2 Models of musical and linguistic structure

2.1 History and paradigms

The history of music theory can be – and has been – traced as a study of “the alternating dominance, the frequent battles, and the occasional peaceful coexistence of verbal and mathematical approaches to music.”¹ Indeed, while one paradigm may have been predominant in any given historical time period, it is clear that the two were closely intertwined and were both present at all times, each affecting the perception of the other.

The field of cognitive studies has recently developed models for musical understanding that acknowledge these connections between the mathematical and verbal paradigms. These cognitive approaches have drawn aspects from both of the traditional approaches in an effort to explain how each of the models shapes our perception of music.

2.1.1 Mathematical paradigms

Mathematical approaches to music are based on Pythagorean calculations of proportions and ratios to determine consonance, dissonance, and harmony. The ancient Greeks believed that the simple harmonic proportions of the octave, fifth, and fourth were illustrations and embodiments of the balance of mathematics and natural phenomena. Music as a mathematical science resurfaced in the Middle Ages, compiled from ancient sources and resurrected by theorists like Boethius and Cassiodorus. Music’s relationship

to the mathematical branch of knowledge is illustrated by its inclusion in the *quadrivium* along with arithmetic, astronomy, and geometry, distinct from the verbal arts of grammar, rhetoric, and dialectic that comprised the *trivium*.

In the sixteenth and seventeenth centuries, Pythagoreanism was synthesized with new empirical knowledge to create new musico-mathematical theories such as *ars combinatoria*. Later theorists such as Rameau renewed Pythagoreanism in the 18th century, and it remained an important paradigm through the 19th century, despite the common conception of Romanticism as driven primarily by artistic aspects such as literature and poetry.

The intertwining of the mathematical and verbal paradigms in the 19th century is clearly visible in Novalis’*s *Allgemeines Brouillon*, which is worth quoting from at length to see the common (combinatorial) structure he ascribes to music and the models of language and mathematics:

Musical mathematics.

Doesn’t music contain some combinatorial analysis and vice versa? Numerical harmonies—number acoustics—belong to combinatorial analysis…. Combinatorial analysis leads to number fantasies—and teaches the compositional art of numbers—the mathematical figured bass. (Pythagoras. Liebniz.) Language is a musical idea-instrument. The poet, the rhetorician, and the philosopher play and compose grammatically. A fugue is completely logical and scientific—it can also be treated poetically. The figured bass contains the musical algebra and analysis. The combinatorial analysis is the critical algebra and analysis—and the musical theory of composition relates to the figured bass as the combinatorial analysis to simple analysis.²

The mathematical paradigm regained prominence in the 20th century in compositional techniques such as serialism and in theories such as those based on mathematical modeling of music.

2.1.2 Verbal paradigms

The verbal paradigm for music has at its origin the Greek concept of musiké, in which the length and pitch of Greek syllables was the primary determinant of musical composition. Plato asserted that of the three components of song – words, rhythm, and melody – “the words are by far the most important of the three, being the very basis and foundation of the rest.”

Plato thus favored a word-dominated music despite the strong mathematical and cosmic paradigm running through The Republic, and this notion, combined with the Aristotelian idea that music could affect moral character and passions via imitation, provided a firm foundation for future theories of mimesis in music. The primacy of words over melody became a justification for many later theories of melodic imitation and affect, including those that advocated direct imitation of speech.

Pythagoreanism re-emerged as the primary paradigm of the Middle Ages; however, as Jonsson and Treitler argue, medieval composers and theorists remained interested in the relationship between language and music but were more interested in designing melodies that clarified the structure of text rather than those which reflected the meaning via imitation:

\[ \text{Melody} \text{ is a means for the clear articulation and elucidation of texts in their oral delivery. In this process, melody plays a role similar to that of} \]

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3 Plato, The Republic, III.
punctuation. The musician’s response to language’s meaning through its structure is the beginning of any study of the music-language relationship.\(^4\)

The Platonic notion of mimesis returned in the late 16\(^{th}\) century with the Italian humanism movement. Vincenzo Galilei and Girolamo Mei reacted against what they perceived as the obfuscation of text through excessive counterpoint and sought to revive the ancient Greek notion of a music dominated by language by imitating the melody and rhythms of speech. Concurrently, the French composer Baïf and his colleagues in the Académie de poésie et de musique were attempting to mimic the rhythm, accents and intonation of the French language in music. The imitation of verbal accent, rhythm, phrasing, and punctuation continued through the seventeenth and eighteenth centuries, roughly paralleling the rise and decline of the popularity of recitative.

