	B		4.8181818
a4-3		B		4.4545455
a7-4			C	1.4545455
a8-3			C	1.3636364

Levels not connected by same letter are significantly different



Level *d*:

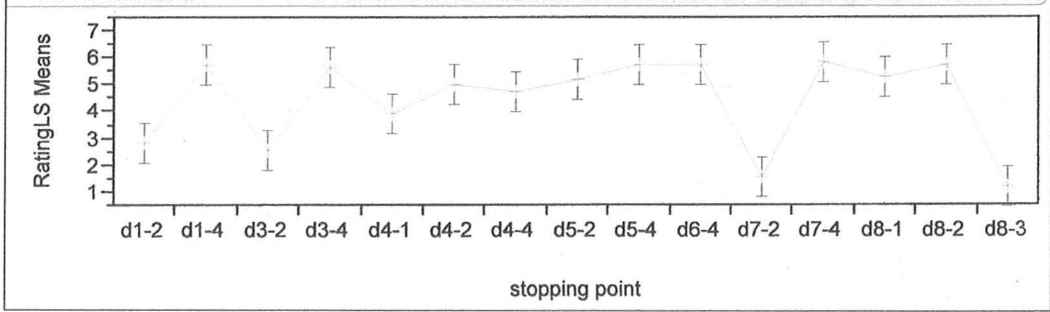
LSMeans Differences Tukey HSD

Alpha= 0.050 Q= 3.44925

Level		Least Sq Mean
d7-4	A	5.8181818
d6-4	A B	5.7272727
d8-2	A B	5.7272727
d1-4	A B	5.7272727
d5-4	A B	5.7272727
d3-4	A B	5.6363636
d8-1	A B	5.2727273
d5-2	A B	5.1818182
d4-2	A B	5.0000000
d4-4	A B	4.7272727
d4-1	B C	3.9090909
d1-2	C D	2.8181818
d3-2	C D	2.5454545
d7-2	D	1.5454545
d8-3	D	1.1818182

Levels not connected by same letter are significantly different

LS Means Plot



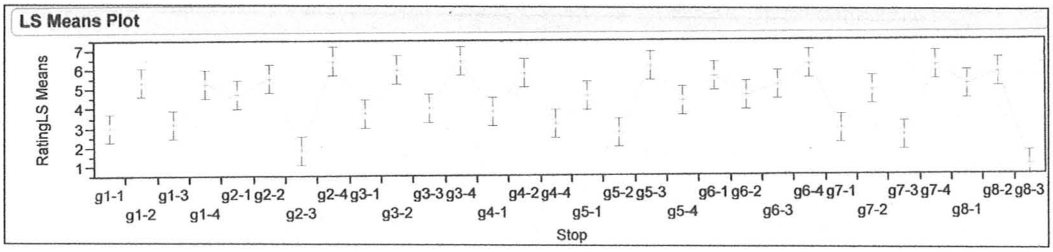
Level g:

LSMeans Differences Tukey HSD

Alpha= 0.050 Q= 3.78613

Level		Least Sq Mean
g2-4	A	6.4545455
g3-4	A	6.4545455
g6-4	A B	6.2727273
g5-3	A B	6.1818182
g7-4	A B	6.1818182
g3-2	A B	6.0000000
g4-2	A B C	5.8181818
g8-2	A B C	5.8181818
g6-1	A B C D	5.6363636
g2-2	A B C D	5.5454545
g1-2	A B C D	5.3636364
g1-4	A B C D	5.2727273
g6-3	A B C D	5.1818182
g8-1	A B C D	5.1818182
g7-2	A B C D E	4.9090909
g2-1	A B C D E F	4.7272727
g5-1	A B C D E F G	4.6363636
g6-2	A B C D E F G	4.6363636
g5-4	B C D E F G H	4.3636364
g3-3	C D E F G H	4.0000000
g4-1	D E F G H	3.8181818
g3-1	D E F G H I	3.7272727
g1-3	E F G H I	3.1818182
g4-4	E F G H I	3.1818182
g1-1	E F G H I	3.0000000
g7-1	F G H I J	2.9090909
g5-2	G H I J	2.7272727
g7-3	H I J	2.5454545
g2-3	I J	1.8181818
g8-3	J	1.0000000

