Understanding Schenkerian Analysis from the Perspective of Music Perception and Cognition

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Abstract

This thesis investigates the perceptual and cognitive reality of Schenkerian theory through a survey of relevant empirical research. It reviews existing Schenkerian-specific empirical research, examines general tonal research applicable to Schenkerian analysis, and proposes the possibility of an optimal empirical research method by which to explore the theory. It evaluates data dealing with musical instruction's effect on perception. From this review, reasonable evidence for the perceptual reality of Schenkerian-style structural levels is found to exist. This thesis asserts that the perception of Schenkerian analytical structures is largely an unconscious process.

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Contents

Introduction

This thesis is an investigation of how empirical research in the fields of music perception and cognition can impact our understanding of the theory of Schenkerian analysis. The primary goal of this thesis project is to discover promising areas in which further study can be done in the perception of Schenkerian theory. The way that we listen to and process music can inform us in ways that discussions and abstract knowledge cannot. It is extremely important then for music theorists to conduct interdisciplinary research either on their own, or by collaborating directly with their colleagues in perception and cognition.

My thesis project will largely be limited to outlining areas of thought that have already been approached in some way or another rather than looking at wholly uninvestigated question areas. Such an undertaking would be outside of the scope of this project. However, several areas for future study will be suggested.

Reading Huron's book on expectation—*Sweet Anticipation*—originally inspired me to delve into interdisciplinary research on Schenkerian theory. His approach is comprehensive in its method and concise in its conclusions. Combined with these impressive qualities, some of the findings seemed like they could conceivably be applicable to Schenkerian principles.

Initially the goal of this project was to summarize the existing research and then apply any research on tonal music in general that contained specific significance to Schenkerian theory. However, during the compilation process it became clear that the studies I hoped to use would require Schenkerian-specific versions in order to come to any sort of concrete conclusions. In order to show my own acknowledgement of this limitation and to help facilitate the undertaking of such studies, the prime aim of the thesis project became to focus on setting up a more succinct

format towards future testing, as well as a general theory of the importance of unconscious perception and cognition when it comes to Schenkerian theory. This required the project to explore and outline the ideal methods to conduct such empirical studies in the future: including collection processes, specific study questions, and the repetition of promising studies.

Briefly, let me define several key terms as I use them in this thesis. There are two pairs of terms that are especially nebulous: subconscious and unconscious, as well as perception and cognition. This is reflected in their often interchangeable use in the literature reviewed in this project. Even Huron neglects to properly differentiate and define these terms. I will begin with subconscious versus unconscious. When referencing the brain's processes, these terms are used to describe situations when processes such as learning, calculation, and prediction are occurring without conscious thought or focus being given to them. Unconscious is the preferred term because it provides less ambiguity in its meaning. A key difference between unconscious and subconscious is that the latter term refers to information and processes that can be recalled. When I describe unconscious processes in the body of this thesis, I am largely referring to computational processes in the brain that occur outside of the conscious mind and can never be accessed on a conscious level.

Now we come to the question of perception versus cognition. These two terms are still not very well defined in current academic writings. They are closely related, in that they both involve the faculties responsible for the processing of information, but cognition notably includes both conscious and unconscious processes. Perception is more nuanced in that perceiving the music necessitates it being at a conscious level. However, the interpretation of the sensory information is often accomplished through unconscious processes in the brain. How the brain uses the influx of sensory information to inform future expectations is a key component of

what my thesis project reviews. Cognition relates more to the way that a listener understands or "knows" something. In this sense, perception is the more relevant area that this thesis reviews research on, as it is more reliant on unconscious processes. However, the multiple areas of overlap warrant cognition's inclusion in the majority of the discussions.

My thesis project is divided into three chapters that approach the topic from different perspectives: empirical research done directly on Schenkerian theory, empirical research done on general tonal principles applicable to Schenkerian theory, and the role of musical instruction on the perception of tonal music. The first and second chapters are set up to review material in a way that shows the various applications of perception and cognition research, as well as point towards the ideal method to use in future empirical studies. The second chapter essentially groups into three large sections: the first looks at examples of how perception and cognition research can contribute to resolutions within Schenkerian theory itself, the second further explores the perceptual reality of hierarchical structure in music that was covered in the Schenkerian-specific literature in the first chapter, and the third and final section approaches David Huron's research methodology that is put forth as the optimal method for continued study. Through examples of what his empirical research has accomplished, its application is shown towards Schenkerian theory. The final chapter may seem to be a somewhat tangential subject, but I believe its inclusion is critical. It is an overview of the effect of musical training and passive exposure to tonal music on perception and cognition. This overview is important in order to establish the relevance of all of the studies reviewed in the first two chapters. Without the conclusions of the third chapter reinforcing the importance of unconscious learning in perceiving Schenkerian analytical structures, the various levels of training that subjects received would be a more relevant question to critique the value of these studies. Through these chapters, a clear

hypothesis emerges: the perception and cognition of Schenkerian analysis is a largely unconscious process, and thus susceptible to empirical research methods such as those of David Huron.

Literature Review

A brief explanation of the material that will be referenced in my thesis project is necessary to present the proper context to the material covered in the body of the main chapters. We will begin with an overview of the general ideas of Schenkerian theory in light of the classic Schenkerian literature by Heinrich Schenker himself. This will be accompanied by a review of Cadwallader and Gagné (2007), the main text that has been consulted with regards to general Schenkerian principles. Finally, a handful of articles pertaining to internal disagreements about the theory will be presented.

The next section will cover the perception and cognition research dealing directly with Schenkerian theory. These sources will be thoroughly analyzed in Chapter 1, so a very brief review of them will be done here. Following this, the general tonal research will be approached including, notably, that of David Huron. To conclude the review of the pertinent literature, a brief look at oft-used alternatives to Schenkerian theory will be presented, as well as relevant research on the effect of musical instruction on perception and cognition.

Schenkerian Literature

The origins of Schenkerian technique are both philosophical and anecdotally observational. The philosophical origin of the theory lies at the root of Schenker's conception of what the essence of a tonal work is supposed to be. Schenker believed that the major triad is the "chord of nature."

He held this belief because the major triad is the triad that appears in the overtone series of any single-toned pitch—as overtones 4, 5 and 6 (with the fundamental numbered as 1). Schenker believed that every tonal composition represented the unfolding of the triad through time.[1]

As far as the anecdotal origins of Schenkerian analysis, they simply reflect the fact that the Schenkerian assertion that underlying structures exist in tonal music came from the way that Schenker himself—and later, his followers—heard music. Because of this, there is no guarantee that a majority of listeners naturally hear in the same way. While there is nothing inherently wrong with these origins, the recently burgeoning area of music perception and cognition creates the possibility of empirical support for Schenkerian theory's ideological perspectives. This approach allows for a relative amount of objectivity to play a major role in the theory.

Harmony (*Harmonielehre*) and *Counterpoint* (*Kontrapunkt*) are the first volumes of Schenker's three-part treatise, *New Musical Theories and Fantasies*. These earlier volumes contain pieces of his later, more fully-formed concepts of voice leading and *Stufen*.[2] *Harmony* introduces the distinct difference between harmony and counterpoint, the philosophical origins of tonal music stated above, and the principle of repetition. Produced in two volumes—one in 1910 and the other in 1922—*Counterpoint* is described as the study of voice leading. In *Counterpoint*, Schenker insists that the study of counterpoint should not be confused with the "theory of composition" and that they are, in fact, separate from each other. The important difference that Schenker maintains is that the rules of strict counterpoint lie in the background of musical compositions, but that these models are not meant to be imitated on the surface of the music.

The latest of Schenker's works, *Free Composition* (*Der Freie Satz*) represents the most fully developed form that his ideas of musical theory attained before his death in the 1930s. The most

[1] See Division 1, Section 1, Chapter 1 and Division 2, Section 1, Chapter 1 of Heinrich Schenker's *Harmony (Harmonielehre)*.
[2] See Drabkin 2002, pp. 817-18 for a full discussion of *Stufen*, or scale-steps.

significant addition to his theory of musical analysis in this volume is the detailed description of the distinct levels of musical structure. A hierarchy of simplicity is developed in which the deeper the structural level, the simpler the musical skeleton will become. Schenker described three separate levels: the Foreground, which is closest to the surface, contains most of the original pitches of a piece; the Middleground, which makes clear the underlying structure of the surface of the music; and lastly, the Background, which represents the simplest musical structure that can be seen to underpin a work.[3] Schenker also introduced the fully formed concepts of the *Urlinie* and the *Ursatz*—the Fundamental Line and the Fundamental Structure, respectively. The *Urlinie* involved the "uppermost" voice descending and had three forms: 3-lines, 5-lines, and 8-lines. These are described as leading down to scale-degree 1 by the end of a work. The *Ursatz* represents the most basic structure of the bass-line being included in the structure of the *Urlinie*.

Allen Forte (1959) wrote an important article called "Schenker's Conception of Musical Structure" that was published in the *Journal of Music Theory*. It introduced and simplified many of Schenker's concepts. It also presented a controversial opinion that *Initial Ascents* to scale-degree 5 in major keys must include a raised four to be considered true ascents to 5. This opinion is at odds with Schenker's own beliefs and is a contradiction that will be addressed in the body of my thesis project.

The question of whether an *Urlinie* that truly descends from scale-degree "8" is possible is addressed in David Neumeyer's article "The *Urlinie* from 8 as a Middleground Phenomenon" (Neumeyer 1987). Neumeyer outlines some of the problems with such *Urlinien* and proposes ways around these issues. Two such problems are the leading tone's tendency upwards and the unsupported descent from 8 to 5. This thesis will address both the criticisms of these structures and Neumeyer's solutions, as well as the perspective that music perception and cognition data

[3] See Chapter 1 of Heinrich Schenker's *Free Composition (Der freie Satz)* for further discussion.

can bring to the argument. David Smyth (1999) adds considerable aid to the side that supports 8-line *Urlinie* as structures suitable for the Background. He largely finds support through citations of Schenker's original works, especially in some of his analyses of works by J. S. Bach.

All general knowledge of Schenkerian concepts and idioms has been gleaned from the study of *Free Composition*, as well as the book *Analysis of Tonal Music: A Schenkerian Approach* by Cadwallader and Gagné (2007). This concise review of the concepts of Schenker's analytical technique is far clearer than his own *Free Composition*. Cadwallader and Gagné is a well-regarded Schenkerian textbook. In the small number of cases that neither source provides an easily understood review of a Schenkerian concept, a chapter from *The Cambridge History of Western Music Theory* dealing directly with a summary of Schenkerian analysis will be consulted (Drabkin, 2002). For the reader less familiar with Schenkerian theory, this short review and list of sources to consult will allow greater comprehension of the articles and studies to be covered in the remainder of this thesis.

Schenkerian-Specific Perception and Cognition Research

Literature in the field of music perception and cognition that addresses Schenkerian theory directly is becoming more prevalent in recent times. This is largely due to the success of the field of perception and the insights that these have brought to the world of music. The confidence in the importance of these studies has created conditions ripe for addressing the most eminent ideas and concepts that music has to offer.

However, direct testing of Schenkerian premises is still in its infancy. Despite these small numbers, some intriguing support has already been discovered. Jason Yust (2012) is an important example of the great possibilities of continued research into this question. His work on

key distance relationships lends strong credence to Schenkerian ideals by showing that deeper levels of Schenkerian hierarchical structure connections can account for greater similarity judgements than key distance relationships alone. Another significant assertion in the article is Yust's emphasis on the importance of keeping aspects of Schenkerian analysis separate from each other—rather than considering it as a unified theory (Yust 2012, 1172). By doing so, Yust makes the theory more approachable to researchers interested in testing various parts of the theory. This suggests that any one component that is supported or contradicted by empirical data does not necessarily affect other aspects of Schenkerian Theory.

David Temperley has directly approached this question in his essay "Composition, Perception, and Schenkerian Theory" (Temperley 2011). His focus comes primarily from the side of the question of Schenker's principles as a theory of composition. He then takes some of the more promising aspects of this and shows that these same principles are also the most promising realizations of music perception. However, Temperley takes the opposite premise that this thesis promotes and asks if Schenkerian theory is a model by which a theory of music perception can be developed. My thesis maintains that the more interesting question is whether Schenkerian theoretical principles are discernible in experiments on the perception of music. This is a small, technical difference—but it is an important one, nonetheless. The bigger problem is his admitted reliance on his own thoughts rather than using or producing experimental results himself. For this reason, I am less focused on his thoughts when related to this project that focuses on grounding Schenkerian analysis in experimental data.

The initial study on "The Cognitive Reality of Hierarchic Structure in Music" by Serafine et al. was an essential first step to understanding Schenkerian analysis from a perceptual perspective. It used a musician familiar with Schenkerian analysis to create reductions that could

be tested in small groups of university students of various musical—and non-musical—backgrounds (Serafine et al. 1989, 401). Serafine et al. conducted a set of six experiments that demonstrated hierarchical structure in music is perceptible by trained and untrained musicians alike. This conclusion helps to form a basic hypothesis of my thesis project: unconscious processes are a key component in the perception and cognition of Schenkerian theory.

Alan Marsden's article, "Schenkerian Analysis by Computer: A Proof of Concept," covers several areas that fall outside the scope of this thesis (Marsden 2010). Nevertheless, the plausibility of generating Schenkerian analyses through computer programming alone is an idea that will likely come to fruition in the coming decades. Marsden presents strong empirical support that even with the computational limitations of today, several of the necessary software parameters are ready to be implemented. This will be briefly reviewed in the Conclusion of my thesis when the fascinating future of perception and cognition research is addressed.