This time period also saw the widespread application of rhetoric to music, though the notion had its origins in Quintilian and had been perpetuated by Isidore of Seville in the Middle Ages. Burmeister, Mattheson, and Heinichen were among the composers and theorists who attempted to systematically apply principles of rhetoric to musical composition.

Music evolved into an absolute artform in the Classical and Romantic eras, in essence allowing music to stand on its own and removing its dependence on mathematical or linguistic models for form and structure. However, the language model remained active and continued to evolve through the 19\(^{th}\) and 20\(^{th}\) centuries; composers looked for

inspiration in language, theorists investigated linguistic systems as tools for analysis and understanding of music, and the emergence of cognitive science as a discipline allowed psychological and neurological theories about language to be applied to music.

Thus the linguistic paradigms invoked by composers and theorists throughout history evolved to include theories of musical meaning, hierarchical structure, and mimesis. The next section investigates these three types of linguistic paradigms and discusses some of their applications to music.

2.2 Types of verbal paradigms

There are essentially three schools of thought in the spectrum of the perceived relationship between music and language. One regards the similarities between music and language to be strong and pervasive, and constructs musical models based on linguistic models.\(^5\) On the opposite end of the spectrum are those who believe that the differences between music and language are too great to draw any type of useful analogy between the two.\(^6\) In the middle are those who believe that while music may not technically be a language, the similarities are strong enough to create a useful analogy.\(^7\)


The question of whether music can be considered a language has been considered since at least the eighteenth century.\(^8\) The question is clearly dependent on the given definition of “language.” A language contains three broadly defined linguistic components: semantics (the meanings of words), syntax (the way words are combined to form phrases), and phonology (the sounds of the language). A study of the relationship between text and music must focus on at least one of these areas.

2.2.1 *Semantics and meaning*

A relationship focusing on the semantic aspects of both language and meaning has as its fundamental premise that as language carries meaning, so does music. These analogies are usually based on real or imagined associations between aspects of music and a given text.

Joseph Swain summarizes the problems inherent in a theory of musical semantics when he says: “A good sentence commands the most precise understanding in a whole auditorium full of hearers, but passages of music elicit only the vaguest inarticulate impressions. … Unlike any natural language, music resists translation.”\(^9\)

The manipulation of musical elements to make a melody seem to convey meaning was one of the driving forces behind the use of rhetorical principles in music. The rhetorical analogy is one of the most pervasive forms of the language-music analogy, and many

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8 Thomas, 1995.
detailed studies have been done on the relationship.\textsuperscript{10} The relationship between rhetoric and music can be traced back to ancient Greek and Roman writers such as Aristotle, Cicero, and Quintilian, whose writings (particularly the \textit{Institutio oratoria}, ca. A.D. 95) emphasized how the use of musical principles can help an orator refine the modulation, tone, rhythm, and inflection of the speaking voice, thus using music to help language persuade.\textsuperscript{11} Quintilian advocated that orators study music to learn how to best adapt “the sound of speech … to the different content of its subject matter, as is done in music.”\textsuperscript{12} The prosody of the orator should be deliberately chosen to reinforce the persuasive nature of the rhetorical argument; thus at this point, music was in the service of language as a persuasive tool.

The rhetorical analogy survived through the Middle Ages, as shown by Isidore of Seville’s \textit{Etymologiarum sive Originum libri xx}, from the early 7\textsuperscript{th} century, and unquestionably reached its apex during the 17th and 18th centuries. Rhetoric became a prominent feature in many works of German, English, and Italian music theorists and composers such as Bach, Burmeister, Heinichen, Kuhnau, Mattheson and Mersenne via concepts such as \textit{Affektenlehre}, hypotyposis, and word and tone painting. The roles reversed, however; music went from being a tool used by language to ensure proper communication, as advocated by the ancient thinkers, to being the medium in which


\textsuperscript{11} Neubauer, p. 31.

\textsuperscript{12} Quintilian, I. x. 23-24.
meaning was illustrated through the use and adaptation of semantic principles of language.

