

A \flat is to G \sharp as D \flat is to ?

Analogy as the Core of Music Cognition

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Abstract

Music cognition research in the past several decades has invoked many disparate paradigms in an attempt to explain the cognitive basis of musical syntax and semantics. Rather than focusing on any particular established model of music cognition, this paper serves to highlight the centrality of analogy in music cognition. It presents a collection of specific examples of musical analogy-making on different hierarchical levels, pointing the way towards future work in music cognition driven by recognition of the centrality of analogy.

A New Answer for Bernstein

In 1976 Leonard Bernstein gave a series of lectures at Harvard entitled *The Unanswered Question*, in which he discussed possible relationships between Chomskian linguistics and music. In the second of the six lectures he asserts that “there *are* similar functions, cognate processes operating in both music and language which are discoverable by linguistic method.” He then proceeds to construct a “quasi-scientific analogy between verbal and musical terms.” For instance, he likens musical notes to phonemes, motives to morphemes, musical phrases to words, etc. but then declares these to be bad analogies. His next attempt describes motives as nouns and chord types such as major or minor as adjectives in a musical grammar. Likewise, rhythm becomes the analogue of verbs. Bernstein settles on a thesis equating transformational grammar with musical transformations and proceeds to discuss musical syntax and semantics.

Although Bernstein’s lectures may not have been successful in discovering a universal, innate musical grammar, some aspects of the lectures do make a great deal of intuitive sense. Indeed, Lerdahl and Jackendoff were inspired by Bernstein’s musico-linguistics to create their *Generative Theory of Tonal Music* (GTTM), a formalized generative grammar approach to musical syntax. Bernstein’s original motivation, however, seemed closer to an interest in universal cognitive mechanisms for music appreciation than the generative approach of GTTM.

A second major school of thought on music cognition derives from Meyer’s (1956) work on emotion and meaning in music. This paradigm is focused on how listening to music generates future expectations (or implications) for the listener. The Implication-Realization (I-R) model (Narmour 1990) describes how listeners expect melodies to continue

with respect to the tension and release resulting from the building-up and later satisfaction of melodic implications.

A third category of music cognition models derives from Schenker’s (1935/1979) work in music theory. Larson’s theory of musical forces (2004) combines Schenkerian analysis with a metaphor of melody as directed motion through a musical space involving analogues of physical gravity, magnetism, and inertia. More difficult to categorize is Margulis’ computer model (2005) of melodic expectation which combines ideas from GTTM, I-R, and musical forces to predict expectations and various types of affective response evoked by music as it evolves in time.

Indeed, a synthesis of each of these approaches to music cognition is reasonable since each serves to explain certain interesting features of the cognitive experience of listening to music. However, the diversity of methods points towards the possibility of finding a unifying principle behind these approaches. Both Larson’s use of a metaphor linking music and physics and Bernstein’s analogy between music and transformational grammar are particularly provocative. They both involve a particular explicit analogy between concepts. Hofstadter (2001) argues that *the* core cognitive mechanism, not just for linguistics or music, but for thought in general, is analogy itself. I propose, then, a particular subcase of Hofstadter’s thesis to provide an alternative answer for Bernstein: **analogy is the core of music cognition.**

Phoneme is to Note as Word is to...

Bernstein began his comparison of music and language by starting with the smallest unit of an individual note and moving upwards through levels of increasing complexity such as groups of notes, entire phrases, sections, and finally an entire piece. In the following section I also ascend through levels of complexity, from small-scale details to large-scale musical forms, but with a different goal in mind: showing how analogy is a fundamental component of music cognition at each hierarchical level. In most cases I will show examples of how two musical items are heard as “the same thing” even when there are real difference between the two items – the listener creates a musical analogy between the two chunks of music in order to hear them as “the same”.



Figure 1: The beginning of Chopin's "Raindrop" Prelude.



Figure 2: The key change to C# Minor between measures 28 and 29.

Ascending through the Levels

Our source of examples in this section is Chopin's "Raindrop" Prelude, Op. 28 No. 15. The note seems to be the smallest unit of music and logical starting point for an ascent through levels of increasing hierarchy. However, in analogy with physics, this atomic note is not really the smallest unit after all. Instead I begin by breaking the atom into constituent parts – the parameters that make up a note such as timbre, pitch, and rhythm – before ascending to higher levels of musical organization.

Timbre

Recently I had the sheet music to Chopin's "Raindrop Prelude" sitting open on my desk, when my friend walked over, asking "which piece is this?" I pointed to the opening measure (Figure 1) and sang "Ya, da daaaaa, da daaaa... it's Chopin's Raindrop Prelude." My friend nodded in recognition.