Levels not connected by same letter are significantly different



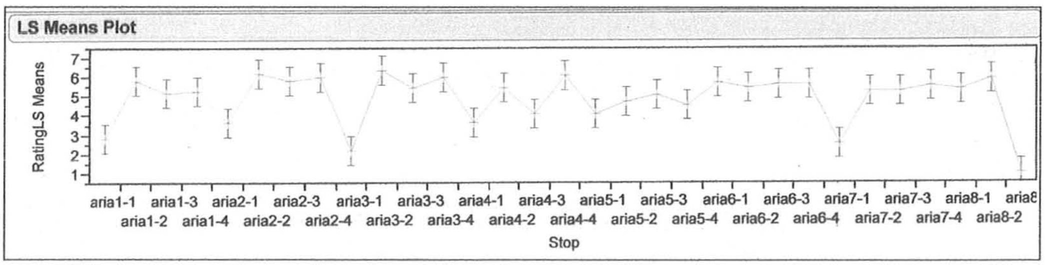
Aria:

LSMeans Differences Tukey HSD

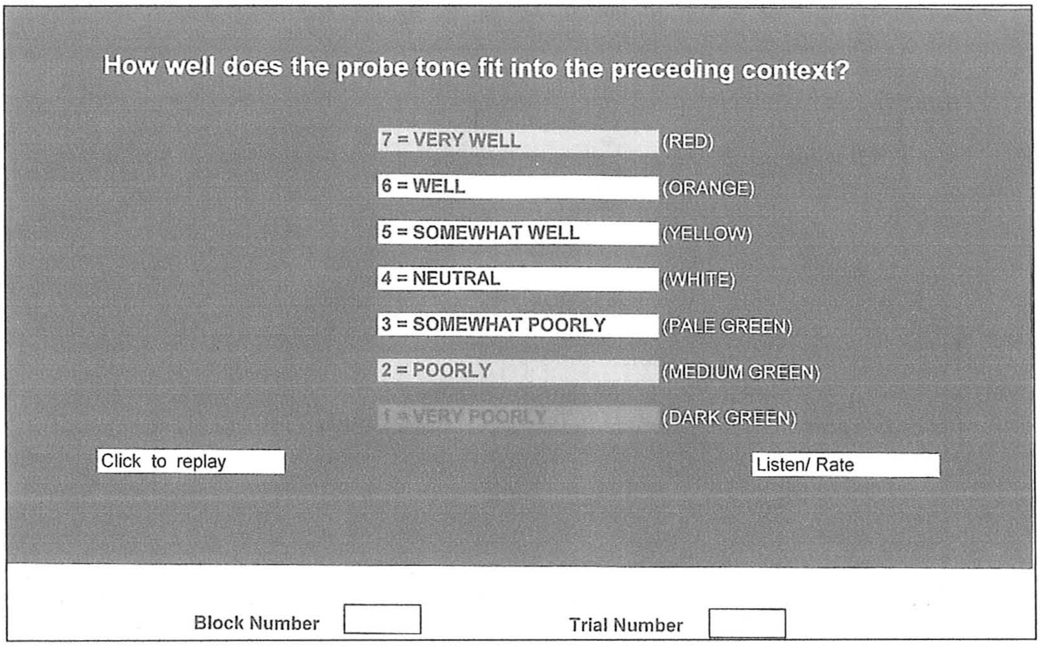
Alpha= 0.050 Q= 3.80142

Level		Least Sq Mean
aria3-2	A	6.3636364
aria2-2	A	6.1818182
aria4-4	A B	6.0909091
aria2-4	A B	6.0000000
aria3-4	A B	6.0000000
aria8-2	A B	5.9090909
aria1-2	A B	5.8181818
aria2-3	A B	5.8181818
aria6-1	A B	5.7272727
aria6-3	A B C	5.6363636
aria6-4	A B C	5.6363636
aria7-4	A B C	5.5454545
aria3-3	A B C	5.4545455
aria4-2	A B C	5.4545455
aria6-2	A B C	5.4545455
aria8-1	A B C	5.3636364
aria1-4	A B C	5.2727273
aria7-2	A B C	5.2727273
aria7-3	A B C	5.2727273
aria1-3	A B C	5.1818182
aria5-3	A B C	5.0909091
aria5-2	A B C D	4.7272727
aria5-4	A B C D E	4.5454545
aria4-3	B C D E F	4.0909091
aria5-1	B C D E F	4.0909091
aria2-1	C D E F	3.6363636
aria4-1	C D E F	3.6363636
aria1-1	D E F G	2.8181818
aria7-1	E F G	2.5454545
aria3-1	F G	2.1818182
aria8-3	G	1.0000000