Theories of musical meaning ascribed affects or meanings to musical features such as rhythms, intervals, or melodies, and claimed that the features were capable of carrying meanings applied to them. Wagner would later intensify the reversal of the semantic relationship between language and music by utilizing leitmotifs to assist in narrative storytelling. However, there was never a universally accepted and codified rhetorical theory of music; affects assigned to modes and meanings assigned to musical figures differed widely, illustrating Swain’s warning about the individuality of interpretation of musical meaning.

The rhetorical/semantic metaphor was employed as late as Deryck Cooke’s *The Language of Music* (1959); Cooke identified melodic figurations appearing in similar expressive contexts and described them as though they were vocabulary words in a dictionary, although he himself vehemently denied that such a compendium of rhetorical devices could be constructed. In addition, 20th century philosophers such as Suzanne Langer and Peter Kivy continued to debate the possibility of musical meaning via rhetorical principles.

2.2.2 *Grammar, syntax and structure*

Grammatical and syntactic systems examine the way individual elements are arranged in hierarchical structures to form coherent, well formed sequences. The syntax of a text can
affect both the semantic and the phonological content: if the structure of an utterance is changed, both or either of the meaning or the sound of the utterance may be changed as well.

The overall music/grammar analogy has been explored significantly.\textsuperscript{13} The organization of many music treatises, especially in the Middle Ages, closely paralleled that of grammar treatises, and used terms borrowed from that discipline to describe the structural division of musical phrases based on grammatical principles.\textsuperscript{14} As Calvin Bower describes it:

An ancient topos appears repeatedly in these treatises; it goes something like this: As individual letters are joined together to form syllables, which in turn form words, and as words are linked together to form phrases and clauses (commas and colons), which in turn become complete sentences (periodi), so individual pitches (voces) are joined to form melodic gestures (syllabae) which, in turn form subphrases (commas and colons), and these combine to make complete phrases (distinctiones); several such phrases join together to form a complete melody (a periodus).\textsuperscript{15}

The analogy between syntax and music returned as one of the prevalent organizational systems of the 20\textsuperscript{th} century thanks to a renewed interest in hierarchical structure. Leonard Meyer’s \textit{Emotion and Meaning in Music} (1956) attempted to bridge semantics and syntax by using a stimulus-response model grounded in psychological laws of attention and

\begin{enumerate}
\item \textsuperscript{14} Treatises that include grammatical analogies include \textit{Musica enchiriadis}, \textit{Scolica enchiriadis}, Hucbald’s \textit{De musica institutione}, Guido’s \textit{Micrologus}, and John’s \textit{De musica}, among others.
\item \textsuperscript{15} Calvin Bower, p. 36-7.
\end{enumerate}
expectation. Meyer developed a musical syntax from a set of stylistic rules based on the principles of stability, continuation, and closure, and claimed that it is when the syntax of music breaks the stylistic rules that music acquires a semantic “meaning.”

In his series of lectures at Harvard immortalized in the collection *The Unanswered Question*, Leonard Bernstein inadvertently illustrated one of the primary difficulties of applying a syntax-driven metaphor to music. At the time of Bernstein’s lectures, Noam Chomsky’s work on universal syntax and grammar was fashionable, and a large portion of Bernstein’s second lecture was devoted to a discussion of the application of a hierarchical system to music. He runs through a series of deliberate dead ends and finally arrives at a “solution” to the problem of drawing a hierarchical parallel between language and music, shown in Example 2.1:

**Example 2.1: Bernstein’s musical grammar (from The Unanswered Question)**

<table>
<thead>
<tr>
<th>Music</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note</td>
<td>Phoneme</td>
</tr>
<tr>
<td>Motive</td>
<td>Morpheme</td>
</tr>
<tr>
<td>Phrase</td>
<td>Word</td>
</tr>
<tr>
<td>Section</td>
<td>Clause</td>
</tr>
<tr>
<td>Movement</td>
<td>Sentence</td>
</tr>
<tr>
<td>Piece (piece)</td>
<td>Piece (paragraph)</td>
</tr>
</tbody>
</table>

Bernstein chose this as the final version of his hierarchy because of what he saw as parallels at both the macro and micro levels; the concepts of *note* = *phoneme* and *motive* = *morpheme* are not unintuitive, and he delights in the realization that the German word *Satz* refers to both a movement in a larger work as well as to a sentence.
However, despite Bernstein’s unquestionable enthusiasm for both language and music, the other levels of this analogy are flawed. The jump from motive to phrase in the musical domain of the analogy is a much larger hierarchical leap than from morpheme to word; thus phrase = word seems counterintuitive. (An earlier version of his analogy had the more intuitive phrase = phrase; however, he discarded that version because of inconsistencies at both the micro and the macro level.) Similarly, the progression to section = clause and piece (piece) = piece (paragraph) are not steps of a similar magnitude in both domains.