General Tonal Research

Steve Larson's article on "musical forces" encourages the descending nature of the *Urlinie* through the process of the force of gravity being attributed to musical expectation, as well as other principles (Larson 2002). The theory of musical gravity also contributes to prominent idioms in Schenkerian theory and will be used in the second chapter to weigh in on an internal disagreement amongst Schenkerian theorists. Larson describes other musical forces that shape the way in which listeners attribute motion to individual pitches, but other research has been done that I will prioritize. He tested his theory of musical gravity to positive results in "Measuring Musical Forces" (Larson 2005).

Cook (1987) discovered that listeners have severe limitations in their ability to hear large-scale tonal closure. He found that key changes are not nearly as perceptible as one would expect—even for highly-trained musicians. A similar study on this limitation was presented by Marvin and Brinkman (1999) but its findings were less conclusive. One of their studies contradicted the results of the rest, including those of Cook. This will be explored in Chapter 2.

Paul von Hippel (2000) investigated the true origin of the tendency of pitch proximity by hypothesizing that constraints on *tessitura* and motion are the real driving forces of this phenomenon. His results were conclusively in favour of this redefinition. His discovery set up the secondary study with Huron that is used in Chapter Two of this thesis.

Von Hippel and Huron (2000) collaborated on a project to better explain the tendency for skips to precede reversals of melodic direction. Rather than being a rigid rule based on melodic expectation, the true nature of this phenomenon was revealed to be the *tessitura*. Skips will usually be followed by changes in direction because, from a probabilistic standpoint, the distance between the original note and the pitch that follows the jump will tend to result in a further distance from the comfortable range of the instrument or voice. This inclination can have interesting insights into Schenkerian theory.

A crucial portion of my thesis project will be engaged in the application of the ideas in David Huron's *Sweet Anticipation* to the principles of Schenkerian analysis. Huron's work in this book on Western melodies provides a wealth of information on the perception of melodies and the cognitive processes that accompany them. In the book, the results of both the tendencies of tonal melodies—through an extensive cataloguing process—and the expectations of listeners are combined to reach a better understanding of tonal music. Huron begins by introducing the evolutionary advantages that predicting events can have on an organism. From there he explains

how this theory of expectation can be applied to listening to music. A key aspect of Huron's work is the insistence on testing the actual tendencies of tonal music as well as our own expectations. This is because he recognizes the inherent fallibility of the human brain, compared to designed computers, and that it will not necessarily calculate probability in a "logical" way. The theory of the process of statistical learning that Huron describes is also of paramount importance in order to gain insights into Schenkerian analysis. His general theory of expectation is called the ITPRA theory and will be detailed in Chapter 2.[4]

Nicola Dibben (1994) discovered strong support for the most fundamental of Schenkerian principles—structural levels. She undertook this study in response to Serafine et al.'s (1989) own work on the cognition of hierarchic structures in tonal music. However, she did not use Schenkerian theory's conception of structural levels. Despite this, Dibben found that listeners do, in fact, sense a "structural skeleton" behind the surface of music. In the article "The Cognitive Reality of Hierarchic Structure in Tonal and Atonal Music," Dibben conducted three experiments to test for the perception of hierarchic structure in music: the first to verify the ability of participants to match reductions with the original piece, the second as a control study, and the third to test participants' ability to perceive structural levels in atonal music. Without the ability to perceive hierarchic structures in atonal music, Schenker's method is of little use. However, this is not to say for certain that no element of the technique is valid in an atonal setting. The concept of "structural levels" of Schenkerian theory forms one of the basic tenets of the method. It is of considerable importance that this concept has a strong basis in tonal reality.

[4] ITPRA stands for the Imagination, Tension, Prediction, Reaction, and Appraisal responses that will be described further in the second chapter of this thesis.

Alternatives to Schenkerian Theory

Nicola Dibben's work on the "structural skeleton" that underlies tonal music has its roots in Fred Lerdahl and Ray Jackendoff's book, *A Generative Theory of Tonal Music*, in which they suggest that the only way to develop a theory of tonal music is by basing it on the "mentally produced organization" of the listening process (Lerdahl and Jackendoff 1983). Instead of Schenkerian graphing techniques, they created a theory of hierarchy in music through tree structure-like notation. My thesis project is based on the notion that the departure from Schenkerian analysis for other alternatives may have been premature and that empirical support is needed to produce a definitive conclusion.

Eugene Narmour's alternative to Schenkerian analysis, the *Implication-Realization* model is largely based on concepts of the cognition of music and is also an alternative theory of musical expectation to what is presented by David Huron (2006). Both of these works are simply used as references to alternative theories to Schenkerian analysis and are not directly addressed in the body of the chapters. They are, however, an important obstacle to be aware of towards direct research on Schenkerian theory (Narmour 1990).

The Effect of Musical Instruction on Perception

Bigand and Poulin-Charronnat (2006) carried out an extensive review of the areas of perception that do not rely on deliberate musical instruction in order to develop a better understanding of unconscious learning. The results were even more significant than they originally imagined, as a significant range of perception and cognition showed only marginal differences between trained and untrained individuals. The extensive importance of unconscious processes that they discovered gives strong credence to the hypothesis of my thesis project.

As a supplement to this extensive review, Morrongiello (1989 and 1990) headed two separate studies investigating the effect of musical training on perception. Of particular interest was its effect on developmental change. Morrongiello found significant differences in the performance of untrained musicians at the age of five compared to those at the age of nine. This suggests that the unconscious learning process is relatively undeveloped at age levels below nine years old.

Conclusion

In this introduction, I have: outlined the basic aims of this thesis project (notably including the primary goal of the thesis, which is to discover promising areas in which further study can be done in the perception of Schenkerian theory), clarified my use of key terms that are often substituted interchangeably within the literature, concisely reviewed the origin and basic tenets of Schenkerian analysis, and given a brief summary of the perception and cognition material that will be covered in the following chapters.

This has been a quick review of the resources that have been valuable in the formation of my thesis project. Some of the sources covered will be given far more extensive overviews in the following chapters. Others are peripheral to the greater argument of this project, and will not be addressed further.

Chapter 1

A Review of Schenkerian-Specific Perception Research

This chapter will focus on presenting and analyzing the limited examples of experimental research already done directly on Schenkerian analysis in the fields of music perception and cognition. The strengths, weaknesses, and untouched areas of each example will be discussed in order to get a greater picture of what is missing from the current landscape of research.

There are only three examples in the research pool of truly Schenkerian-specific empirical, perceptual research: Serafine et al. (1989), Temperley (2011), and Yust (2012). Unfortunately, one of them is almost completely devoid of experimental data of its own (Temperley 2011), and the other was only presented at a conference and not published (Yust 2012). Despite their small sample size, these articles put forth important information and data towards a further understanding of Schenkerian theory. Serafine et al. were the first to empirically test the perception of hierarchical structure in music. David Temperley's article looks at Schenkerian analysis from two related perspectives, and Jason Yust uses a novel approach in similarity judgements to show Schenkerian theory's real perceptual advantages.

Unfortunately, there have been surprisingly few examples of this type of research and that reality is echoed by most of the articles presented in this chapter. Despite Schenkerian analysis' prevalence—especially in North America—there has been a distinct lack of perceptual research on its basic tenets.

In the second chapter, a wider range of experimental research will be analyzed that pertains to tonal music in general. The purpose of this is to discover what has already been researched in the broader questions of the perception of tonality itself and could be further explored more specifically to the topic area of this thesis. This material will be examined in a way that illuminates both questions about—and possible answers to—various Schenkerian principles that call for more experimental data.

Serafine et al.

To begin, the most basic principle of Schenkerian theory will be addressed using Serafine et al. (1989). This is the principle that underlying the surface level of all tonal music are deeper levels of musical structure. The surface level of the music can be seen to be built on top of the deeper framework. As noted in the literature review, these structures are labelled as Background, Middleground, and Foreground. In order to support the existence of these deeper structures on a perceptual level, empirical research must be done and then further refined and replicated.[1]

Currently, Serafine et al.'s (1989) initial study has been altered and replicated by another researcher, Dibben (1994), but since then no further attempts have been made to improve on the data. This is one of the problems plaguing research in general. The replication of the findings of various studies in order to legitimize the initial results is imperative to the integrity of the field. Without multiple studies on each question, empirical findings can be skewed due to small sample sizes (replicating this study—along with further refining the research methods—would be one of the first handful of projects that I would undertake using the methods outlined in this thesis).

[1] Clearly the argument can be made that the importance of a form of analysis isn't necessarily directly tied to the listener's ability to hear it, but a possible perceptual basis gives much credence to its wide-spread acceptance. The philosophical origins of Schenkerian analysis also lend credence to its evaluation from a perceptual perspective: see pp. 4-6 in the Literature Review of this thesis.

The study by Serafine et al. on "The Cognitive Reality of Hierarchic Structure in Music" was ground-breaking research, the first of its kind to empirically test the perception and cognition of hierarchic structure in music (Serafine et al. 1989, 398). Unfortunately, surprisingly little has been done in the last twenty-six years since this study was undertaken. Once again, the small number of articles referenced in Chapter One reflects that reality.

The preliminary results of this study suggest that perception of such structures could be more of a "subconscious" process. This is because the explicitly stated structure that was being attempted to be matched with its original piece was met with less success than the "rapid" similarity judgement of the first experiment (Serafine et al.1989, 398). These results are somewhat contradicted by the latter three studies in the article because of discrepancies in the returning data from altered variables between the studies. However, the question of whether the grasp of hierarchical structure—and by extension, Schenkerian theory in general—is an unconscious or trained observation will be further discussed in the portion of the second chapter dealing with David Huron's theory of musical expectation.[2] It will also be a major focus of the third chapter of this thesis.

This research's importance—both in historical terms and in the data that it produced—to the overall perceptual knowledge of Schenkerian theory warrants a more detailed overview than would otherwise be necessary. Thus, a breakdown of the details will be undertaken in the following sections.

The study involved six separate experiments done in order to discover whether or not structural levels would be perceivable at greater than chance levels. The first experiment involved subjects listening to three fragments: the original melody taken from twelve compound melody excerpts of J.S. Bach, the Schenkerian structure underneath it, and a fragment that was

[2] See Chapter 2, pp. 51-56 of this thesis.

not the appropriate Schenkerian structure (Serafine et al. 1989, 399). For each excerpt, a theorist trained in Schenkerian analysis did the "correct" reduction and "erroneous" reduction (foil) at the Foreground and Middleground levels (Serafine et al. 1989, 401). This ensured a genuine Schenkerian reduction practice. An important detail of the difference between the correct reduction and the foil is that only the upper melody of the foil is different. The degree of difference between them in this experiment is the subject of a criticism and method adjustment by Nicola Dibben that will be discussed in the second chapter.[3] Subjects were also told there was no "right" answer in order to reduce the likelihood of the results being artificially skewed (Serafine et al. 1989, 402).

The results of the first experiment drew interesting conclusions. The first among them were overall success rates of .64 for the Foreground and .59 for the Middleground (Serafine et al. 1989, 403).[4] Both results show better than chance distinction, as well as a lower recognition at the deeper structural level of the Middleground. The former suggests that Schenkerian structural levels are most definitely perceivable, but that the more abstract the levels become (i.e., the deeper the structural level), the less relevant they are for actual perception.[5] The second conclusion was that those with ten or more years of training averaged a success rate of .66, versus .56 for those with no training whatsoever (Serafine et al. 1989, 403). This in turn suggests that musical training is a significant indicator of the ability to perceive these deeper musical structures. However, this is refuted by the fact that Serafine et al. noted that "listening longer did not make identifying the correct structure more likely" (Serafine et al. 1989, 404). The result suggests that there may be an unconscious component to the perception of Schenkerian

[3] See Chapter 2, pp. 41-44 of this thesis.
[4] Being rated out of 1.00: 0.50 being chance levels of success.
[5] This will be further evinced in the section of Chapter 2 dealing with large-scale tonal closure. See pp. 45-47 of this thesis.

structures, because more conscious attention to details should produce a higher level of recognition. This was not found to be the case.

Serafine et al. claimed that according to Schenkerian analysis, musical reductions are "largely implicit and based on musical intuition" (Serafine et al. 1989, 404). This is in line with some of the readings and the generally subjective nature of Schenkerian analyses. Based on this description, the results of the study would have been expected to find a correlation between tones that have certain characteristics and their frequency as part of the deeper structural background. This was indeed found to be the case, as the results showed that "focal tones tend (1) to occur on strong or accented beats, (2) to be tones of longer rhythmic duration, and (3) to be among the tonic tones…in use at a particular point" (Serafine et al. 1989, 404).

The purpose of Serafine et al.'s second experiment was to discover whether the choice of reductions derived in the first experiment were simply from the reduction being more aesthetically pleasing than the foils (Serafine et al. 1989, 408). They dropped the original model in this experiment in order to only compare the foils and reductions. Subjects were told to simply select the most pleasing excerpt of the two. The results clearly indicated that aesthetics were not indicative of hierarchical relationships as there was no correlation between aesthetic choices and the correct reductions (Serafine et al. 1989, 409).[6]

With aesthetics now being firmly controlled for, experiment three attempted to increase the success-rate of the initial study. Of particular interest was the relatively small difference between the musically untrained and highly trained—ten plus years of musical study—in matching the model and the correct reduction. In order to possibly increase the success of the subjects,

[6] It is also important to note that a different group of students was used for the second experiment, so it is within the realm of possibility that the differences in aesthetic choices accounted for these changes. The data to discount this is that there was no correlation between these choices and the "structural importance" proportions based on metric accent in the previous experiment. Nevertheless, whenever possible, the same group should be used for elimination-of-bias studies such as this.