Naturally, even though I was singing the notes instead of playing them on the piano, my friend still recognized the melody. My singing created an implicit analogy between the sound of my voice and of a piano. Neither of us thought about it at the time since such analogy-making is so natural but it occurred nonetheless.

Pitch

One of the most important musical attributes of a note is its pitch. Still, it is easy to think of one pitch as being the "same as" another even when the frequency of the two sounds are different (excepting individuals with perfect pitch, of course). We are more sensitive to the position of a note in the tonal context of a scale than the absolute pitch. The fundamental frequency of a note itself is not even so well defined when we consider an opera singer with a large amplitude of vibrato.

The most trivial example of analogy in pitch is that we hear notes separated by octaves as very similar. Octave equivalence is so directly based on acoustics that it almost seems like a property of the physics of sound instead of analogy. When a choir of men and women sings a passage in unison, for instance, it sounds like both groups are singing the same melody, even though the men typically sing an octave lower.

Even when a pitch is repeated, we might consider noticing this repetition to be analogy-making. One of the most characteristic features of the Raindrop Prelude is the nearly constant repetition of the A \flat throughout. Each time one hears the A \flat , it is in fact slightly different from the others: the attack and loudness will inevitably differ from note to note, the previously sounding vibrations in the string will give the sound a different character, and the other notes present at the same time will affect the sound. Even more important is the harmonic context in which each A \flat occurs. Indeed, although the frequency of the note does not alter one bit at the end of the first section of the piece, in measure 29 of the score it is replaced with its enharmonic equivalent, G \sharp , indicating that the tonal underpinnings have changed. The music transitions from D \flat Major to C \sharp Minor (Figure 2).

As soon as the bass chords begin at this key change, the A \flat /G \sharp simultaneously sounds "the same" as before – it is the same pitch – but it also sounds darker in this new context. Indeed, as I listen to the measure before the key change, I anticipate the coming measure and notice that the A \flat gradually takes on a more sinister character. Paradoxically, the repeated note sounds like it is remaining the same and changing into something else (G \sharp) at the same time. Here, analogy is a unifying force, keeping the perception of repetition intact to some degree even as the context changes.



Figure 3: G# becomes B in measure 41.

Rhythm

As soon as we contemplate musical structures larger than single notes, we encounter the concept of rhythm. Often, a characteristic rhythm becomes a unifying musical feature that suggests similarity between two otherwise disparate structures. A simple example is the incessant repetition of the eighth note G# octaves from m. 36 through m. 40. The rhythm of repeated eighth notes is about the simplest rhythm possible, yet in the next measure (m. 41) it becomes crucial to continuity as the most stable element of the piece changes. The G# octaves become B octaves (Figure 3).

Were it not for the repetition of the eighth note rhythm here, I might have written that the G# octaves are *replaced* by B octaves. However, the rhythmic pulse keeps going forward and the eighth notes keep pulsing. The analogy between the previous measures and m. 41 seems clear: this measure does seem distinct from earlier material in that it feels like a climactic moment in the piece, but it is a climax of the same sort of musical material. The minor chords of this dark C# Minor section suddenly transform into a loud E Major and the unexpected B octaves appear, but they are the same as before, due in large part to the rhythm.

The opening motive of the piece (Figure 1) also has a characteristic rhythm: dotted-eighth, sixteenth, half. The melody in m. 3 sounds very similar to m. 1 even though the pitches are quite different (except, of course, for the repeating A♭). Rhythmic similarity also helps link the final measure here (m. 4) with m. 23. Both the initial phrase (m. 1-4) and a slightly modified version of this phrase (m. 19-23) end with a seven-note tuplet in the right hand. The second time it occurs, though, Chopin modifies the final seven pitches (Figure 4).



Figure 4: Measure 23 (analogous to m. 4.)

This phrase appears again at the end of the piece when it finally returns to A♭ Major. The tuplet has ten notes instead of seven and is missing the grace note at the end of the third beat, but it certainly sounds like more of the same thing,

expect that this flourish at the end of the phrase has become more elaborate due to the extra notes (Figure 5).



Figure 5: Measure 85 (analogous to m. 23).

Motive

Continuing upwards to larger-scale structures, we encounter motives – characteristic recurring short patterns of notes and/or rhythms. Familiar examples are found in Bach’s inventions, which are in large part based on the contrapuntal treatment of short motives that return in all sorts of transpositions, inversions, and other modifications. Beethoven’s Fifth Symphony starts with the famous “fate” motive and develops the motive throughout the rest of the first movement. Chopin may not make such obvious and pervasive use of motives as Bach and Beethoven. Of course, the Raindrop Prelude certainly has one very significant motive: the repetition of A♭/G#. Listening to the piece, it is easy to identify several other short motives that gain significance during the course of the piece. Due to the centrality of motive we examine several of these motives before moving on to larger scale forms. During this analysis it is useful to keep in mind that motives are interesting because when we notice non-literal repetition of a motive it indicates that we have formed an analogy. Indeed, the process of hearing note groups as motives requires categorization, which in turn is intimately connected with analogy-making.