Bernstein’s difficulty with creating a hierarchy that relates at the micro, middle, and macro levels of the analogy illustrate that there may indeed be parallels between musical organization and linguistic organization, but the analogy may work more effectively on some levels than on others. In contrast to Bernstein’s emphasis on the micro and macro levels of the analogy, Swain asserts that the relationship between music and language is the strongest at the phrase level, which is precisely where Bernstein’s final analogy intuitively seems the weakest:

In both music and language, syntax seems to be most powerful at the same levels of structure. … At the phrase level of structure, musical syntax is working hard, reducing the randomness, extracting patterns of melody and harmony, thus allowing listeners to process the phrase. … Linguistic syntax, too, seems most powerful and explicit within the sentence and clause.\(^{16}\)

Swain is not alone in his belief that the relationship between language and music is strongest at specific hierarchical levels. We will return to this notion below.

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\(^{16}\) Swain, p. 26.
2.2.3 **Phonology and prosody**

Language and music are both “organized sound, or, more specifically, … culturally tempered systems of arbitrary, recurrent and structured sounds.” As described in Chapter 1, the phonological and prosodic features of a text include how the text sounds when it is spoken aloud – the pitch, duration, and loudness of the components that comprise the utterance.

Music shares the characteristics of pitch, duration, and loudness, and therefore has the capability of reinforcing or obscuring these qualities of spoken language. Analogies that focus on the relationship of the phonology and prosody of language to music study the sound of language and its influence on the sound of music, focusing on aspects of rhythm and melody in language and the possible effects those characteristics have on music. Chapters 3 and 4 discuss studies of this kind and provide new research into the relationship between speech prosody and musical rhythm and melody.

2.2.4 **Psychological and neurological relationships**

There is a substantial amount of scientific evidence that certain aspects of language and music are closely linked in human psychoacoustic perceptual processes. Studies and experiments on brain hemisphere function show that while other elements of language are processed by the left side of the brain (the “rational” side), speech intonation is processed

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by the right side of the brain, as is music.\textsuperscript{18} However, in tonal languages such as Thai, studies show that the left side of the brain assumes the responsibility for processing pitch, as pitch in a tonal language is essential to meaning and syntax and therefore must be processed simultaneously.\textsuperscript{19}

While the recognition of musical pitch is processed in the right hemisphere of the brain, it has been noted that professional musicians also utilize areas of the left hemisphere typically used for language while listening to or making music. John Blacking claims that this may be a result of musicians devoting as much time to making music as they do to speech, or, with what we hope is with his tongue firmly planted in his cheek, that it may be the result of their professional activities leading them into “basically unmusical ways of making and appreciating music.”\textsuperscript{20}

However, neuropsychological research demonstrates there is little overlap between the processing of some musical elements and linguistic processing. For example, Peretz (1993) determined that a fixed-interval scale and emphasis upon a tonal center, as described by Krumhansl (1993), appear to be processed in a specific way that does not


\textsuperscript{19} Jakobsen and Waugh (\textit{The Sound Shape of Language}, 1979: 30ff., 45ff.) cite studies showing that while word tone, as in Thai, is processed in the left hemisphere, the right hemisphere still controls the processing of both music and intonation.

coincide with linguistic processing.\textsuperscript{21} As Patel et al (1998) point out, the reason for this apparent difference in processing probably arises from the fact that the musical elements being studied do not have any linguistic counterpart, and therefore would be expected to be processed separately from linguistic information.