Serafine et al. adjusted three variables for the third study. Firstly, they allowed for "self-controlled…unlimited hearings" in hopes that this would allow for greater perception of the deeper levels of the music. Second, they added a motivational reward for choosing correctly in the form of a small amount of prize money. Finally, Serafine et al. altered more tones in the foil of this experiment than had previously been used in the initial experiment (Serafine et al. 1989, 410). Serafine et al. assumed that the higher number of differing tones would make it easier for the subjects to tell which reduction was the "foil". In the end, the results showed no improvement in identification and actually a slightly *lower* rate of success (Serafine et al. 1989, 412). Added to this, the second motivational reward could be seen as skewing the test results in an unscientific fashion. Blind and double-blind studies are considered more scientifically valuable when they are free of both intentional and unintentional direction to the subjects. In other words, the third experiment was a resounding failure.[7]

Some of the interesting discoveries from the failed experiment are quite telling of the nature of the perception of this most basic of Schenkerian principles. The study found that after metric analysis, "structural importance…significantly correlated with reduction matching" (Serafine et al. 1989, 413). There should be no surprise with that discovery, but it is worth mentioning because of its support of the theory. Serafine et al. explain that the negative correlation between the number of listenings and success could be that repeated listening "degrades structural perception"—which would give further credence to the possibility of the perception of Schenkerian analytical structures being strongly influenced by unconscious perception—or simply that worse subjects needed more listenings to come to a satisfactory decision (Serafine et al. 1989, 414). It is important to discover which of these factors caused the resulting data.

[7] It was merely a failure in its intended purpose, not in the results that it procured. Failed studies can offer up fascinatingly useful bits of information, as this one did.

Serafine et al. designed experiments four through six to be based on similarity and rating judgements. The qualitative data came in sets of two excerpts that would be played in the following permutations: similar because of the same harmonies, similar because of the same structural skeleton, and similar in both categories. The experiments ended up showing that the same underlying structure was highly important for the subjects in matching, but that the same harmony was not important in matching if the deeper structure differed. Repeated hearings increased this effect. In fact, "similarity judgements were based on underlying hierarchic structure, even in the face of radical harmony differences on the surface. In the fifth experiment, this effect increased in strength with repeated hearing[s]" (Serafine et al. 1989, 397).[8] Schenkerian theory is based on the idea that counterpoint is more important than harmony because voice-leading gradually generated harmonic principles as more voices were added during history (Cadwallader and Gagné, 22). Here are some of the details of the last three experiments.

Experiment four involved both a matching task that allowed unlimited hearings, as well as a rating task that required immediate decision after one hearing. The matching task lined up with the previous experiment's data and showed more matching of surface similarities to the detriment of the perception of the deeper structure with repeated hearings. Meanwhile, the rating task that featured rapid judgements showed more matching "based on the deep structure of the fragments" (Serafine et al. 1989, 421). This data point is crucial for corroborating the conclusion of the previous experiment that repeated listenings may degrade structural perception.

However, the fifth experiment was an outlier in the data. Harmonic Foils were "regarded as more similar to Model 1 than were [Counterpoint Foils]." This countered the suggestion from

[8] This last point lies contradictory to the other data in this study and contrary to one of the main hypotheses of this thesis—it is important to note.

previous data of the studies that repeated listenings drew attention to the surface rather than the structure, because the strength of the perception of [Harmonic Foils] to [Model 1] increased with repeated hearings (Serafine et al. 1989, 426). Since this was the only support to the contrary in this set of studies presented by Serafine et al., it is reasonable to conclude that it may have just been an anomaly. This requires further investigation and attempts at replication to be certain of its validity.

The sixth and final experiment was designed to investigate the role of longer term memory in grasping underlying structure. This was done through the attempted memorization of the correct reduction and subsequent retaking of the experiment to test any changes to the outcomes. Unfortunately, the conclusion from Serafine et al. notes that more research needs to be done to investigate the "distinction between *subconscious*[9] as opposed to conscious or *focused* attention, and which type is more likely to result in the grasp of structure" (Serafine et al. 1989, 429). The sixth experiment insufficiently explained the impact of memory on these judgements, so further research is required and strongly suggested by Serafine et al.

The third and fourth experiments are a wealth of support that unconscious processing factors are at play in the perception of Schenkerian theory. The available rise in listenings in both produced a negative correlation in success and the lack of increase in success rate with an added incentive in the third experiment suggests that increased conscious focus is not beneficial in the perception of Schenkerian structures. The third experiment also helped to show Dibben that *more* changes between the foil and the correct reduction did not necessarily increase the ability to choose accurately. The third experiment should be redone with information on subjects' grades and musicianship aptitude in order to help determine whether the negative correlation between

[9] I use the term *unconscious* throughout this thesis, as unconscious is the more accurate scientific term to describe this.

listenings and success rate was due to worse perceivers needing to listen more times before a satisfactory decision could be made, or whether independent of their perceptive abilities that more listenings would produce lower structural level distinction. Combined with the lower success ratings of extended listenings, Serafine et al. found a positive correlation between "rapid similarity judgements" based on a single listening in the fourth experiment and success rate. This data lends strong credence to this thesis' hypothesis that unconscious processes are important to the perception of Schenkerian theoretical principles.

The experimental data that Serafine et al. produced was a crucial step towards analyzing the various aspects of Schenkerian theory. However, as will be further outlined in the second chapter through the experiments of Nicola Dibben (1994), improvements on their method can be made. It is a shining example of how relatively straight forward some of the collection of empirical data on Schenkerian theory can be. It is also a study that should have been replicated—or tweaked and replicated—multiple times to solidify the findings. Regrettably, only Dibben has done so in the nearly three decades since the study was published.

David Temperley

David Temperley's article—"Composition, Perception, and Schenkerian Theory"—has many strengths in its approach to Schenkerian analysis (Temperley 2011). The foremost of these strengths is its breaking down of the material into concrete ideas that translate well into experimental testing. Temperley's approach was a large inspiration for the present thesis. His general method of collection, interpretation, and suggestion is mirrored in my project.

Temperley first divides the question of Schenkerian analysis into whether it can be seen as a theory of composition or a theory of perception (Temperley 2011, 147). An important distinction

must be made between his view of the relationship between Schenkerian analysis and perception (a distinction that is at odds with the basis of my thesis project). Temperley postulates that Schenkerian theory could give rise to a theory of perception, rather than testing to see if Schenkerian theory matches up with the reality of perception data. The difference is small, but striking. Temperley would find no reason to question or adjust any aspect of the theory. Instead, he is concerned with simply whether or not it can be seen as a theory of perception.

Temperley holds that Schenkerian theory as a theory of composition can predict the way that music actually occurs. This is an important idea for both Huron's approach to tonal music as well as for the possible applications of grounding Schenkerian analysis in perceptual data.[10] His assertion that testing these views of Schenkerian theory involve their predictive properties comes with the stipulation that their predictive ability does not have to be perfect, but "hold true most of the time" to be of great value (Temperley 2011, 148). In order to facilitate an understanding of Schenkerian theory's predictive properties, Temperley suggests Bayesian probabilistic modelling as the solution to analyzing to what degree the data can confirm the theory's predictions (Temperley 2011, 149). Despite this important suggestion, Temperley himself does not attempt any such interpretation of data in his article. However, it is a crucial suggestion to remember for any study done on Schenkerian analysis' generative predictive ability. An important offshoot of this assertion is that Temperley believes that the opposite should hold true as well. In other words, a theory should be judged not only on its predictive power within its own field, but also the lack of such a predictive ability in other areas (Temperley 2011, 150). This will become important in the second chapter when Dibben's own study is analyzed.[11]

[10] See Conclusion, pp. 70-73 in this thesis.
[11] See Chapter 2, p. 43-44 of this thesis. Dibben conducted a non-Schenkerian structural level study on atonal music.

An important detail that Temperley notes fits with Serafine et al. (1989): the perception of Schenkerian structures is not necessarily available to consciousness. He "claims that Schenkerian structures *explain* certain aspects of our perception and experience—the sense of coherence we may experience in a piece, for example—seem to imply that such structures are being mentally represented" (Temperley 2011, 147). The support has begun to become strong for this thesis' hypothesis that unconscious factors are crucially important in the perception of Schenkerian theory, and that this should be reflected in the style of empirical research applied.

In order to properly create testable conditions for Schenkerian analysis, Temperley goes to great lengths to emphasize that Schenkerian principles need to be separated from theory in order to be tested. He does so by creating a "context-free grammar" that both individuates the components of Schenkerian theory, but also strips them of their specific Schenkerian labels and context (Temperley 2011, 151). Unfortunately, in this way, Temperley goes too far in his attempts to make the tenets of the theory testable. This renders some conclusions deniable and the process of setting up studies unwieldy. As will be described later in this chapter, Jason Yust proposes a similar but simpler solution to this problem.[12]

One of the most characteristic figures regularly analyzed in Schenkerian theory is the *Zug*[13]—described aptly by Temperley as being a "stepwise line connecting two structural tones." He further describes that the possible perceptual reality of *Zuge* suggest "that a step is likely to be followed by another step in the same direction" (Temperley 2011, 153). In fact, this is one of the few occasions that Temperley calls on existing data to solidify his argument. The data that shows this in an example of Bach chorales and Mozart/Haydn string quartets that demonstrate a roughly 70% chance of an ascending/descending interval being followed by another in the same direction

[12] See p. 27 in this chapter.
[13] The plural form being *Zuge*.

(Temperley 2011, 153). He also cites pp. 77-78 of Huron's *Sweet Anticipation* as having a similar study showing "step inertia" as being for descending steps only.[14] Huron's book contains several important concepts, approaches, and data sets that will be extensively covered at the end of the second chapter.

These studies show the natural likelihood of the prevalence of *Zuge* in tonal music, but more specific parameters must be noted and further tested to be certain of its special notation. Comparisons between the incidences of Schenkerian-like *Zuge* versus patterns of descending motion in melodies that do not quite fit the theory would be the best place to start. Surveying a great enough sample size of tonal works[15]—ideally using computer software and clear parameters—is crucial to discover the overall pattern and likelihood of different outcomes in practice. This is one of the main areas of data collection that Huron uses in his own research and is something that is a crucial component of understanding the perception of music in general.

Stufen, or scale-steps, is a concept in Schenkerian theory that forms the basic underlying chordal structures of a given tonal work. *Zuge,* in the bass line are generally considered less significant in Schenkerian analyses, but the greater understanding they provide over more traditional forms of harmonic analysis can be shown in unconventional harmonic movements. Their predictive power in harmonic progressions is demonstrated by Temperley in an example from a Mozart Symphony No. 40 progression I-V6-IV6-I6/4-ii6-I6 (Temperley 2011, 153). This progression breaks many traditional rules of harmony—V followed by IV, etc. Its unconventional motion can be better explained through the bass line's linear descending progression, or *Zug*. This matches Temperley's assertion that a theory of composition must make

[14] See Chapter 2, pp. 53-56 of this thesis. This work is also similar to Larson's work on musical "forces", particularly "musical gravity."
[15] Over a hundred would be the minimum for a more accurate approximation of patterns to emerge.

predictions of real phenomena: Schenkerian theory predicts this motion better than other available options.

Once again, Temperley expresses sentiments that suggest an unconsciously learned and experienced component of the perception of Schenkerian theory. He asks the question whether Schenkerian analysis as a theory of perception would include all of those having tonal music familiarity, or only those with a high degree of musical training (Temperley 2011, 157)?[16] In answering his own question, he asserts that "to claim something as a 'theory of perception' implies that it characterizes people's perception beyond what is due to explicit study of the theory"—and thus, that much of the perception of musical norms and structures are reliant on inexplicit means.

From his own viewpoint and the studies that he has analyzed, Temperley believes it is likely that Schenkerian's psychological validity dissipates over larger time spans (Temperley 2011, 159). Temperley notes that this is evinced by Cook's 1987 article on the perception of larger scale tonal closure that even experienced listeners are "unable to tell whether the piece ended in the same key in which it began" (Cook 1987).[17] However, Schenkerian theory is largely seen as a sort-of Russian doll type concept, where the form and function of systems is largely similar at the bottom as at the top—simply with differing levels of detail. It could be seen then, that if the perceptual reality of Schenkerian concepts at lower levels is found to contain ample support, then confirmation at deeper structural levels is not needed to validate the theory. Instead, such deeper structural levels would be seen as interesting particulars of the process. Temperley calls for a study of the perception of linear progressions at deeper structural levels to attain a clearer idea of this limitation—or to counter it (Temperley 2011, 159).

[16] The question of musical training's effect on perception and cognition is approached in the third chapter of this thesis.

[17] This article will be touched upon again in the second chapter as part of a larger analysis. See p. 45 of this thesis.

In the end, Temperley comes to the conclusion that if what he has posited throughout this article is accurate—without almost any empirical data at his disposal it must be noted—then "Schenkerian structures, by this view, are not basic building blocks of tonal music. Rather, they are patterns that were used occasionally by tonal composers—perhaps quite often, but not all the time—and usually at fairly local levels" (Temperley 2011, 164). Essentially, his view is one of Schenkerian structures as occasional schemata. This thesis does not hold quite such a pessimistic view of Schenkerian theory's usefulness in the field of musical analysis, but more data is needed to refute Temperley's interpretation of some of the characteristic Schenkerian structures.

Jason Yust

The most recent example of truly Schenkerian-specific perception research comes from Jason Yust in his work on key distance relationships. In a single study only a few short pages in length, Yust ingeniously shows just how easily the field of empirical data could be grown if academics made Schenkerian analysis a major focus of perception and cognition research. The most promising of approaches would be Schenkerian theorists collaborating with colleagues in general perception studies, or by simply carrying out their own research through the use of extant models.