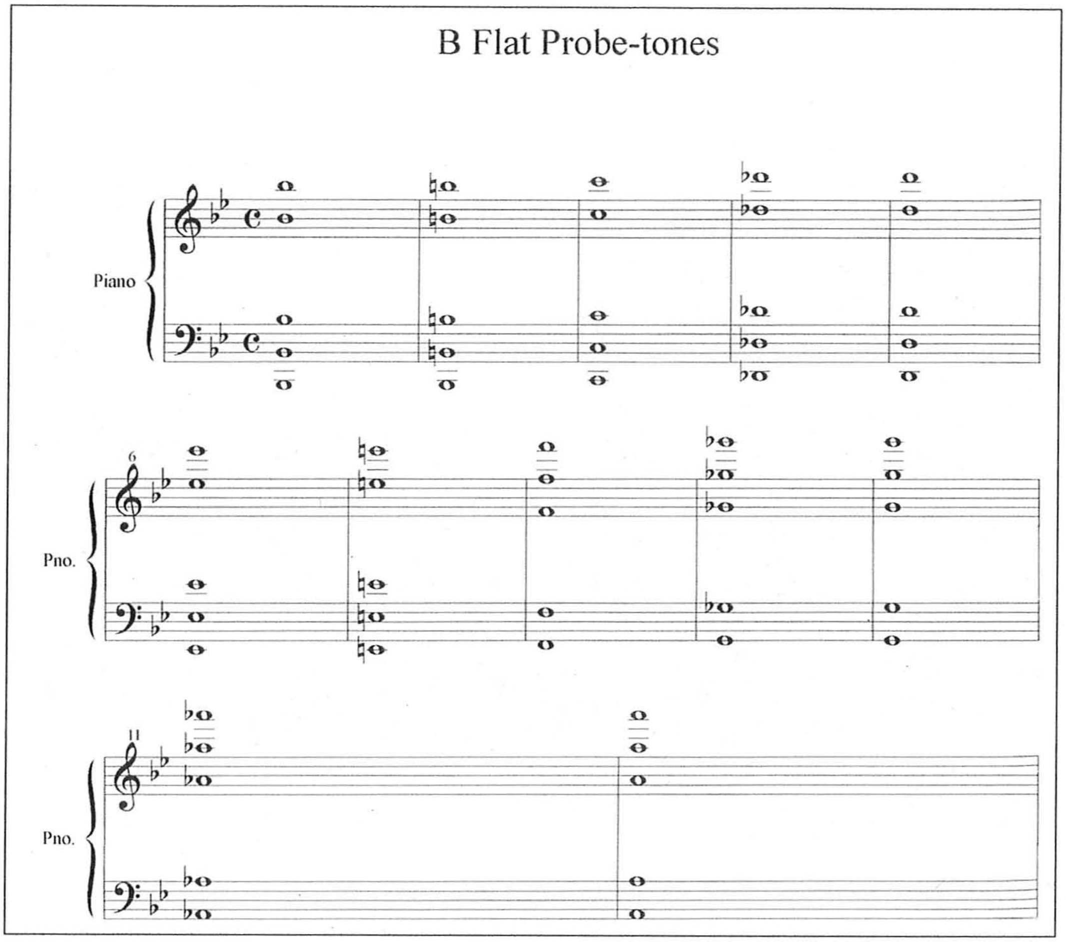
Levels not connected by same letter are significantly different



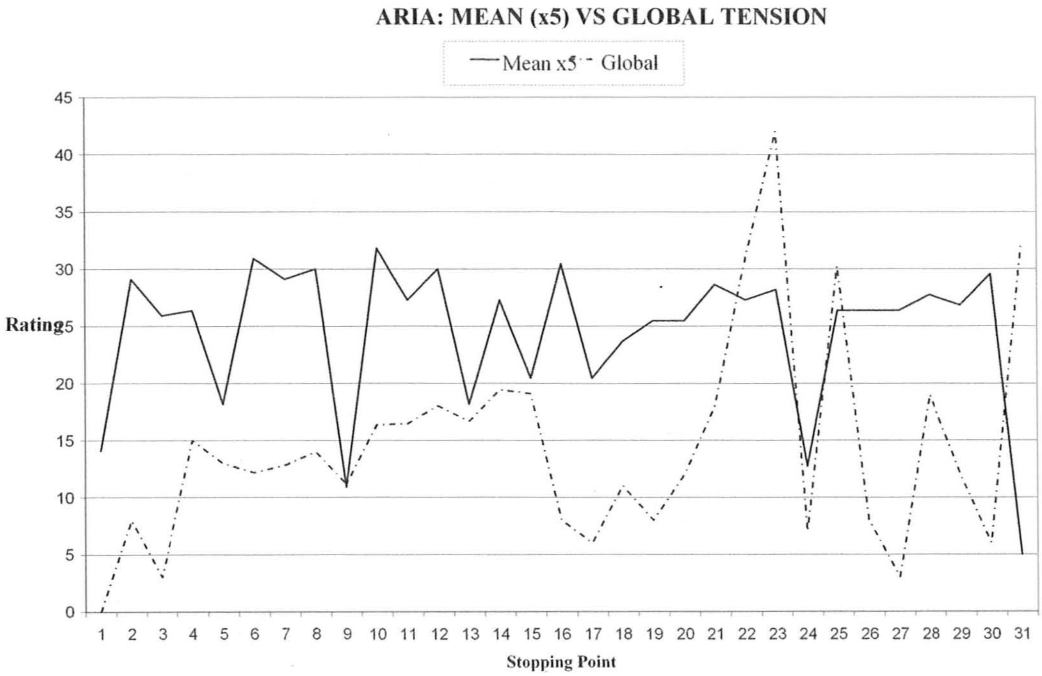
APPENDIX XIV: Probe tone Screen (Blue)