A♭/G# Revisited We already mentioned the fortissimo moment where the repeated G# changes to a repeated B. Here, the rhythm and repetition of the motive make it clear that the B is still part of the same G# repetition motive even though the pitch is different. This happens in a few other places in the piece as well. Later in the minor middle section, G# moves to F# and then A. The G# switches between octaves a few times as well; sometimes it is lower, sometimes higher, and sometimes doubled.



Figure 6: A \flat becomes F.

It even becomes C \sharp for a moment in m. 71 before the end of the minor section, as it moves from the upper to the lower octave. The A \flat in the first section of the piece also moves to G \sharp in m. 11, anticipating a descent through G \flat in m. 14 to become an F for five measures (Figure 6).

In all these cases, we still hear the repetition motive regardless of the difference in pitch. Even when it changes to F, it's still the same thing as the A \flat . The analogy is strengthened here because the change occurs as the piece modulates to the key of B \flat Minor. F is the dominant pitch in B \flat , just as A \flat was the dominant of D \flat (and G \sharp is the dominant of C \sharp). The motive thus seems to be of the form "repeated eighth note on the dominant".

Later in the piece, once the motive has been so well-established, even a single repetition of an eighth note is enough to evoke the motive when in the proper context (Figure 7).



Figure 7: Another variant of the repetition motive.

Dotted-Eighth, Sixteenth, Half The very first three notes of the piece in the right hand present an important motive with a characteristic rhythm (Figure 8).



Figure 8: Rhythmic motive.

When the same rhythm appears in the third measure, the similarity is immediately noticeable, even though this version has more notes playing simultaneously and moves up by step instead of leaping down (Figure 9).



Figure 9: Rhythmic motive appearing in another form.

It also appears at the end of several measures such as m. 11, although here it has three grace notes just before and is in a different metric position – the last beat instead of the first beat – and does not evoke the original motive as strongly (Figure 10).



Figure 10: Another appearance of the motive.

This motive may appear relatively rarely so that it maintains its distinctiveness whenever it makes an entrance. Each time the F-D-A \flat version starts a measure, it is obvious that the opening melody has returned. This is particularly important at the end of the minor section, when the motive signals the return to the major key and the end of the middle section of the piece.

High Descending Notes The next most obvious motive to me (aside from the seven-note tuplet discussed earlier) starts with a series of descending eighth notes from the high points of the phrases in the B-section of the first page of the piece (m. 9-19). The motive concludes each time with a return to a longer note that is a bit higher than the final eighth note. The first instance is in m. 10, starting on the high G \flat (Figure 11).



Figure 11: Measures 8-11: High descending notes motive.



Figure 12: Return of the high descent motive.

The next measure (m. 11) is the second instance of the motive. It is about a fourth lower in pitch, moves through a minor scale, and involves a leap of a third, but it still sounds like the same thing. This motive comes back in a different form at the climax of the short coda of this prelude. The first note in the motive becomes much longer and higher (2 quarter notes tied together on a high B \flat), while the others become quarter notes and involve a larger leap (Figure 12).

This is a quite significant moment in the piece as it the only time the repeated eighth note motive stops. If I think of the “Raindrop” subtitle of the prelude, this moment makes me think of a ray of sunlight.

Phrases

The first page of the prelude divides nicely into phrases. The first four measures become a phrase (call it **a**.) The next four measures are quite similar, but the phrase cadences and comes to a pause instead of moving forward with the seven-note tuplet of **a**. Otherwise the phrases are exactly the same. The analogy between them is almost trivial, especially since the second is a truncation of the first; no notes are different. I’ll label this phrase **a'**. Next, a contrasting phrase (**b1**) begins, although it only has three measures, followed by (**b2**) for four measures and (**b3**) for another four measures. The relationships between these phrases are more complicated and hard to pin down, even though it is easy to hear them as closely related. Each of these phrases involves a combination of the descending high note motive and another more vague motive involving quarter notes (m. 12, 16, 18). After these **b** phrases, the **a** phrase returns two more times. The first return is the same phrase as before except for a modification of the pitches in the seven-note tuplet, while the final **a'** is just like **a** only shorter and with a more conclusive coda followed by a transition into the minor section.

Grouping measures into phrases and noticing that **b1**, **b2**, and **b3** are related is based on noticing similarities between motives, rhythms, textures, etc. in the phrases. That is, making analogies between phrases is based on the analogy-

making occurring at smaller scales. It is more complicated to describe the relationships between the **b** phrases precisely because of the number of elements that make up their similarity.

