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Linguistic Contributions to Music Theory: A Multimedia Presentation

Cory D. Crawford

[This paper reflects the actual presentation in which an assistant played samples from various musical pieces to illustrate theoretical points.]

I must first apologize for the title. I had expected to have everything outlined and presented using "high" technology, but a wise word from those with more experience in computer mishaps than I successfully encouraged me to ask the assistance of a much more competent resource. Thus Andrew Crane, a good friend, gifted musician, and accomplished performer, will be at the piano assisting me in demonstrating examples of music theories.

In this paper I will present an overview of scholarly research pertaining to music and its connections to language. I will hopefully speak in such a way that all will be able to understand, even when speaking of a realm outside that of traditional linguistics, namely music theory. I will examine the questions "Is there a link between music and language?" and "If so, what can linguistic theory offer to music theory?" I will show that there is a link between them and that linguistic theory has in fact made significant contributions to music (cognitive) theory.

I suppose that we should begin with a question posed by Charles Ives: "whither music?" (Bernstein 1976). This question is by no means new to humans. Humans seem to have always been drawn toward music. There has never been any culture (that we know) devoid of music. And philosophers have speculated for thousands of years on the nature and structure of music. So why present a paper on music theory at a linguistics conference? I suspect that many here have wondered about the structure of music, and if there exists a correlation of musical structure to language. Neubauer points out that Rousseau postulated music is derived from language, that music evolved from a permutation of speech acts (1986:100). Similarly, Diana Raffman cites Howard Gardner as stating that

An analogy to language may not be out of place here. Just as one can tease apart a series of levels of language -- from the basic phonological level, through a sensitivity to word order and word meaning, to the ability to appreciate larger entities, like stories -- so too, in the realm of music, it is possible to examine sensitivity to individual tones or phrases, but also to look at how these fit together into larger musical structures . . .

Buried far back in evolution, music and language may have arisen from a common expressive medium . . . Many scholars suspect that linguistic and musical expression and communication had common origins and, in fact, split off from one another several hundred thousand years ago (1993:11-15).
SIMILARITIES
Even a superficial examination of music and language reveals many similarities. They both exhibit progression in time, written systems, definite structures, a hierarchical nature in the structure, and a signer and a signified (although there is some debate now among theorists as to whether there is meaning conveyed in all music). In music as well as in language there are conveyers (the composers) and perceivers (the listeners). Stress and length are used in both to accent a certain word, chord, note or motif (which is called prosody). Finally, there exist different musical idioms as there are different languages.

The histories and applications of music theory and linguistic theory are also similar. Early musical "grammars" were largely prescriptive (even to the point of dictating which chords were allowed and which weren't) and complex. Currently, there are minimalist theories at work in both, making the simplest interpretation the best; (Schenker is the most famous name associated with musical minimalist theory). There have been behavioralist principles applied to both (in music, the behaviorists hold that all music is interpretation and representation--in its most rudimentary form, imitation of birds and other such animals, and even human speech, in some cases).

Current applications are similar in both fields: computer analysis, recognition, and reproduction. There are volumes of books and journals and conference proceedings treating music as a formal language. I will not discuss these areas today more than stating that the fields exist. Semantics and semiotics are also expanding fields in both linguistic theory and music theory.

Cognitive studies is another growing field in which both linguistics and music are being examined.

But perhaps the field in which linguistics has been the most successful at application of theory is the field of generative grammar. In 1973 Leonard Bernstein delivered the Norton Lectures at Harvard on precisely the point of a merger between linguistic and music theories. He had realized some 40 years before that in several different musical idioms there was a series of notes that seemed to be at the foundation of several pieces. He wanted to make a connection between these, but the dominant behaviorist theories of the time caused him to reject any tie between the two faculties. Later, he read Chomsky's works and found new light to the possible solution to his problem: the series of notes was, in fact, related at some deeper structural level, and the notes had undergone a transformation of some sort to emerge as the surface structures of the different pieces (Bernstein 1976). He therefore gave those lectures as a preliminary attempt at a merger of the theories. It was a valiant attempt, although too strict (he even wanted to call notes morphemes, chords words, and groups sentences).