Rather than insisting on a fully context-free grammar—as Temperley argues—Yust instead calls for the separation of tenets into testable ideas—without removing their Schenkerian context, which would often be unnecessarily arduous. Yust believes that without this separation, the theory looms too large to be approachable by would-be researchers. Yust proposes that "to be relevant to empirical research, Schenker's theory must be treated as a collection of interrelated but independent theoretical claims rather than a comprehensive analytical method" (Yust 2012,

1172). Furthermore, he says that this "opens the possibility of challenging the usefulness of certain aspects of the theory" without having to question the entirety of the analytical technique (Yust 2012, 1172). This is an incredibly important point, as a unified theory crumbles if any details of its makeup are found to be based on questionable ideas. Viewing Schenkerian theory as a set of interrelated but independent claims allows for some argument and reform with enough empirical data to sway even the most stubborn of theorists. Yust notes that instead, "music theorists have unintentionally discouraged empirical testing of Schenkerian theory by treating it as a comprehensive and integrated method of analysis, which is too complex to be tested directly" (Yust 2012, 1172). This, combined with the reality that Schenker's theories do not often translate well into "experimental paradigms without a certain amount of sensitive interpretation," and it can be understood why Yust sees this as the major roadblock towards empirical research on Schenkerian theory (Yust 2012, 1172).

These discouraging characteristics have led to multiple empirical studies being done using other theories of hierarchical structure over that of Schenkerian theory. Instead, more literal theories of reductionism (such as Lerdahl and Jackendoff) have been used in most research—some of which will be reviewed in the second chapter as prime candidates for being redone with Schenkerian ideals in its place.[18] Yust's idea of individualizing the tenets of the theory was a major inspiration for my thesis project.

Yust conducted a preliminary study of the ability to distinguish between keys in order to get a base reading on listeners' sensitivity to key distance relationships. The conclusion of this test showed that "listeners are sensitive to a change of key signature of up to two accidentals" and that "listeners' ability to identify key signature change directly were poor in many instances, suggesting that other musical factors might also be at play" (Yust 2012, 1172). This result is

[18] See Chapter 2, pp. 41-44 in this thesis.

suggestive of the data to come. Yust's findings showed "that listeners' ratings of key distances are strongly influenced by factors explained through Schenker's principle of composing out a harmony and voice-leading prolongations" (Yust 2012, 1173).

The design of the Schenkerian structural experiment was as follows. Various three-voice homophonic chord progressions were used with the following basic formula: six chords to establish a home key, six chords in some contrasting scale, and finally seven chords identical to the first set of six, but resolving on a perfect authentic cadence. Yust randomly generated these chord progressions (Yust 2012, 1173). The subjects were asked to rate the perceived tonal distance on a scale from 0-10—a 0 rating being the same key. Yust hypothesized the results of the study based on Schenkerian principles. He expected that "the more logical the harmonic relationship between chords (by 5^{th} first, 3^{rd}, and by step last), the lower the expected rating," as well as the extent to which the underlying "skeleton" forms would fit with proper voice-leading principles suggested by Schenkerian theory (Yust 2012, 1173).

The results were clear and striking. Yust found that changes of key signature altered tonal distance ratings by one point for every two accidentals that differed (Yust 2012, 1174). This is the baseline, expected data. Of utmost importance, the melodic relationships between the background structures were shown to be the most significant indicators of tonal distance ratings, as "disconnected melodies increased ratings by about the same rate as three accidentals" (Yust 2012, 1174). This clearly demonstrates that the melodic structural skeleton of the deeper levels described by Schenkerian theory are more important in distinguishing tonal distance ratings than key changes themselves: a three-accidental difference versus a two-accidental difference per point rating.

Yust discovered a fascinating difference between deeper structures and their perceived effect between the upper-neighbour and the lower-neighbour motion. The lower-neighbour motion in effect cancelled out the equivalent influence of key distance on ratings. Yust explained that this could possibly be caused by "the changed accidentals [being] 'hidden' in an inner voice or a [F]oreground passing line" (Yust 2012, 1175). The "weakened effect of key distance for 'motion to an inner voice' stimuli supports the idea of hearing in terms of a background melody," further supporting Schenkerian ideals (Yust 2012, 1176). To contrast this averaging result, upper-neighbour structural motion led to low ratings even greater than the effect of key distance. Schenkerian theory has long considered upper-neighbour structural level motion to be at a higher level than lower-neighbour motion, as the voice seems to become lost within the inner voices as it descends. This study gives credence to this idea. The second chapter of this thesis will further approach this question of upper-neighbour versus lower-neighbour structural motion. In summary, upper-neighbours lead to low ratings, leaps to high ratings, and lower-neighbours to average ratings. This supports the obvious conclusion that it is "plausible that relationships between structural chords are more important than changes of scale alone in listeners' evaluation of key distance (Yust 2012, 1176).

Conclusion

In this chapter, I have concentrated upon Yust, Temperley, and Serafine et al. Yust's study was able to show that Schenkerian theory accounts better than key distance relationships alone. He also called for more empirical research on Schenker: "the perception of key distance is one promising avenue for further such research, and the Schenkerian theories of composing-out and voice-leading prolongation" have been shown to be at least marginally present in the perceptual

reality of listeners (Yust 2012, 1176). No doubt his work in the future will add to the empirical research data on the perception of Schenkerian theory.

Serafine et al.'s six studies showed strong support for the perceptual reality of hierarchical structures in tonal music. However, the lack of great differences in matching accuracy between highly trained and untrained subjects was a surprising detail in the various results of their studies. Furthermore, studies three and four showed that the more conscious attention that was given to the matching of Schenkerian structural reductions to the original surface level of the music, the less accurate the subjects became at matching the material. This result supports this thesis' assertion that unconscious learning is a critical component of the perception of Schenkerian analytical structures.

Temperley's article explored the possibility of Schenkerian theory being used either as a theory of composition or as a theory of perception. His most interesting ideas from the article came from the sections reviewing Schenkerian theory as a theory of composition. This was shown in his assessment of the ways that the Schenkerian concepts of *Zuge* and *Stufen* could be shown to better explain unusual voice-leading and harmonic progressions in tonal music. It was also noted that he Temperley agreed with Serafine et al.'s conclusions that Schenkerian structures are not necessarily available to consciousness.

Both Serafine et al. and Yust represent the best current approaches to empirical perception research on Schenkerian analysis. Temperley forms a good model for where to look within the theory before any data is gathered, but his lack of original empirical data detracts from his work. All three scholars, however, show the potential for more rigorous and necessary study of Schenkerian theory from this perspective.

Chapter 2

Understanding Schenkerian Analysis from Indirect Tonal Perception and Cognition Research

This second chapter covers general tonal perception and cognition research in three large sections. The first section proposes that disagreements by Schenkerian theorists might be better addressed with the aid of empirical studies in tonal perception and cognition, notably Seraphine et al., and Dibben. The second section is further divided into two sets of studies that once again deal with the perception of deeper hierarchical structures in music. The chapter concludes by addressing the work of David Huron, which constitutes the best current methodology for applying empirical research in tonal perception to a study of theories such as Schenkerian theory.

The chapter begins by discussing the role semitone relationships play in dictating the form of Schenkerian structures as this is understood by prominent theorists. A survey of empirical tonal perception studies is undertaken and the result used to examine divergent approaches in Schenkerian theory. These empirical studies may help to resolve differences between different factions and individual practitioners of Schenkerian analysis.

An empirical-based project of this sort would be an important first step in creating the ideal method and data collection process for a perceptual and cognitive understanding of Schenkerian theory, and would make it easier for future empirical research to be performed. This chapter also applies some of the empirical data covered in Chapter 1 to the overall argument about Schenkerian semitone relationships.

The Schenkerian structure of the *Initial Ascent* is an especially important topic of interest for this thesis. The discussions regarding it draw upon Steve Larson's work on musical forces, as well as the general concept and parameters of the *Initial Ascent* as reimagined in David Huron's work on musical expectation—particularly melodic expectation. Huron's work will be reviewed at the end of this chapter.

Throughout the chapter, the limitations of perception on large-scale forms will be addressed. The proposed Background structure of Schenkerian analysis will be addressed by examining the findings by Nicholas Cook, as well as Marvin and Brinkman. We shall also address Dibben's article on hierarchical structure in music—based on the Serafine et al. study discussed in the first chapter.[1] In concluding, the method of David Huron and one of his prominent students, Paul von Hippel, will be reviewed.

Semitone Relationships in Schenkerian Analysis

Schenkerian theory is by no means a unified theory in which all of the components are agreed upon by all theorists. Differences in opinion abound. One of the most controversial topics in Schenkerian theory is the question of what types of structures are possible at deeper levels of the analysis. *Initial Ascents* to scale degree 5, the existence of 8-line *Urlinie*,[2] and neighbour tone dominance are deeply connected with these areas. All of the areas of study listed employ semitone relationships as either an argument for or against different structural realities. In this section, I will seek to demonstrate that the influences of semitone relationships on different structural levels are often exaggerated in their perceived importance.

[1] See pp. 15-22 of this thesis.
[2] See Drabkin 2002, pp. 818-21 for further description.

The importance of semitone relationships in music is evident at all Schenkerian structural levels, even on the surface level. The strongest of these relationships create tendency tones. The most universal of these is the leading tone—scale degree 7. Upward motion from 7 to 1 has led to an exaggerated belief in the power of the semitone to create melodic motion. This strong tendency is better understood as a combination of the semitone with the pull of the tonic. This realization helps to avoid giving semitones too substantial an influence on the organization of structure. Another strong tendency tone is that of scale degree 4 in the dominant seventh chord. The major and minor key versions of this chord are identical in their employment of the diminished fifth between the seventh and fourth scale degrees. However, the pull of 4 downwards to 3 is accentuated in the major mode thanks to the semitone relationship between the scale two degrees.

The *Initial Ascent* is a common Schenkerian feature beginning a piece of music. The influence of semitone relationships occurs most strongly in ascents to scale degree 5 where it serves as the *Kopfton*.[3] Allen Forte believes that—in the major mode—scale degree 4 must be raised for a true ascent to 5 to take place (Forte 1959, 18).

In the minor mode, scale degrees 3 to 5 relate to each other by whole tones. There are thus no strong tendency tones that might impede the upward motion to 5. Another factor is that a raised scale degree 4 in minor would produce an augmented second on the climb up to the *Kopfton*. This is a very unusual idiom that does not occur frequently—it contributes nothing to a smooth line. Forte's idea thus applies only to the major mode, where the relationships between tones 3, 4, and 5 differ in an important way from the minor mode. As he describes it, scale degree 4 "tends to lead downward" to 3 (Forte 1959, 18). As a tendency tone, this statement would garner little argument from theorists. However, Forte follows this up with the assertion that because of

[3] See Schenker's *Free Composition,* § 5 for a further description.

the tendency for natural 4 to lead down in the major mode, the chromatic alteration is "necessary" for the motion upward to scale degree 5 to occur (Forte 1959, 19). There is a large leap between *tends* to and *needs* to. This distinction is not addressed by Forte.

Forte cites Schenker to demonstrate his point, but argues unconvincingly against Schenker—simply stating he was mistaken (Forte 1959, 19). Once again, Forte gives no follow-up argument for his critique, assuming that the semitone relationship of scale degree 4 is sufficient support for his point of view—it is not. The language that Schenker uses is much more convincing, describing the chromatic alteration of 4 as an accentuation of the motion up to 5, rather than a necessity (Forte 1959, 18). Forte goes on to describe a specific example of Schenker's "incorrect" reading of Handel's *Air in B-flat*. The motion up to scale degree 5 lacks the raised 4 that Forte desires. Forte adjusts the entire structural form of the piece in order to fit his claim. In Forte's analysis, the *Kopfton* arrival is on scale degree 3, rendering any further upward motion secondary. The biggest issue with this change to seeing it as an ascent to 3, followed by a space opening motion to 5, is that following the arrival at 3, the scale degree 4 on the lower level is still considered to rise up to 5 later—but at a lower structural level—rather than returning back to scale degree 3. This raises the question why at a certain point on the surface level a motion is possible, but at a deeper level it is not. Forte decides at what level the voice leading is possible with insufficient explanation or support.

Here Forte subjects Schenkerian theory to familiar criticism: analysts fit pieces of music to theories rather than allow the details of the work to guide interpretation. It is dangerous to state a rule in musical syntax or form as being universal, as music is particularly open to exceptions to rules—in a way similar to that of the spoken word.

In this case, unlike Forte, Schenker presumably appraised the structure of the piece and decided on his analysis based upon multiple fields of information, including harmonic support, foreground patterns, as well as other factors. However, Forte is adamant that regardless of any other factors, without a raised 4, the fundamental line can't possibly begin on 5 (Forte 1959, 18). Such a decision has far-reaching significance, and there would seem to be too many variables in play for the fundamental structure to be decided by a single semitone relationship.

The frequency with which 8-lines appear as *Urlinie* in the Background level is remarkably low. Even with the weight Schenker gave to 8-lines in *Free Composition*, he included only four examples of such a structure from the over three hundred works analyzed for *Free Composition*. This statistic alone has suggested to many Schenkerian theorists that something must be inherently inferior with the 8-line form.

David Neumeyer addresses some of the most common complaints used to attack the legitimacy of 8-line *Urlinie*. These include a lack of options for harmonic support of scale degrees 7 and 6, the problem of the 7-8 semitone, and the inability of 8-lines to produce an interruption,[4] and the apparent necessity for multiple bass arpeggiations in order to accomplish proper support for the *Ursatz* (Neumeyer 1987, 3). While at first glance these may seem like overwhelming hurdles to the viability of the 8-line, a closer look at the assumptions behind each complaint must be undertaken.

David Smyth responds to the main issues Neumeyer expresses in "The *Urlinie* from 8 as a Middleground Phenomenon." Smyth is dubious of the idea that the 8-line is unable to produce an interruption. He points out that prolongational techniques are possible with this structure and so it should not be perceived as a shortcoming.