Fred Lerdahl, in his 2003 essay “Two ways in which music relates to the world,” posits a hypothesized brain organization of musical and linguistic structures illustrating the breakdown of neuropsychological characteristics both unique and shared between music and language. His chart, reproduced below in Example 2.2, is based upon cognitive studies that demonstrate that the brain processes certain characteristics of music and language in the same location. Lerdahl argues that the characteristics the brain processes similarly are, in essence, common structures based on the neurological link.

\textbf{Example 2.2: From Fred Lerdahl’s “Two ways in which music relates to the world”}\textsuperscript{22}

<table>
<thead>
<tr>
<th>exclusively musical structure</th>
<th>common structures</th>
<th>exclusively linguistic structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>pitches &amp; intervals</td>
<td>durational patterns</td>
<td>syntactic categories &amp; relations</td>
</tr>
<tr>
<td>scales</td>
<td>grouping (prosodic hierarchy)</td>
<td>word meaning (lexicon)</td>
</tr>
<tr>
<td>harmony &amp; counterpoint</td>
<td>stress (contextual salience)</td>
<td>semantic structures (reference, truth conditions …)</td>
</tr>
<tr>
<td>tonality</td>
<td>metrical grids</td>
<td></td>
</tr>
<tr>
<td>pitch prolongations</td>
<td>contour</td>
<td>phonological distinctive features (etc.)</td>
</tr>
<tr>
<td>tonal tension &amp; attraction</td>
<td>timbral prolongations</td>
<td></td>
</tr>
</tbody>
</table>

The “structures” Lerdahl claims are processed similarly for both music and language include primarily prosodic features of language: \textit{durational patterns}, \textit{stress}, and \textit{metrical grids} are related to the perceived rhythm of speech; \textit{contour} and \textit{timbral prolongations}


\textsuperscript{22} Fred Lerdahl, “Two ways in which music relates to the world,” \textit{Music Theory Spectrum} Vol. 25 No. 2 (Fall 2003), pp. 367-373.
are abstractions related to pitch and sound color; and grouping is related to the hierarchical structure at which prosodic aspects converge to make larger coherent units.

Lerdahl includes syntactic categories & relations among the structures he views as exclusively linguistic constructs. However, techniques originally developed to study syntactical aspects of language perception have been applied to the study of musical syntax, and neurologists have found that musical and language processing occur in the same area of the brain, and there appear to be parallels in how musical and linguistic syntax are processed.23

2.3 The phrase model

Swain’s assertion, discussed briefly above, was that the relationship between language and music is strongest at the phrase level, and numerous studies have illustrated this principle experimentally. Aiello (1994) summarized three experiments that demonstrated a syntactical relationship between language and music at the phrase level. Sloboda (1974, 1997) illustrated that a skilled musician uses roughly the same technique in sight-reading as an experienced reader does in reading language. Tan, Aiello, and Bever (1981) presented the results of two experiments focusing on phrase segmentation, demonstrating that musicians tend to process information that happens within phrases more accurately than material that integrates two phrases, and that added stimuli heard in the middle of phrases tends to be perceived as happening at the end of the phrase (Fodor and Bever 1965, Gregory 1978). Speech melody and musical melody also exhibit similar

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characteristics of *phrase final lengthening*, as studied by Klatt (1975), Todd (1985), and Honing (2003). Thus the syntactic unit of the phrase appears to be perceived similarly in both language and music, and also to have some shared characteristics across the two disciplines.

In his 2001 article, Brown argues for a “musilanguage” model of musical origin, claiming that the specializations of music and language evolved from a common origin, and that shared features (lexical tone, combinatorial syntax, and expressive phrasing) should be thought of as “musilinguistic” features rather than as belonging specifically to one discipline or the other.\(^\text{24}\) Both Brown and Lerdahl describe a hierarchical grouping or syntactic system as an important part of the shared features of music and language. Like Swain, Brown’s unit of similarity, or the level at which he believes music and language share the most in common, is also that of the combinatorial arrangement of the phrase. As Brown points out:

… [B]oth speech phrases and musical phrases are melodorhythmic structures in which melody and rhythm are derived from three sources: acoustic properties of the fundamental units (pitch sets, intensity values and duration values in music; phonemes and phonological feet in speech); sequential arrangement of such units in a given phrase (combinatorial rules in both domains); and expressive phrasing mechanisms that modulate the basic acoustic properties of the phrase for expressive emphasis and intention (phrasing rules in both domains).\(^\text{25}\)


\(^{25}\) Brown, p. 273.
Thus there is some consensus that the phrase is an important syntactic unit in both music and language. What constitutes a phrase linguistically or musically, and what cognitive traits do the two share that create this important structural parallel?