Enter Fred Lerdahl and Ray Jackendoff. They, too, had profound interest in musical grammars: Lerdahl, the composer and musical theoretician versed in linguistic theory and logic, and Jackendoff, the well-
known cognitive linguist and performing pianist. They took Bernstein's initiative and explored and developed a connection between linguistics and music for 10 years. They posited that a strict application of linguistics to music such as was Bernstein's was ineffective (and probably just plain wrong). They applied linguistic principles of innate structure to existing music theory in their work, *A Generative Theory of Tonal Music* (henceforth, GTTM). They incorporated already existing ideas of reduction found in the central theorem to the Schenkerian hypothesis, "The listener attempts to organize all the pitch-events of a piece into a single coherent structure, such that they are heard in a hierarchy of relative importance" (Peel and Slawson 1984:273). They developed a theory and a system of rules that are strikingly similar to Generative theory. It is now appropriate to look at what the theory entails and at the implications and effects of the theory.

The goal of such a theory is to be able to formally describe the mental organization and intuitions of a listener who is experienced in a musical idiom. Lerdahl and Jackendoff state at the outset that theirs is not a comprehensive theory: they concentrate on the hierarchical components and omit elements such as timbre and dynamics. They specifically examine the following hierarchical elements: Grouping Structure, Metrical Structure, Time-Span Reduction, and Prolongational reduction. These four components are subjected to certain rules, called Well-Formedness, Transformational, and Preference Rules. These rules are based on traditional methods of analysis. We shall leave the present discussion at this point and look for a moment at these methods in a simple, abridged manner.

The classical system of musical analysis is based on the seven principal notes of the octave: A, B, C, D, E, F, and G.

[Andrew Crane plays the notes on the piano.] A scale beginning with one of these notes becomes the basis, or key, for a piece of music. Let's assume the piece that we want to analyze is in the key of C major (major and minor have reference to the intervals between each of the seven notes that comprise a scale). This means that the order of our notes is C, D, E, F, G, A, and B. Now, in addition to scales ordered by this series of notes, we have groupings of notes that sound simultaneously in a piece, called chords. Chords are 'built' upon one of those notes. For instance, a C chord could contain the notes C, E, and G. If we assign this chord a roman numeral, this becomes I, or tonic chord, because it is built upon the first note in our series. Similarly, a chord built on G would be the V (or dominant) because it is the fifth note in our series. The reason for the assignment of the roman numeral is that, as such, we can talk about any scale, and we are not limited to the key of C. Thus in a scale beginning on A, E will be the dominant, or V. To illustrate this concept, Andrew will now play a simple piece that most here are familiar with, "Sweet Hour of Prayer" (Bradbury 1985). He will also simultaneously call out the roman numerals that correspond to the chords being played.

[Andrew plays.] As one can easily infer, this system of analysis is limited and only describes the notes that sound together. With this in mind, we continue with GTTM.

As mentioned earlier, there are 4 hierarchical components of music that are subject to the three types of rules. The first, Grouping Structure, has to do with the
segmentation of music into motives, phrases, and sections. Metrical Structure is the structure of the strong and weak beats that comprise a piece. Time-Span Reduction is the process that distinguishes the hierarchy of pitches with respect to their grouping and metrical structure. Finally, Prolongational Reduction assigns hierarchies of tension, relaxation, continuity, and progression, both harmonically (simultaneous sounds) and melodically (sounds over a period of time). The rules that these four components are governed by are also defined. Well-Formedness Rules determine the possible analyses of a piece. For example, Grouping Well-Formedness Rule 1 states that "Any contiguous sequence of pitch-events, drum beats, or the like can constitute a group, and only contiguous sequences can constitute a group" (345). The Transformational Rules are special cases that apply distortions to otherwise hierarchical descriptions. For instance, sometimes there will not be a clear line between the end of one group and the beginning of another. This is due to the Transformational Rule of Grouping Overlap.

Lastly, the Preference Rules predict the structure that the listener will prefer. Grouping Preference Rule 1 states to "Avoid analyses with very smaller [sic] groups--the smaller, the less preferable" (345). Now we can see where the traditional analysis (roman-numeral, mentioned above) plays a role. The roman numeral analysis allows us to speak of the preferences of listeners according to chord structures. For instance, Time-Span Reduction Preference Rule 2 states that "Of the possible choices for a head of time-span T, prefer a choice that is . . . relatively closely related to the local tonic [or roman numeral I, as we discussed previously]" (350). Similarly, a listener will hear the dominant chord (V) as a point of maximum tension.