[4] See Cadwallader and Gagné's 2007, 116-20 for further discussion on interruptions.

Neumeyer suggests that scale degrees 7 and 6 are difficult to support harmonically on the way to 5. Smyth argues that harmonic support is neither necessary nor desirable at the deepest structural levels (Smyth 1999, 103). He points out that Schenker stipulates that later structural levels are meant to frame unsupported background stretches, so there is no inherent problem with unsupported passages of the *Urlinie*. One possibility that Smyth provides is that of scale degrees 7-6-5 being set as 3-2-1 in key of dominant (Smyth 1999, 104).

The last obstacle that Neumeyer addresses is the necessity of arpeggiating the *Tonraum*—or, tonal space—multiple times in order to adequately support the 8-line. Tying back to the previous idea, from Schenker's point of view there is no issue with unsupported stretches in the background. Later levels may provide support for further prolongation. For this reason, Neumeyer's initial assumption is false, as it is not necessarily true that multiple arpeggiations must occur. At the deepest levels, sometimes one single arpeggiation will suffice for the entire 8-line *Urlinie*. Once again Smyth argues against Neumeyer's premise itself—insisting that there is nothing weaker about a structure that is enriched with more than one arpeggiation (Smyth 1999, 105).

Actively avoiding 8-lines is counterproductive and harmfully rigid. Neumeyer puts forth intriguing alternatives to 8-lines as background phenomenon, but this is brought about by overemphasizing weaknesses in 8-line constructions. In fact, Smyth points out that the rules of strict species counterpoint imply that "maximal clarity and closure would be achieved when both voices of the *Ursatz* begin and end on the tonic" (Smyth 1999, 102).

Strict counterpoint is what Schenkerian analysis' hierarchical structural levels are supposed to be based on, so this is an important note for the perceptual reality of 8-line structures. Setting up empirical testing for 8-line *Urlinie* compared to other possibilities would be highly difficult. The

examiner would need to either find pieces that seem to fit multiple interpretations equally or create their own examples.

Lastly, I would like to set forth my own question about the largely overemphasized effect of the semitone relationship. The question that I will focus on is the difference in significance between upper-neighbour tones and lower-neighbour tones—with a special focus on those neighbour tones that decorate scale degree 3. Similarly to the raised 4 addressed earlier in this paper, the differences in the semitone relationships of the scale degrees between the major and minor modes is a key factor in this argument. Upper-neighbour motions are generally considered more structurally significant in Schenkerian theory—this is evinced by the special notation of the flag that is used for upper-neighbour tones, but not for lower-neighbour tones.[5] The questioning of the dominance of the upper-neighbour over the lower in deeper structural levels is an intriguing area to explore.

Neighbour tones surrounding scale degree 5 are less problematic than those around 3, yet there are still questions about the dominance of the upper-neighbour tone in this position. There is a strong semitone relationship with scale degree 6 in the case of minor modes, so the significance of this upper-neighbour motion is supported by this tendency. However, in the major mode, the same structural dominance is considered to occur, despite the whole tone relationship between 5 and 6 avoiding a strong tendency towards motion back down to the 5. The continued supremacy of the upper-neighbour tone from 5 suggests another factor other than the semitone relationship as the primary influence in the structural motion.

In the major mode, scale degree 4 relates down to 3 by a semitone, and so the upper-neighbour motion leads strongly back to its source. In the minor mode, however, the upper-neighbour motion involves a whole tone relationship. This lack of a strong directional tendency

[5] See Cadwallader and Gagné's 2007, 310: Example 10.30 (a) and (b) to see this notation.

in returning to scale degree 3 belies the continued bias toward the upper neighbor—even in the minor mode. There is no reassessment of the importance of the lower-neighbour tone in minor, even though the semitone relationship is between scale degrees 2 and 3—with the tendency to lead up to the 3, rather than down to the tonic. In short, a contradiction in the importance of semitone relationships is shown in this treatment of the hierarchy of neighbour tones.

On this basis, an argument could be made for an adjustment in the perceived structural importance of lower-neighbour tone motions from scale degree 3 in minor modes. There is another way to explain this general pattern though. Steve Larson explores the idea of "musical forces" in order to explain various tendencies that govern melodic motion in music. The most pertinent force Larson describes is that of "gravity"—the tendency of pitches to fall (Larson 2002, 352). In the cases of scale degree 4 coming back to 3 and 2 leaning more strongly to 1 in the minor mode, gravity is a much more obvious and convincing explanation of the significance. It also explains why lower-neighbours are never as significant to overall structure as upper-neighbours are—lower-neighbours lack the much superior pull of gravity to support the return to the fundamental tone. When scale degree 3 leads down to 2, the pull of gravity creates a tendency to hear it as motion to an inner voice. This tendency makes a move back up to 3 less significant and thus shows that semitone relationships are, in essence, trumped by the musical force of gravity.

This conclusion is heavily supported by Jason Yust's study on key distance relationships. His article demonstrates why upper-neighbours are treated as more important than lower-neighbours in Schenkerian structures, regardless of semitone relationship. As the reader will recall, upper-neighbour structural motion creates the equivalent to a 2-3 accidental difference in key distance relationship, while lower-neighbour structural motion only negates an accidental difference of 2

(Yust 2012, 1174). It is important for research to be done comparing the difference between the significance and prevalence of Schenkerian graphing interpretations and their relation to semitone, gravity, and other musical forces. Like the forces of nature being of varying strengths, it is likely that all of the "musical forces" have differing magnitudes. Larson has already done work on empirically testing his theories and presented his findings in "Measuring Musical Forces" (a worthy supplement to that work is David Huron's extensive data gathered on musical expectation that will form the final section of this chapter).

Another extremely significant implication of this idea of musical gravity that Larson describes is its application to the previous argument for the existence of 8-lines in spite of the upward pull of scale degree 7. The leading tone in this situation could be described as being overpowered by the musical pull of gravity. This is arguably one of the better supports of the 8-line as a viable *Ursatz*.

Throughout this section, semitone relationships have been shown to be touted by prominent theorists as reasons both for and against certain voice-leading structures. Forte insisted that scale degree 4 must be raised for an Initial Ascent to arrive on 5 as the *Kopfton*. This approach was shown to be too rigid, ignoring too many other variables to be a viable stance on the possibilities of *Initial Ascents* in 5-line structures. Smyth showed that Neumeyer's hesitations regarding the 8-line were largely based on premises that are far from insurmountable. With a quick reassessment of the validity of the apparent "weaknesses" of the 8-line fundamental structure, a proper exploration of the rich diversity and contrapuntal possibilities of this oft-avoided form can be undertaken. My own question about the dominance of upper-neighbour tones, regardless of the semitone relationships involved, led to the realization of a greater tendency force being at work. As put forth by Steve Larson, the pull of musical gravity better explains both the higher

structural importance of upper-neighbours as well as more convincingly supports the possibility of 8-lines—despite the strong tendency of the leading tone, due to its semitone relationship with the tonic.

The conclusion I draw here is that semitone relationships assist in more convincingly moving towards certain notes and solidifying the deeper levels, but are in no way *necessary* for certain structural movements to occur. Music is similar to language. Even the strictest rules are open to exception. In this sense it is arbitrary to set finite limits on the possibilities of musical form. While semitone relationships govern many rules and tendencies in the language of tonal music, their influences are never intransigent. Empirical testing further ensures relatively unbiased approaches and understandings of the system of Schenkerian analysis.

Hierarchical Structure

The work by Serafine et al. on structural hierarchy in music—discussed in the first chapter—was replicated by Nicola Dibben through three experiments that tested listeners' ability to match reductions of tonal extracts with their original source. However, several critiques and alterations of Serafine et al. went into Dibben's study.

Dibben concluded that the foil reductions used in the initial study were "not constructed in a systematic way" (Dibben 1994, 5). This was because there were too many changes made between the reduction and the foil, so that the subjects had an easier job of choosing the "right" reduction. However, this was a speculative conclusion—as the improved results of Dibben's own studies after fewer changes to the foil reduction suggest otherwise.[6] Instead, Dibben used only one change of note per foil reduction in order to maximize the similarity of the two reductions—

[6] It is possible that this result was more a product of the higher experience level of the listeners chosen for this study, rather than an incorrect hypothesis by Dibben of the effect that the number of changes between the foil and the reduction have on the ability of listeners to correctly identify the proper reduction.

one being correct, the other being the foil—so as to avoid the foil being too obviously incorrect (Dibben 1994, 5). A further weakness observed by Dibben with the original study by Serafine et al. was that their reductions were "not very 'reduced'" (Dibben 1994, 5). This was exacerbated by the fact that the original studies' examples were each about three measures long and consisted of unaccompanied melodies. To remedy this, Dibben used piano music excerpts up to sixteen measures long as the models from which reductions were made (Dibben 1994, 4). This allowed Dibben further room to limit reductions to one event per measure (Dibben 1994, 5). As a final criticism—mirroring this thesis' own hesitation noted in the first chapter—Dibben agrees that instructions to listeners may mislead the subjects (Dibben 1994, 5). Much care is needed when accounting for unintentional skewing of the data through the influence of suggestion.

While not explicitly stated as a criticism of Schenkerian theory, Dibben chose to use Lerdahl and Jackendoff's structural trees from their time-span reduction method as a replacement theory in order to produce the reductions used in the experiments (Dibben 1994, 2).[7] This lessens the applicability of the study for assessing the perceptual reality of Schenkerian analysis.

All three of the experiments involved three "expert" subjects out of twenty-eight total participants—two of which were music lecturers specializing in analysis and one that was a post-grad music student. The first experiment immediately showed that the "expert" subjects performed at a slightly higher success rate than the rest of the participants—all music students. This is further exemplified by the fact that Dibben's first experiment produced better results than Serafine et al.'s which contained a mixed group of experience levels (Dibben 1994, 7). This data suggests that the ability to match reductions is certainly affected by the amount of musical training that a subject has received. It would be pertinent, however, to redo this study with

[7] Also, see Lerdahl and Jackendoff 1983, 119 for a more detailed explanation of this reduction method.

similar parameters, but with a mixed group of experience levels to compare against the data of Serafine et al. and deduce what factors were the true causes of the difference in outcomes.

The second experiment by Dibben resembled Serafine et al.'s control study that was designed to determine whether choices of reductions were based in part on aesthetic judgements. Dibben did an independent study of her own to test if the choices of reductions in her first experiment were made simply based on the relative "internal coherence" of a given reduction, rather than from an ability of the study participants to deduce the reductions that represented the "correct" structural skeleton behind the surface of the music (Dibben 1994, 12). The experiment results reveal "a significant difference between the coherence of reductions, [but] it does not appear to be a factor in choosing the best matching simplified version of an extract." Instead of internal coherence, the data suggested that subjects "form event hierarchies for pieces of tonal music based on the *stability conditions* of tonal music (Dibben 1994, 14).[8] However, unlike Serafine et al., Dibben used the same participants in both studies. This ensured that other factors were not at play in the results, such as different aesthetic preferences between groups that could have skewed the data. This detail is a further area in which Dibben's study is superior to Serafine's methods and procedures.[9]

Dibben designed a third experiment in order to determine whether the cognition of hierarchical structure is also transferable to atonal music. The third experiment showed that listeners have a harder time with atonal extracts than tonal ones. The study participants were unable to match structural reductions of the excerpts to their original sources (Dibben 1994, 20).

[8] The designation of "tonal music" was used in the quote of Dibben because of the results of the third experiment described below.

[9] This was presumably because of hindsight that the earlier study by Serafine et al. used different participants, as they may have realized the need for a control experiment after the original study had been completed. Despite this, it is still important to note that such a process is inferior to the well-planned one that Dibben accomplished in her experiments.

This led Dibben to conclude that "atonal music may not facilitate the inference of hierarchical relationships between events" (Dibben 1994, 23). It is safe to assume that a similar limitation of applicability would be found using traditional Schenkerian theory's structural reductions on atonal excerpts, but only the replication of this study through those means could demonstrate this for certain. The inability of study participants to distinguish reductions from foils in atonal examples once again complies to David Temperley's suggestion that Schenkerian theory as a model of perception should be measured not only on its ability to predict patterns within tonal music, but its inability to do so in other contexts—in this case, atonal music.[10] This shows that the perception and cognition of hierarchical structure in music is likely largely a tonal phenomenon.

The final conclusion became that "reductional analyses appear to represent abstract concepts: the musical events at the higher levels of a reduction represent relationships between lower level events and not simply a reduced structure." Listeners are able to deduce a "structural skeleton" from the surface level of the music that represents a deeper structural level of the music (Dibben 1994, 24).

At this point, it becomes clear that a call for a catalogue of all structural level studies to be redone using Schenkerian principles is a necessary step for the understanding of Schenkerian theory on a perceptual and cognitive basis. By keeping all of the parameters the same except the replacement of Lerdahl and Jackendoff tree structures with Schenkerian reductions, this provides a great ease of study replication.[11] This will serve to encourage the undertaking of studies by removing hurdles to their implementation.

[10] See the discussion on Temperley in Chapter 1, pp. 22-27 of this thesis.
[11] Narmour's "Implication-Realization" model is another Schenkerian alternative that is often used instead. See Narmour 1990 and Narmour 1992 for more details of his approach.

Large-Scale Tonal Closure

Despite the suggestive support of the perceptual reality of hierarchical structures in tonal music, studies conducted by both Cook and Marvin, alongside Brinkman, on the limitations of structural levels in the testing of large-scale tonal closure call into question the extent to which this is applicable. Their research proposes that the deepest level of the Background is more of an intellectual exercise of the organic origins of the Middleground and Foreground than something that can actually be heard and mentally distinguished during listenings.