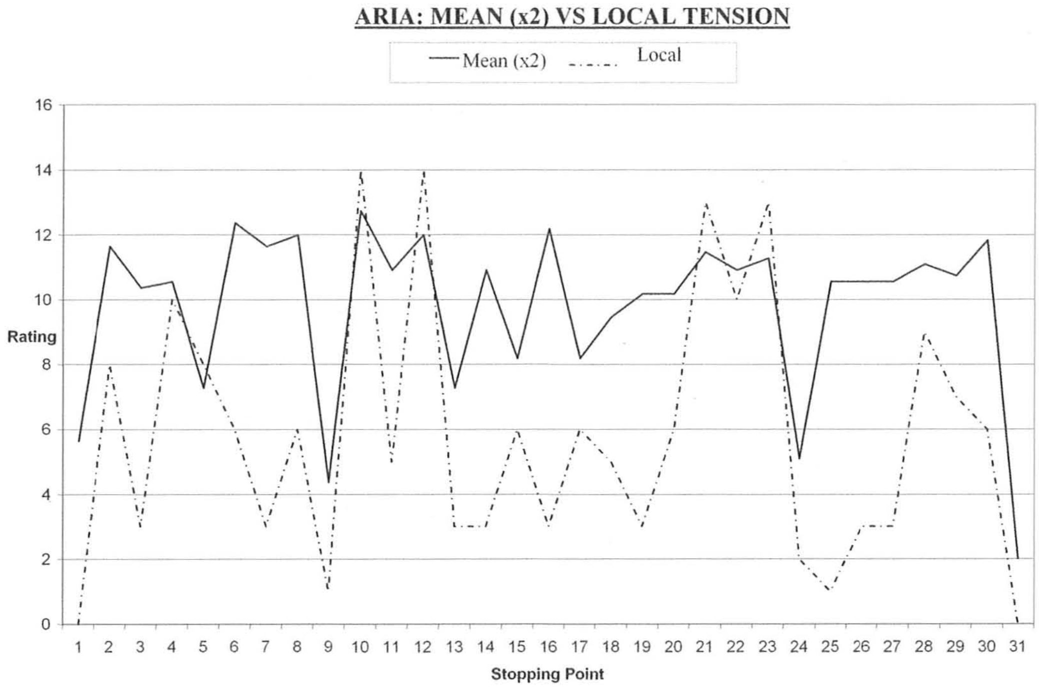
APPENDIX XV: Probe tones



APPENDIX XVI: Observed Tension (x5) Versus Lerdahl Global Tension



APPENDIX XVII: Observed Tension vs. Lerdahl's Local Tension



APPENDIX XVIII: *Aria* TENSION VALUES

Stopping Point	Global	Local	Inherited	Predicted	Observed Mean
1	0	0	0	0	2.818182
2	8	8	0	1.608	5.818182
3	3	3	0	0.603	5.181818
4	15	10	5	1.975	5.272727
5	13	8	5	1.573	3.636364
6	6	6	0	1.206	6.181818
7	3	3	0	0.603	5.818182
8	6	6	0	1.206	6
9	1	1	0	0.201	2.181818
10	14	14	0	2.814	6.363636
11	5	5	0	1.005	5.454545
12	14	14	0	2.814	6
13	3	3	0	0.603	3.636364
14	3	3	0	0.603	5.454545
15	6	6	0	1.206	4.090909
16	8	3	5	0.568	6.090909
17	6	6	0	1.206	4.090909
18	11	5	5	0.97	4.727273
19	8	3	5	0.568	5.090909
20	12	6	5	1.171	5.090909
21	18	13	5	2.578	5.727273
22	31	10	18	1.884	5.454545
23	42	13	26	2.431	5.636364
24	7	2	5	0.367	2.545455
25	1	1	0	0.201	5.272727
26	8	3	0	0.603	5.272727
27	3	3	0	0.603	5.272727
28	19	9	10	1.739	5.545455
29	12	7	5	1.372	5.363636
30	6	6	0	1.206	5.909091
31	0	0	0	0	1

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