In short, this theory is designed to account for the structure that a listener assigns to a piece. According to Figure 1, a listener hears the musical surface, and immediately the well-formedness rules are consulted. Then if there are transformations to be made, those figure in to the analysis before passing to the preference rules, where all the possible underlying analyses are weeded out and a preferred analysis emerges. (Figure 2 is placed next to Figure 1 to show the similarities and differences between Generative Grammar and GTTM.) Figure 3 shows an example of a piece that has undergone the analysis set forth in GTTM. The top tree structure is a graphical representation of Prolongational and Time-Span Reductions. Notice that it resembles tree-structure diagrams frequently seen in linguistic theory. Below that same staff we see a series of dots. This is a graphical representation of the hierarchical metrical structure, and the long horizontal lines are a representation of Grouping Structure. The two staves below the first represent the reduced notes that a speaker 'hears.' (Note that the first staff is an already reduced form--I include it here for simplicity in explanation.) In both cases the smaller branches of the tree structure are lopped off, leaving only the strongest branches, or heads, in the lower reductions. To musically illustrate this, Andrew will play the first staff shown in the diagram, followed by the second and third. [Andrew plays.]

I should add here that while it is obvious that the field of Linguistics has impacted this theory of music, there are some fundamental differences between
generative theory in linguistics and GTTM. Linguistics focuses on transformation and competence (or grammaticality), while GTTM has as its central foci ambiguity and preference. In other words, GTTM could be considered an offshoot of linguistic theory, but it should not be taken as linguistic theory. It has entirely different goals and objectives. We should not try to merge the two in too strict a manner, as Bernstein did.

At the end of GTTM, Lerdahl and Jackendoff briefly discuss the relevance of their work to other areas in the cognitive sciences. They begin with musical universals. A rule is a universal when it applies in the same way in every idiom of music. This means that each idiom must utilize the component to which the rule is sensitive. For example, they hypothesize that metrical preference rule 4, which states that stresses are heard as strong beats, is a universal. It is counterintuitive to imagine an idiom which considers a stressed note as a weak beat. They further hypothesize some overall characteristics of universals, such as

1) "Musical intuitions are organized along the four hierarchical dimensions"
and
2) "The structure of a piece in each component is determined by the interaction of well-formedness rules, preference rules, and transformational rules" (280).

Next they turn to the question of musical innateness. They posit that the unlearnability of the grammar, or the complexity of the grammar, is a strong argument for innateness. So a listener could not infer, or realize, the existence of a prolongational component: it has to be innate. Secondly, a postulation is offered that because universals exist in music, different musical idioms are seen as differences in the musical grammars.

Lerdahl and Jackendoff finally treat the question of contemporary music (such as 12-tone or serial compositions). The authors avoid making value judgments of atonal music, but they propose that atonal music contradicts the innate musical organization of the mind because the lack of a tonal center (or tonic) makes prolongational reduction collapse. There is also often in this kind of music a lack of regular metrical structure. These weakenings of the hierarchies pose problems to the listener, causing a lack of global analysis and a resort to local analyses. While these systems are most certainly not devoid of structure, that structure "is not accessible to the listener." Following this presentation I will play a tape of some contemporary 12-tone music, and you may see if these arguments are true for you or not.

In preparation for this paper, I have communicated via email with Ray Jackendoff about this grammar. I asked him about the strengths and weaknesses of his and Lerdahl's theory. He counted the fact that they were able to make music theory "psychological in an explicit way" as their greatest contribution to music theory (1999). From my research on their work, I can say that music theorists would agree. Jackendoff said that its greatest strength was the "degree to which it can deal with so many structural aspects of a whole piece in a global way." Its greatest weakness, according to Jackendoff, lies in "no treatment of affect." "But," he adds, "that's because nobody has a treatment of affect in general which could be applied to music."

This work received a mixed review.
The journal of the Yale School of Music seemed bent on disproving the theory by highlighting weaknesses in applying GTTM's analysis to certain pieces (Peel and Slawson 1984). Other journals commented in the same vein. Still others hailed it as a long-sought connection between the two related sciences. I asked Jackendoff if Bernstein was aware of their work. He replied, "Sure, he was aware of our work. But I had written a slightly critical, though mostly laudatory review of his book, and Bernstein being Bernstein had nothing but contempt for us afterwards" (Jackendoff 1999).