2.3.1 Linguistic definitions of phrase

Phrases are typically described in units, which may vary in length or in structure. In fact, a phrase can be comprised of one unit or more than one unit combined together into one larger phrase. Phrases often act as boundaries for syntactic or phonological elements; for example, phonological events that can happen within a phrase, such as the phenomenon of flapping a word-final $t$, will not happen across a phrase boundary.

Wennerstrom (2001) uses the term intonational phrase to describe this unit, and defines it as “the unit at which the cognition, physics, syntax, phonetics, and phonology of speech converge.” This indicates that multiple linguistic structures tend to form coherent units at this hierarchical level. These units have been variously called intonation phrases, an intermediate phrase, a tone unit, an intonation unit, a breath-group, a sense-group, and a rhythm unit. The terminology often depends on what linguistic element is being linked to the phrase level; those referring to intonation or tones are often focusing on melodic

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27 Word-final flapping of the letter $t$ and its failure to occur across a syntactic boundary can be illustrated by comparing the typical manner of speaking the utterance “Did you get a car?”, where the words get and a tend to blend together into “geta,” as opposed to the utterance, “What did you get? A car?”, in which the two words are not typically run together because of the syntactic and intonational boundary between the first phrase, “What did you get?” and the second, “A car?”.
28 Wennerstrom, p. 28.
aspects, whereas *rhythm unit* is clearly referring to rhythmic aspects of a language’s prosody.

2.3.2 *Musical definitions of phrase*

Just as in linguistics, speaking of the *phrase level* in music necessarily invokes the question of exactly what constitutes a phrase, and this has been approached from as many different viewpoints musically as it has linguistically.\(^{30}\) The traditional model of phrase construction is often considered to be the antecedent/consequent (or question/answer) model where each is a unit on its own, but combines to make a larger hierarchical unit. Schoenberg described his conception of the *sentence*, a hierarchical structure in which two or four smaller phrases are combined together (in a specific, symmetrical fashion) to create one larger unit. There are a wide variety of similar historical definitions, such as those by Koch, Riepel, and Marx, that describe a phrase as a unit comprised of smaller hierarchical units.

In contrast to the hierarchical definitions, in his book *Phrase Rhythm in Tonal Music*, William Rothstein offers Roger Sessions’ rhetorical question as a different type of definition of *phrase*: “What, for instance, is a so-called ‘musical phrase’ if not the portion of music that must be performed, so to speak, without letting go or, figuratively, in a single breath?”\(^{31}\) This invokes a physical (and metaphysical) analogy between language and music, and echoes the notion of the *breath-group* from Chafe (1994).


\(^{31}\) Rothstein, p. 4.
2.3.3 Physical and cognitive definitions of phrase

As Chafe (1994) states, “the size of the intonational phrase is optimal to occupy ‘echoic’ memory, an immediate, short term recall system that allows a listener to process each unit of speech as a whole.” Our echoic memory is usually about seven to eight seconds long; most linguistic phrases fall within this time span, as the seven-to-eight second window is the optimum length for an utterance based on the physical constrictions of the human physiological system. Studies by Robert Gjerdingen and others demonstrate that most musical phrases fit within that time span, thus lending credence to the arguments of Swain, Brown, and Lerdahl that the phrase is an important hierarchical level of comparison for language and music.

2.4 Conclusion

Models of musical structure are predominantly based on either mathematical or verbal paradigms, and the verbal models used tend to focus on semantic, grammatical, or prosodic elements of language and the relationship to music. Recent work in neuropsychology has been able to scientifically verify that the two disciplines share some neural processing resources, and therefore are perceived similarly.

Swain, Lerdahl and Brown all highlight an important similarity between language and music when they discuss the relationship between the hierarchical units described as a phrase in both language and music. There is converging evidence from linguistics, music theory, and the fields of neurology and psychology that this hierarchical unit plays a

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32 Chafe, p. 55.
33 Gjerdingen, op. cit.
crucial role in the relationship between language and music. This study will investigate the relationship between linguistic prosody and melody at this phrase-level convergence of language and music.