Nicholas Cook's findings were straightforward in concluding that "the direct influence of tonal closure on listeners' responses is relatively weak and is restricted to fairly short time spans—much shorter than the duration of most tonal compositions" (Cook 1987, 197). The experiments took original works and either kept them as they were or spliced them with different keys than the sections would originally be. Cook describes large-scale tonality in that "the intervening keys are to be thought of (or, as musicians say, 'heard') as dissonant, so that the return to the 'home' key is experienced as a resolution, and this resolution is responsible for the sense of satisfaction and completion created by such music." He explains that this is the basic thought of theories of hierarchic structure such as Schenkerian analysis (Cook 1987, 198). Countering the significance of this idea of large-scale resolution, it was found that only in pieces shorter than a minute was the original version preferred aesthetically. Thus, it would seem that large-scale tonic tonal closure is less functionally important to perception. However, Cook does argue that large-scale tonal closure—regardless of its perceptual reality—is still important in compositional organization.

The support was much less clear in a study by Marvin and Brinkman that was inspired in large part by Cook's own work on the subject (Marvin and Brinkman 1999, 390). They chose to

focus instead on expert listeners in the traditional sense—highly trained musicians. Marvin and Brinkman wanted to eliminate the expressive judgements necessary in previous studies—including Cook's—because untrained musicians are generally unfamiliar with musical language and the explicit discussion of musical concepts. Instead, they "asked participants to make only music-structural judgments" (Marvin and Brinkman 1999, 392). This is why the study was unable to incorporate musically uneducated subjects.

The study included two experiments to see if their tests could provide more positive results for the perception of tonal closure over large time spans. The first experiment exposed experienced musicians to modulating and non-modulating musical excerpts in their "original" form and asked them to discriminate between them. The initial experiment showed a correlation between higher accuracy and more formal training, as "music scholars were most accurate overall" (Marvin and Brinkman 1999, 396). This was the result that the team was looking for, but contradicts the findings of Cook's experiment.

Looking to replicate this promising outcome, Marvin and Brinkman came up with a second experiment in which "listeners heard complete compositions that began and ended in the tonic key (but contained modulations in the middle), or they heard manipulated versions of these compositions in which the formal units were rearranged." Unfortunately, the results of this second experiment matched with the original Cook research (Marvin and Brinkman 1999, 396). Marvin and Brinkman concluded that the contradictory results from each experiment could be due to the test subjects using the typicality of compositional cues in order to determine whether a passage was part of the closure of a piece. The most important detail here is that the cue was not pitch itself (Marvin and Brinkman 1999, 406). This is crucial to understanding Schenkerian theory, as the pitch spaces of a tonal work are vital to the background structures of the analysis.

An inability to recall these structures at larger time scales is problematic for the validity of the theory on the level of cognition and perception. It seems that the second experiment contained examples with far more misleading compositional cues that could be responsible for the results of both experiments. This conclusion suggests that experienced listeners may be less attentive to the key areas of a work and distracted by the surface level of the music. With only one of the two experiments going against the existing data, it is currently reasonable to conclude that large-scale perception is limited even in highly-trained musicians.

From this data, one might conclude that the extension of Schenkerian large-scale structural perception is accessible only to the highest of trained musicians—if it is available to perception at all. However, the result of the first experiment could very well have been an anomaly. This seems to be the likeliest of options because of the data that has been reviewed up to this point. Replication of both experiments is highly recommended in order to discriminate the nature of the original results. The potential to use Schenkerian masters as test subjects to compare against the performance of other musicians and non-musicians is discussed at the end of chapter three of this thesis.[12]

Huron's Conception of Musical Expectation

Finally we come to the methods and empirical results of David Huron. His work on tonal music and musical expectation was the main inspiration for this foray into the interdisciplinary field of music perception and cognition. Huron's approach is all-encompassing in its attention to detail. He gathers data from as many sources as possible and looks at each problem from multiple angles. Huron's exemplary methodology is the ideal that this thesis suggests be used for further

[12] See pp. 66-68 in this thesis.

studies done in the perception and cognition of Schenkerian theory.[13] It is no wonder then that the most intriguing research project proposed by this thesis comes from the work that he presented in his book on musical expectation—*Sweet Anticipation*. This project will be elaborated on below, but first; a breakdown of his methods and their general possible applications will be undertaken—beginning with the latter through the work of one of his most prominent students, Paul von Hippel.

One of the crucial differences between Huron's approach and that of other music perception and cognition scholars is his insistence on data collection of music itself. Rather than only focusing on the perceptions of the music, he also analyzes the statistical tendencies of real compositions and does so in larger quantities. For this to be viable, some understanding of computer programming becomes necessary to set up these surveys of great numbers of actual pieces and excerpts of music. Huron instilled this process in von Hippel and it allowed him to make an astute observation about the perceptions of a particular melodic rule. He set out to show how views of musical rules such as "large leaps are followed by a step in the opposite direction" are affected by the statistical actuality of the music itself and can be used to better explain rules of this nature (von Hippel and Huron 2000, 59). His discovery is used in order to extrapolate this reimagined driver of musical rules towards the understanding of Schenkerian theory. This is especially applicable, because *post-skip reversal* has been considered to be—and taught as—a basic tendency of melodies for years. Counterpoint has many rules and Schenkerian theory—especially in its more reduced formal analyses—is heavily governed by these rules. Through both von Hippel and Huron, it will be shown how perception and cognition can better explain some of the arbitrary rules of voice-leading and —particularly the "lesser" nature of the Initial

[13] Huron's method is so useful, in fact, that I would recommend it in any project regarding the perception and cognition of music.

Ascent when compared to the descent of the *Urlinie*. However, the latter subject will be addressed later on in this chapter.

Von Hippel first carried out his own independent research on *pitch proximity.* From the data that he collected, von Hippel concluded that constraints on *tessitura* and *mobility* are a much better explanation of the phenomenon of *pitch proximity* than the traditional definition of it simply being a "tendency for small pitch intervals to outnumber large ones." He details "several advantages" to the new viewpoint. The original definition only enabled the prediction of interval sizes, while the new definition is able to predict the direction of the interval as well. Furthermore, the normal definition only predicted small intervals in a general way—compared to the newly proposed that "predicts context-sensitive variations in interval size" (von Hippel 2000, 315). The use of this new definition creates "a sharper and deeper description of melodic structure" (von Hippel 2000, 326).

With a new definition of *pitch proximity*, von Hippel joined Huron to present findings about *tessitura*'s impact on melodic structure through the question of the origin of *post-skip reversal*. Von Hippel and Huron offered three different theoretical accounts of *post-skip reversal*. Two of these were generative models based on listeners' expectations, while the third model suggested constraints on melodic tessitura alone as thoroughly accounting for the phenomenon. The tessitura model was favoured because from the data gathered in von Hippel's previous study, the "accounts based on expectation do not seem necessary to explain post-skip reversal (von Hippel and Huron 2000, 61).

They designed two hypotheses to measure the effect of *tessitura* on *post-skip reversal* and they were as follows: "when tessitura constraints are statistically controlled, the tendency towards post-skip reversals will disappear" and that "when tessitura constraints are imposed on

any melody…skips in that melody will tend to precede reversals. In fact, post-skip reversals in a random melody will be just as common as in a comparable melody of non-random origin" (von Hippel and Huron 2000, 64). When the idea is thought about logically, it seems immediately evident that large interval movements are more likely to be directed towards the extremes of a tessitura. Von Hippel and Huron conclude themselves that "from the extremes, a melody is nearly obliged to retreat by changing direction" (von Hippel and Huron 2000, 64).

The results were conclusive. They found that the clearest data came from the generation of random melodies. Directly predicted by the second hypothesis, the result was that "post-skip reversals are just as common in random melodies as in folk songs and Lieder." Furthermore, "post-skip reversals will occur in *any* melody unless the composer has [actively] taken steps to avoid them" (von Hippel and Huron 2000, 81). If *post-skip reversals* are simply products of probability relating to the departure from the mean of a given piece or instrument, then its previous definition is not very useful in predicting musical patterns. The predictive powers of the two hypotheses stated above are too impressive to ignore.

The final conclusion is quite clear: "it seems that post-skip reversals arise from constraints on tessitura." Melodies change directions quite simply "because they lack the space to do otherwise" (von Hippel and Huron 2000, 83). The reality of the data revealed that listeners' expectations were not responsible for composers doing their best to write in such a way as to accommodate them. Instead, the logical constraints of voice range amply describe the behaviour of Western tonality's melodies and better predict its various possibilities.[14] This is an excellent demonstration of how the understanding of musical rules or tendencies can be rethought and better understood through the lens of both perceptual testing, *as well as* data collection—and

[14] Voice range is meant in a general context here to represent any instrument—whether that is the human voice or any other external musical device.

using this data for further testing, as was done here. The same will be accomplished through the further exploration of Huron's research.

From von Hippel's two studies, a grasp of the depth of Huron's basic approach to perception and cognition can be gathered. His method is comprehensive on a scale that far outweighs the other approaches covered during the collection process for this thesis. Aside from the inclusion of the data collection and categorization of real musical material and its norms, Huron's method includes two very important additions to the standard experimental approach in music perception and cognition. These are: the creation of cognitive theories based on the cumulative data and any contradictions that may exist between them, and the deduction of evolutionary causes for the cognitive mechanisms to be in place. These two additional approaches will be explained more thoroughly through examples that become pertinent to Schenkerian theory.

Huron's work on musical expectation forms the groundwork for the main hypothesis presented in my thesis project. Huron first introduces the ITPRA theory—which is his psychological theory of general expectation, and the underlying theory behind his account of musical expectation—in the preface of *Sweet Anticipation* (Huron 2006, vii). It is largely explained from the perspective of evolutionary theory. As "from an evolutionary perspective, the capacity to form accurate expectations about future events confers significant biological advantages. Those who can predict the future are better prepared to take advantage of opportunities and sidestep danger" (Huron 2006, 3). The ITPRA theory is described through emotional responses of which the details of the process are as follows: the ***I****magination Response*, which is the ability of the mind to imagine future outcomes; the ***T****ension Response*, which involves the preparation for an event—by matching arousal and attention levels to the expected outcome; the ***P****rediction Response*, which reflects the general pleasant or unpleasant

feeling organisms would experience from either correctly or incorrectly predicting the outcome of a given situation; the ***R**eaction Response*, which is subtly distinct from the *Prediction Response* in that the reaction is related to the reality of the outcome, not the expected nature of it; and finally, the ***A**ppraisal Response* follows the quick and unconscious *Reaction Response* but incorporates a more informed reaction to the outcome. Huron uses the example of an experimental biologist walking in the forest who is startled by a large spider that drops onto her shoulder, but quickly her perception of the event turns to joy when she realizes she may have discovered a new species (Huron 2006, 8-15). These form the building blocks for predicting and assessing the perception of tonal music by listeners.

Particularly important for his theory of melodic expectation is the *Prediction Response*. If an organism receives positive feelings for correct predictions and negative feelings for incorrect predictions because of the *Prediction Response*, then naturally the brain would develop a structure that would maximize the ability to properly predict events—in this case musical events. The brain would do this through the cataloguing of all of the stimuli it received in order to produce its own assumptions about future events. This is the cognitive process Huron describes as *statistical learning*. Huron states that the "optimum inductive strategy is to *expect the most frequent past event*." This inductive strategy of *statistical learning* is done through exposure to tonal music (Huron 2006, 360-61). Importantly for this thesis, it is an unconscious process—the staggering number of calculations, the memory required to make sense of them, as well as the complicated algorithms needed to use them for prediction are far too complicated for the conscious brain to untangle. This is the beauty of the unconscious mind.

When it comes to using expectation in the lab, Huron employs various methods to demonstrate that a given stimulus was expected, but the most oft used is the *Reaction Time*

Method. This method relies on the accepted fact that "when you hear an expected sound, you will typically be able to process it more quickly and respond to it faster" (Huron 2006, 51). Thus, response times become incredibly important in the understanding of how subjects are perceiving stimuli.

Huron describes his evolutionary theory of expectation as nearly akin to another physical sense. "Our senses are adaptations that select, distill, augment, and (sometimes) deceive" (Huron 2006, 355). This unintended consequence to, on occasion, deceive becomes very important now that we come to the data that Huron's empirical research uncovered pertaining to the concepts of *step inertia* and melodic arch.[15] *Step inertia* is a term coined by Huron's student—Paul von Hippel—to describe the tendency of step-wise motion in a given direction to be followed by step in the same direction. However, it became clear through an extensive survey of compositions that this tendency is only there for descending steps. The tendency for ascending steps to be followed by another in the same direction was no better than chance levels. Huron discovered that while listeners expected both ascending intervals and descending intervals to continue, the compositional reality only pertains to descending steps—as 70% of them are followed by another descending step (Huron 2006, 78). In response to this conundrum, von Hippel proposed an explanation based on expectation as a sense that is deceiving the greater mind. He discovered that "if ascending and descending steps were equally prevalent, then a step-inertia expectation would prove correct in just over 60 percent of cases. But ascending steps account for only about 42 percent of all step motions. This further reduces the penalty for wrongly expecting that an ascending step is likely to continue in the same direction." This results in the fact that "on average, a step-inertia expectation will prove correct in roughly 62 percent of cases." What

[15] An excellent example of the tendency for senses to deceive your mind is the phenomenon of optical illusions, in which our brain's attempts to make sense of the sensory information—that are usually quite successful at interpreting stimuli in most cases—are tricked by unusual external stimuli.

explains this curious inaccuracy is that if our brains used a more "correct" prediction method of only expecting *step inertia* when it comes to descending intervals, the prediction rate would be identical at about 62 percent accuracy (Huron 2006, 79). The brain is a marvelous computational device, so making use of an easier algorithm—that all step-wise motion tends to be followed by step-wise motion in the same direction—to get the same prediction rate is an efficient, if inaccurate, strategy. The result is that the reality of *step inertia* actually corroborates the general sentiment of Schenkerian theory that descending step-wise motion is more important, as well as more prevalent. It should be noted that these results are analyzed from the very surface level of the music, and so are especially subject to revision if more Schenkerian-specific research were undertaken and applied to this idea. Their usefulness is further called into question when we look at melodic arch.