Despite its critics, GTTM seems to have become a touchstone for cognitive musical theoreticians. Their theory still continues to receive attention from music theorists and cognitive scientists alike. I discovered a journal entitled *Music Perception* published by the University of California at Berkeley that is devoted to psychological music research. There are countless articles related to our discussion today, many ostensibly drawing the connection between language and music. And I found two that provided specific empirical evidence for the analytical success of GTTM. Nicola Dibben from the University of Sheffield showed "evidence of listeners' ability to match a performed reduction of an extract of tonal music to the piece of music from which it was derived" and also that her experiment demonstration for "the internal representation of tonal music in terms of a hierarchy of events such as that proposed by Lerdahl and Jackendoff (1983)." A final experiment by Dibben showed that listeners were unable to match derivants (reductions) of atonal music to the original piece. "This research suggests [that] atonal music is not perceived in terms of a hierarchic structure" (Dibben 1994:1). Another experiment, conducted by Ilene Deliege, tested the grouping rules in musicians and nonmusicians. She says that "the results show the validity of the rules." But another interesting point is that "the two categories of subjects [did] not show a radically different grouping behavior" (Deliege 1987:325).

POSSIBLE FURTHER RESEARCH
GTTM has raised other questions worth investigation. First, what is the role of inexperienced listeners? What can we learn from listeners inexperienced in a musical idiom? Perhaps this would help in finding the answer that Lerdahl and Jackendoff pose about the source of the experienced listener's knowledge: "To what extent is it learned, and to what extent is it due to an innate musical capacity or general cognitive capacity?" (1983:4). Another area already alluded to is aesthetics and affect. What do cognitive capacities such as the one proposed have to do with aesthetic qualities? Or also, what does GTTM mean to brain localization theory? Do experienced listeners exhibit increased language capacities? Here at BYU there is a group working on a theory different than Generative Grammar, which is called Analogical Modeling. How can analogical modeling be applied in the context that has been discussed today? These are just a smattering of questions of which some have begun to be investigated, but for the most part are yet to be answered.

CONCLUSION
GTTM has been fundamental to the
psychological treatment of music cognition.
And linguistics was fundamental in the
development of GTTM. We have seen
today by the application of similar theories
that it is probable that language and music
are closely related. We have also seen that
linguistics has contributed to the
development of music (cognitive) theory. I
hope that the resemblance between
linguistics and GTTM has been obvious, as I
have not had the time to delineate each
similarity. I also hope that this presentation
will stimulate further discussion, thought,
and research, as there is much more to be
done. Thank you.

Questions:
1. How does Jackendoff's theory apply to
other musical idioms, for instance, Gamalan,
which doesn't utilize the fifth of the scale?

Answer: Jackendoff and Lerdahl would say
that their rules apply inasmuch as the
construct on which the rule is based exists in
the musical idiom. So if there is not a fifth
degree of the scale, such as is the case with
Gamalan, the rules which have to do with
the fifth of the scale will not apply. Because
the dominant is a major player in the
creation of musical tension, the other rules
might need to be modified to adjust the
relative importance of rules having to do
with tension in the music in that specific
idiom. The theory doesn't collapse because
there is still a hierarchy that is accessible to
the listeners. In Gamalan a certain chord or
series of chords is simply not utilized, so the
rules that have to do with that series of
chords will not apply, just as the rules about
head-first languages will not apply to head-

2. Does Jackendoff make any statements as
to the similarities between innate musical
structures and innate language structures?

Answer: I am not aware of any explicit
statement as to the relationship between
innate structures of language and music, yet
we read in GTTM that "much of the
complexity of musical intuition is not
learned, but is given by the inherent
organization of the mind, itself determined
by the human genetic inheritance" (281).
This suggests that the inherent organization
of the mind affects all innate structures in a
similar way. However, on the next page we
read of an "innate musical capacity,"
suggesting that innateness is subdivided into
different mental components. I would posit
that innate musical structures and innate
linguistic structures are closely linked but
not exactly equivalent.

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Figure 1. Model from *A Generative Theory of Tonal Music*. Adapted from Lerdahl and Jackendoff 1984:10.

Figure 2. The Aspects Model of Language. Adapted from Harris 1993:93.
Figure 3. An example of GTTM analysis. From Lerdahl and Jackendoff 1983:267.