Melodic contour describes the overall direction that a phrase moves in a given context. Several different melodic contours are possible, the simplest of which are the following: ascending, descending, concave, and convex (melodic arch). Huron ran a survey of thousands of Western tonal melodies in order to deduce the most common patterns. The results showed that "convex contours [are] four times more common than concave contours." The exact numbers being 40% convex to 10% concave. Ascending and descending phrases accounted for half of all contour types between them—or roughly 25% each. However, "further analysis showed that ascending and descending phrases tend to be paired together (thus forming an "arch" over two phrases). Moreover, while ascending phrases tend to be followed by descending phrases, the reverse is not true" (Huron 2006, 85-88). The overwhelming prevalence of melodic arch—since it pertains more thoroughly to the deeper structure, or melodic contour, of a piece—in tonal phrases has a larger impact on the perception of Schenkerian theory. It also seems to contradict

the surface level data predicted by the tendency of *step inertia*. Direct testing will be necessary in order to distinguish the factor that more clearly affects the deeper structural. This thesis maintains that it is the phenomenon of melodic arch that is the most promising.

Another addition—once more inspired by Huron's work—to the proposed methods of further empirical study on Schenkerian theory comes in the form of the meta-analysis of Schenkerian graphs/analyses.[16] Again, this is drawn from Huron's computational analyses of many tonal melodies and pieces to collect a breadth of data on the norms of Western tonal works. These are then used to compare and contrast the way that listeners expect these things to unfold. Such an undertaking with Schenkerian analyses would assist in multiple areas, including: the argument for the best methodology, figuring out which school of Schenkerian analysis is closer to the reality of perception studies, comparing Schenkerian theory's stated parameters to the way that Schenkerian analysts actually use the technique in practice—as well as comparing the analyses to the survey of the norms that occur on the surface level of the music. This would be especially useful for the proposed investigation into the relative importance of the *Initial Ascent* in Schenkerian graphs.

What could these two conclusions about *step inertia* and melodic arch mean for the function of the *Initial Ascent*? This thesis maintains that a reimagining of its structural importance could take place with further direct research. In testing the prevalence of the *Initial Ascent*, a computer analysis of Schenkerian theorists' use of the idiom would allow us to see what percentage of analyses have it and how prevalent it is during analyses—included in the measure of prevalence would be what percentage of the work experiences the *Initial Ascent* and its currently "lesser" repeated forms later on in pieces, returning the melodic line to the original *Kopfton*. If incredibly prevalent, then the arc phrase may be more important in tonal hierarchical structure than

[16] A further discussion of how this might be possible is touched upon in the Conclusion to this thesis, pp. 71-72.

Schenkerian theory currently gives it credit for and it is simply the error in the way the brain's predictive algorithm organizes itself that has listeners mistakenly expecting melodic lines to continue to fall—missing the larger tendency of the melodic arch shape to characterize Western melodies.

Connected with the nature of *step inertia* and melodic arch, Temperley's propositions about *Zuge* become more easily tested.[17] Seeing *Zuge* as mini-descents is the standard understanding given to us by Schenkerian theorists. However, with the possible increase in importance of the *Initial Ascent*, its analogous structures within the work could become as important as *Zuge* in a new understanding of the theory. This would be a follow up study to the survey and experiments about *Initial Ascents*.

Huron's tonal research is based on the fact that the brain learns the tonal language merely through exposure and that music prediction is largely an unconscious activity. Does this apply to Schenkerian theory as well, since it is based on the syntax of tonality? This idea is corroborated by Serafine and Temperley's research on the perception of hierarchical structure, in which it appears that the perception of these structures is largely an unconscious activity, and that the more attention brought to structure, the more surface detail becomes important—rather than the opposite. This question will be further analyzed in the next chapter.

Conclusion

This chapter began with an exploration of music perception and cognition's potential to settle arguments over disagreements in Schenkerian theory. Several important writings on the subject of the impact of semitone relationships on Schenkerian interpretations—such as Forte (1959), Neumeyer (1987), and Smyth (1999)—were consulted and analyzed through the lens of

[17] See the discussion in Chapter 1of Temperley's approach to *Zuge* on pp. 24-25 of this thesis.

applicable tonal perception research. Larson (2002) and Yust (2012) were invoked to suggest that semitone relationships are subordinate to the pull of musical gravity and neighbour tone connections in influencing interpretations.

Following this, Dibben's revised set of experiments based on Serafine et al's original research was presented and further critiqued for its own weaknesses. Cook (1987) and Marvin and Brinkman (1999) were presented in order to suggest that However, all of these models lacked the data collection of real music to compare, contrast, and understand the results they received with the norms of the music itself. Huron's former pupil, von Hippel (2000), was offered as an example of a study that would not have produced accurate results without the addition of data collection on tonal music in general paired with the perception research. In this case, the subjects' perception of the reality of post-skip reversal was an inaccurate expectation predicted by the brain and that the constraints of *tessitura* more accurately described the norms of music. Finally, Huron's own methodology and research on musical expectation was reviewed—especially his work on refining the idea of statistical learning that the unconscious brain employs to predict sounds as it applies to music.

The problem of the absence of the data collection of the norms of tonal music could be remedied by applying Huron's methodology to future studies. In summary, further research might take the following forms: (1) The repetition of promising studies: this should be much more oft used because the parameters are all there. The only requirement is to assemble a sample group, which is much easier to accomplish than creating your own study from scratch. (2) The tweaking and repetition of studies: this one is only slightly different than the previous point, but the important difference is that some parameters of the original study are changed—either in order to improve the study results or to change what the results are applicable towards. (3) The

Schenkerian-izing of general tonality studies by extrapolating their results and applying them towards important research questions and hypotheses. (4) Finally, expanding to the full model of Huron from theories to general data collection to compare perceptual results and compositional realities—an important addition to this process being the survey of Schenkerian graphs on given works to compare, contrast, and catalogue the behaviour of Schenkerian analyses and any patterns that are illuminated.

Chapter 3

Musical Training and Perception

In this chapter, I shall consider the effect of musical training on perception. In preceding chapters, we have identified areas in need of further research—as well as the optimal method of collecting and analyzing such research. It would be pertinent here to look into unapproached areas and further expand our investigation into the theory. Our hope is to come to some tentative conclusions that will themselves be in need of further Schenkerian-specific research in the future. This will be the purpose of the final chapter.

To begin, I will briefly review examples of the variance in the training level of subjects in the studies covered in the previous two chapters. Subsequently, I address the major hypothesis of this thesis—that the unconscious plays a major role in the perception of Schenkerian structures—and speculate what the studies covered in the rest of the chapter can do to support this claim. This first research that I consult involves research headed by Morrongiello (1989, 1990) that investigates the effect of musical training on the perceptive capabilities of children. Morrongiello notes significant differences in these faculties between children at the ages of five and nine. The main section of this chapter deals with a review of the musical capacities that do not rely on musical training. Through the research of Bigand and Poulin-Charronnat (2006), this thesis' major hypothesis finds greater support in the importance of unconscious learning in the perception of Schenkerian analytical structures. The chapter concludes with a concise list of

suggested future tests and subjects to use in order to further support the research conclusions of this chapter.

Musical Instruction and Perception

The effect of instruction on the perception of tonal music has been studied in the past few decades. Some of the empirical research studies discussed in the previous chapters have shown that unconscious learning and processing of information is a crucial component of Schenkerian perception. Serafine et al. and David Temperley noted this in their Schenkerian-specific articles.[1] David Huron's entire approach to musical expectation is based on this concept as well. This makes it an important question to supplement with further research, as Schenkerian theory was specifically designed as a theory of tonal music.

Many of the studies analyzed in this thesis used either undergraduate students with varying levels of musical training or music students ranging up to ten or more years of instruction. Serafine et al., for example, involved an assortment of training experience levels—as a quarter of the subjects had no training, while a quarter had only 1-4 years training, another quarter had about 5-9 years of instruction, and finally the last quarter had 10+ years of direct musical training (Serafine et al. 1989, 399). Contrast this to Yust's participants: sixty-one undergrad music majors whose base instruction level would clearly be higher than the average of the broad university population (Yust 2012, 1173). It is conceivable that these great variances within and between studies could have drastically influenced the resultant data. This possibility will be addressed and refuted by the research reviewed in this chapter.

It is probable that the perception of Schenkerian structures is based on unconscious learning. The traits utilized by Schenkerian analysis in general are characterized by this factor. Despite

[1] See Chapter 1, pp. 13-25 of this thesis.

Schenkerian theory usually being taught at the highest level of musical academic instruction, Schenkerian analyses themselves have always been thought by practitioners (including Schenker himself) to be done largely through intuition of the way the music *sounds.* It may be that *explicit* awareness and understanding of Schenkerian/tonal principles is based on *explicit* learning, but that most of the *implicit* understanding and perception of these concepts is unconscious and produced simply through sufficient exposure.

The idea that trained musicians will be better able to describe and detail their listening capabilities in a way that an untrained individual would be unable to leads to the erroneous assumption that the non-musician is unable to perceive these details. Comparisons between tonality and language become suggestive here. While a native English speaker may understand the language because of experience, without explicit instruction they may not be able to describe the language in a satisfying manner. In Lerdahl and Jackendoff's book, *A Generative Theory of Tonal Music,* they concluded that listeners devoid of deliberate musical training could still be considered "expert listeners" in their ability to perceive musical structures—as long as they had sufficient exposure to Western music. But they do so simply in a "more limited way" (Lerdahl and Jackendoff 1983, 3).

Musical Training's Effect on Children

How much exposure is sufficient to implicitly learn musical patterns? Barbara Morrongiello headed research teams in two important studies that illuminated the answer to this question. She tested the differences in measurements of melodic perception made by musically trained and untrained children (Morrongiello et al. 1989). The initial study tested four to six-year olds in the discrimination of transformations in a given unknown six-tone melody. "Results revealed that

discrimination performance varied as a function of (1) musical training, (2) what features of a melody were changed, (3) number of features of a melody that changed, and (4) rate of presentation" (Morrongiello and Roes 1990, 447). They also discovered that the musically trained children "showed enhanced sensitivity to the more specific melodic features (i.e., individual frequencies [and musical intervals])." The raw numbers of the study demonstrated that musically trained children averaged a 65% success rate across experimental conditions versus 40% in untrained children (Morrongiello et al. 1989, 454). This result shows that musical training does have a marked effect on perception at this age level and in this particular context—surface-level note changes. The study also reported that untrained children focused largely on general pattern features such as the contour of the melody and required more observable change to discriminate the transformations present than musically trained children did (Morrongiello et al. 1989, 448). After Morrongiello, it has become clearer that musical training can enhance the process of learning-by-exposure.

This conclusion is enhanced in the second study, published the following year. Several changes were made to this study—the most important of which being the age groups chosen. Instead of four- to six-year old children, for this study Morrongiello selected only five- and nine-year olds—separating the subjects into two distinct age groups (Morrongiello and Roes 1990, 817). This allowed for a clear pattern to emerge with respect to age differences and not just musical training or lack thereof. Instead of identifying note differences, this study focused on the discrimination of changes in melodic contour (Morrongiello and Roes 1990, 817). The melodies were also altered to contain nine tones—rather than the previous six—presumably in order to better facilitate more contour changes over the span of a single melody.

The results produced quite intriguing answers, as a significant difference began to be seen by nine years of age, especially in the untrained musicians compared to their five-year old counterparts. For the most part the differences are presumably from the insufficient exposure to Western tonal music at the age of five versus that of a nine-year old (Morrongiello and Roes 1990, 819). However, musical training does seem to accelerate this process of learning—the effect of which slowly diminishes over age, as demonstrated by a larger gap between the taught and untaught children at the younger ages of roughly five years old.[2] Morrongiello and Roes thus concluded that the "sensitivity to diatonic scale structure of Western music emerges between 5 and 9 years of age. Children apparently implicitly acquire this knowledge on the basis of exposure to tonal music in much the same way that they acquire language, that is, without conscious effort or formal training" (Morrongiello and Roes 1990, 819). This effectively answers the question of when the exposure to Western tonal music has reached a critical mass age at which the brain has been sufficiently developed to perceive tonality's regular patterns.

An important side note follows a suggestion of Temperley: predictive power should be less effective outside of the area a theory is designed to deal with. This study shows that five-year olds are equally challenged to distinguish between tonal and atonal melodic contours—but by nine years old, children performed noticeably better for tonal versus atonal melodies (Morrongiello and Roes 1990, 817). The statistical learning process that Huron postulates from the data sets he possesses corroborate this occurrence—as does Dibben's study on the perceptual reality of structural skeletons in tonal music, but not in atonal music.[3]

[2] Taking into account the ages of the children in the previous 1989 study.
[3] See Chapter 2, p. 43-44 in this thesis.

A Review of Musical Capacities That Do Not Rely on Musical Training

I find further support for my hypothesis on the importance of unconscious processes in the extensive article review on "the musical capacities that do not depend of formal musical training" by Bigand and Poulin-Charronnat. They approached their study and review of the material expecting a stronger effect of high levels of musical training and were surprised by several of their findings.

Bigand and Poulin-Charronnat note that there tend to be two approaches taken with regards to the effect of explicit training on perception. On the one hand, people with enough exposure can be considered "experienced listeners"—as corroborated by Lerdahl and Jackendoff—but will have fewer abilities than trained musicians. On the other hand, they argue that "musical competence is mostly determined by an intensive musical training and remains rather rough in untrained listeners." An offshoot of this second approach is the belief that these skills develop naturally up to the age of ten, but after this point there will be no improvement without explicit musical training (Bigand and Poulin-Charronnat 2006, 101). The window of the previous study by Morrongiello falls just short of age ten, so further studies comparing pre-teens, teens, and adults would be useful in testing this belief.

The initial test conducted upon trained versus untrained listeners was to perceive underlying structure by distinguishing links between variations of a theme and its source. This test is very similar to the Schenkerian idea of structural levels and the concept of composing-out, as the composer has literally elaborated around a structural skeleton that is quite a bit more obvious than traditional Foreground skeletons compared to the surface level of the music. This is because there can be a direct comparison between what are supposed to be identical hierarchies. The results turned out to be remarkably similar to the study by Serafine et al.—which found that

those with ten or more years of training averaged a success rate of .66 versus .56 for those with no training whatsoever(Serafine et al. 1989, 403)—in that 72% were answered correctly for trained musicians and 58% for untrained subjects (Bigand and Poulin-Charronnat 2006, 105). Bigand and Poulin-Charronnat were surprised by the relatively high rating of the untrained musicians (Bigand and Poulin-Charronnat 2006, 105). While there was a significant difference between the two groups, the untrained subjects still performed better than chance in a statistically significant way. This will come as no surprise to the reader given the previous studies that have been covered in this thesis, but it is important to note. It seems that the unconscious' role in perception has not become well acknowledged despite available evidence for that being the case.

Bigand and Poulin-Charronnat note that it is "well established in several domains of cognition that the ability to anticipate events is a major characteristic of expertise" (Bigand and Poulin-Charronnat 2006, 108). This is shown to not necessarily be the case in music, however. This conclusion is contradicted by the results of their own study of expectation and also matches up with Huron's conclusions on the subject.[4] Expertise in music seems to simply mean exposure.

One of the few areas in which Bigand and Poulin-Charronnat found a significant difference in training was in the recognition speed for musicians at extremely fast tempos. However, in this context the tempos were so fast that they would never be used in an actual piece of music. This renders these findings relatively unimportant for the topic of music perception (Bigand and Poulin-Charronnat 2006, 113).

Bigand and Poulin-Charronnat studied the processing of large-scale structures in music, which is of particular interest to Schenkerian analysis. They did so by asking subjects to memorize several short segments of a Haydn sonata that were either in the proper order, or shuffled so as to make no syntactical sense from a musical perspective. Remarkably, the

[4] See the discussion of Huron in Chapter 2, pp. 47-56.

untrained subjects performed similarly to the trained musicians. This striking finding, "which differs from what has been systematically reported in studies on expertise in other domains, suggests that musically trained listeners may not have a better comprehension of large-scale musical structures than non-musicians" (Bigand and Poulin-Charronnat 2006, 114). They add that "all these findings support the view that there is an initial predisposition of the human brain for music processing" (Bigand and Poulin-Charronnat 2006, 120).

Bigand and Poulin-Charronnat make a point of noting those that will ask why this data seems to contradict the anatomical and functional structure differences between musicians and non-musicians. In a pre-empted response they call attention to the fact that these changes mostly occur in the areas devoted to motor skills, sensory skills—such as differentiation of timbres—or to "very specific analytic perceptual processes" (Bigand and Poulin-Charronnat 2006, 125). This shows that there is no inconsistency between the results of these perceptual studies and the neurological discoveries that have been made in the last few decades regarding the effect of musical training on the observable physical structure of the brain.

The final conclusion of Bigand and Poulin-Charronnat is that "supplementary training in music schools…is not what determines the musical ability of human beings"—where *musical ability* is defined as the perception and cognition of music (Bigand and Poulin-Charronnat 2006, 126). "The human capacity to perceive and process music…rests on fast-acting and irrepressible processes that enable us to extract subtle musical structures from short musical pieces" (Bigand and Poulin-Charronnat 2006, 119).

Their work needs to be expanded by comparing regular subjects to those of true experts—rather than just highly-trained musicians in university programs. As Huron notes in *Sweet Anticipation*, no controlled studies to check if analysts are "unduly influenced by confirmation

bias" currently exist (Huron 2006, 97). This is a reality for music theory in general, not just Schenkerian theorists. However, Bigand et al. are skeptical that a significant difference would be found, given their current data (Bigand and Poulin-Charronnat 2006, 122). The argument that experiments not done on Schenkerian experts are flawed is thus a weak one, but because of the lack of data this sentiment cannot be refuted with full confidence. Another counter argument is that experts are such a small percentage of the listening public—as well as being a small fraction of the music world—that any data they could provide would either be too small a sample size for reliable conclusions, or relatively useless in forming a general theory of music. If Schenkerian theory were only perceivable by Schenkerian experts, would it really be all that useful as an analytical theory of tonality?

Advanced testing of Schenkerian skills should be undertaken. The initial focus should be on getting study participants at the Schenkerian master level. If this can be done, then subsequent testing of the parameters can be duplicated at the lower experience levels of the scale. The following scale of expertise could be adopted: at the bottom untrained subjects, then amateur musicians, music students in university or college, professional musicians with post-secondary academic music education, Schenkerian-trained academics, and finally Schenkerian masters[5]. Internet conference technology of today such as Skype and FaceTime would allow for such studies to be undertaken on a large scale and with a broad range of demographics and locations.

The initial study should follow the parameters of Serafine et al. or Dibben in testing an established result against the specific differences in success rate between the various experience levels. Detailed self-reported musical experience should be collected as part of the study, preferably submitted as a component questionnaire beforehand. Another detail of studies that

[5] A Schenkerian "master" would be any academic who specializes in Schenkerian theory and is an accepted authority on the subject.

often seems to be missing is getting post-test feedback on how the subjects responded to the test parameters. This would also help to adjust test parameters in future studies so as to get the most accurate results possible.

Conclusion

This chapter considered the following areas of research related to the hypothesis of unconscious perception's importance in the understanding of Schenkerian theory in empirical research: (1) The effect of musical training and passive exposure to tonal music on children was considered through the work of Morrongiello et al. (1989) and Morrongiello and Roes (1990). Morrongiello et al.'s research showed that untrained children at the age of five perform poorer on tests than musically trained children of the same age and untrained children at least age nine. My conclusion was that statistical learning is either insufficiently developed—or that more passive exposure is necessary to reap the benefits of statistical learning—at the age of five years old. (2) A review of the musical capacities that do not rely on musical training was studied through the research of Bigand and Poulin Charronnat (2006). Through their compilation of research, further support for the importance of unconscious learning was provided in the relative lack of differences between the test results of trained and untrained subjects in various areas. (3) Finally, this chapter reviewed the possibility of further testing of the existing research being expanded to include higher levels of Schenkerian experts to ascertain whether their inclusion will alter the current data in a significant enough way that a revision of the conclusions in this thesis must be made.

Further research in more specific Schenkerian contexts would be required in order to learn whether Schenkerian principles apply to the perception. If Schenkerian principles and theory are

applicable to perception, then David Huron's methods of investigation would seem to be ideal, since his approach is largely based on unconscious learning processes.

Conclusion

In this concluding section, I shall briefly consider the future research possibilities in perception and cognition given current trends in technology. This will be accomplished through a review of the following topics and research: Moore's Law and its relevance for technological advancement, Marsden's (2010) article on the concept of Schenkerian analyses being eventually accomplished by computers, the advancement of computing power inevitably leading to the mapping of the entire human brain and its use to better understand the way that the brain processes and functions, and finally, the accomplishments of this thesis are reflected upon and an eye towards the future of musical research is maintained. It is important for researchers to remain aware of the tools that will be available to them in the coming years. These future possibilities are fascinating.

Looking Ahead

Huron (2006) made various cognitive hypotheses regarding the way that our brains process musical information and expect certain outcomes. Our current understanding of the brain is limited because of the vast complexity involved. In this way, Huron's hypotheses can only be tested in their predictive capabilities. However, the future holds some tantalizing prospects for where the fields of perception and cognition can take us.

Technological discovery and achievement has been improving at greater and greater rates over the last few decades. A noteworthy area of this development is the exponential increase in processing power—particularly in computers. This has followed a relatively steady rate of

doubling roughly every eighteen months to two years for the past sixty years. Gordon Moore first described the phenomenon in a 1965 article for Electronics magazine (Moore 1965). This trend is most commonly known as Moore's Law.

Huron's method of collecting data through the survey of existing tonal works requires computer technology in order to be viable. However, the future of technology promises many more benefits to the field of perception and cognition than quicker data collection.

The exponential growth of computing predicted by Moore's law has brought us to the cusp of the hardware capacity equivalent to that of a single mouse brain. If current trends hold, this means that processing capabilities will reach the equivalent of one human brain during the mid-to-late-20s.[1] Staggeringly, the exponential increase of computational power will then reach the equivalent processing capacity of all the human brains on Earth by about 2050. It is difficult to fathom what will be possible at this point, but this increase in computer capabilities enables several interesting things to take place for perception and cognition research.

In his article "Schenkerian Analysis by Computer: A Proof of Concept," Marsden (2010) attempts to show the viability of computers to create Schenkerian analyses through programming alone. Allan Keiler notes in his own translation of the original German, that "Schenker claims that 'there are no rules which could be laid down once and for all for recognizing scale steps'" (Keiler 1983/84, 210). It should be noted that Schenker had no concept of computer technology upon his death, but the complexity of such technology is an important step in getting around this statement. The future of technology includes such a mind-boggling level of computing power that things of this nature cannot be dismissed offhand. Unfortunately, currently the process is

[1] Conservative estimates push this back a decade or two, but the important detail is that software will not have caught up by this point to create a direct recreation of the human brain and its functions.

"too computationally expensive" and "only extracts of a few bars in length can be reduced" (Marsden 2010, 269).

The combination of Marsden's method and the computer technology of the future would conceivably allow for the instantaneous creation of dozens of viable Schenkerian analyses. This allows for two things: the theorist to choose from this pile the one that he/she feels is the best fit for the piece (and possibly even letting the machine know of this decision for feedback into a learning program), and for this decision to be made without the bias of previous experiences and patterns of analyzing that the theorist possesses effecting the Schenkerian graph they initially produce. In short: an unbiased approach becomes possible. More possibilities would be presented before you that would have otherwise been inaccessible on an individual level. The incorporation of cognition and perception studies on Schenkerian theory can enable the more accurate codifying of such computational models and enhance the feedback loop of attempting to better explain the way that the theory is implemented. This is because "attempting to write a computer program to make analyses exposes the deficiencies of the principles alone and offers a means for explicit exploration of the additional knowledge required" (Marsden 2010, 269).

In conclusion, the collection and processing of music and Schenkerian graphs by computers will also be greatly eased by the exponential growth in computer technology. Vast quantities of data will be conquerable through bulk calculations and the incredible software that will inevitably arise from the possibilities.

In the general area of perception and cognition studies, the mapping of the human brain will be more easily undertaken. This is also known as the development of the Connectome (Nair 2013, 5739). This entails the mapping of all the neural connections in the brain. The cognition side still largely relies on untested theories, but with the mapping of the brain's connection—

brought about by greater computing power—will come a greater understanding of these brain processes. It will also allow for greater and easier explanations of brain processes such as Huron's (2006) theories of perception and expectation (statistical learning). This proposed brain process could become intimately understood.

Closing Thoughts

Through an exploration of the available empirical, perceptual research applicable to Schenkerian theory, a better understanding has been reached of the areas in which perception and cognition studies can benefit the analytical technique. This exploration presented support for the hypothesis that the perception of Schenkerian structures is largely an unconscious process, especially regarding the concept of hierarchical levels. Huron's approach in *Sweet Anticipation* was shown to be especially applicable to future empirical research on Schenkerian analysis—namely in the investigation of the true perceptual significance of the *Initial Ascent*.

My thesis project has echoed the call from several of the scholars, including Temperley (2011) and Yust (2012), that more empirical research directly on Schenkerian theory is necessary to develop larger data pools.[2] The importance of cross-disciplinary research and communication between academic units cannot be overstated. It is a way to avoid tunnel vision, and in so doing limiting the impact and comprehensiveness of research. Empirical methods are especially important in the quest for knowledge, as it provides the nearest to definitive answers that academia can provide. Thus, areas such as music that do not traditionally demand empirical

[2] Extrapolating data from studies to situations that are not directly covered by them can be unsubstantiated, as the only data that has been "proven" is that which falls under the direct parameters of the study. Some postulates can be highly accurate from such information, but more feedback is necessary to come to relatively definitive conclusions. It is therefore imperative that larger data sets be sought through the direct replication and diversification of studies to cover many possible permutations.

research methods should be especially eager to merge these areas of thought. In short, interdisciplinary research is the way of the future.

This project has outlined various areas of research in need of experimental data collection and interpretation pertinent to the understanding of the foundations of Schenkerian analysis. An optimal method of experimental research has been taken from the model of David Huron's research—as reflected in his book *Sweet Anticipation*—that may be applied to future work done in the area of perception and cognition focused on Schenkerian theory. The deeper academia plunges into field specialization, the more important it becomes to remain aware of and collaborate with other areas of research. These other areas provide different tools and perspectives of analysis that are invaluable to the furthering of academic knowledge. My thesis project is a stepping stone to the much larger project of properly examining Schenkerian theory and paves the road for a true understanding of Schenkerian analysis through the empirical tools of music perception and the evolutionary and biological framework of music cognition.

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