Large-Scale Form

The phrases of the first section group naturally into larger structures (periods) so we can describe the first section of the piece as **ABA'**. The minor middle section has a more complicated larger form, although **CCD** is a good approximation. Finally, the coda might be labeled **A'E** (a variant of the original two phrases followed by an ending). Just as the **b** phrases involved more sophisticated analogies between many elements, the minor section of the piece (**CCD**) is quite complicated and would take a good deal of prose to describe well. However, it is easy to listen to the middle section and hear relationships between the phrases.

Overall, the piece itself follows an **ABA'** structure. This structure is easy to spot due to the key changes that divide the piece into sections, and the final **A'** is quite obviously related to **A** due to near-literal repetition of the initial phrase. Perhaps the level of the entire piece is easier to discuss than middle levels because so many details have been abstracted away by lower-level analogies. The **ABA'** structure indicates that we have an initial section, a contrasting middle, and a final section related to the start. Noticing this contrast involves analogy making as we group all the pieces of **A** together and notice how they are distinct from **B**, but it seems that the more interesting analogy-making in this example happens at lower levels.

Raindrops Keep Falling...

Although it seems unlikely that Chopin himself subtitled this etude the “Raindrop”, it can be difficult to dissociate the music from thoughts of rain now that the subtitle is so closely attached to the piece. Naturally, this evokes a large-scale analogy wherein the music is compared with falling rain. When I hear the piece, the dotted eighth opening note evokes thoughts of a raindrop collecting on a tree branch or

overhang of a roof. The following sixteenth sounds like the point as which the mass of collected water becomes too great and the water droplet breaks free of surface tension and falls down to the half note A \flat . It continues to the octave below, splashing into a puddle of many A \flat eighth notes: “plunk, plunk, plunk.”

This interpretation of the opening motive is of course my own idiosyncratic view based on my personal experience, while the incessant “plunk, plunk, plunk” of the repetition motive seems likely to be a more universal interpretation. Once the name has been associated with the piece, I find it likely that most people will think of something like this “plunk, plunk, plunk” image of raindrops falling. Additionally, the minor section in the middle evokes predictably gloomy, stormy images. In this case of this prelude, although raindrop analogies are easy to make, it might be enjoyable to listen to the piece without rain in mind. Indeed, in the *Unanswered Question* lectures, Bernstein challenges his audience to listen to a performance of Beethoven’s Pastoral Symphony without thinking of the cartoon images from the movie *Fantasia*.

In any case, it is remarkable that music can evoke such concrete images about the real world. This seems to make the ultimate case for analogy as the core of music cognition: at least once I am primed by seeing the subtitle of the piece, listening to this prelude leads me form detailed analogies between notes in the piece, between various rhythmic elements, musical shapes, motives, phrases, sections, and so forth. These elements of analogy work at various levels in the piece to make sense of the structure and unify it into a whole piece that makes sense even at a representational level. I can listen to the prelude and hear it as a light rain shower followed by a more serious windy storm, followed by a lightening of the sky, a burst of sunlight, and a final few plunks of raindrops before the end of the storm.

Analogy as the Core of Music Cognition

We have seen many examples of musical elements that can sound like other elements due to analogies between the elements. How, though, do these examples support the thesis that analogy is the core of music cognition? What do we mean by this statement? Specifically, I claim that we

1) *make sense of music* by making analogies between musical elements to aid in grouping and understanding, &

2) *appreciate music* by enjoying the similarities and differences expressed by each analogy.

An entire musical piece is a large, complex structure, which only is digestible in terms of smaller chunks. These smaller chunks are formed by grouping sections, phrases, measures, or notes together by virtue of similarities expressed via analogy.

Aside from forming such chunks, some sort of meaning is found simply by remembering that a new musical element is similar to something heard before. Musical semantics is a

thorny philosophical issue that I do not mean to delve into, but I do believe that simple recognition of a familiar chunk is enough to make one feel as if a musical statement is meaningful. For example, the return of the opening motive at the return of the major section at the end of the piece sounds significant and means something to the listener just because of the happy recognition of the dotted-eighth motive. Much of the enjoyment of music comes from the analogies we make naturally when listening. For instance, the recognition that the A \flat has turned into a sinister G \sharp is a wonderful moment where the induced affect derives from noticing the analogy between the notes.

Analogy is core in music cognition because it occurs spontaneously at every level of musical listening, from individual sounds to the form of an entire piece and even further “upwards” to connect music with the external world. Additionally, parallel analogy-making at different scales facilitates the building-up of larger and larger compound structures of musical understanding.

A subtle difficulty with analogy in music cognition research is that analogy-making is so automatic that it is hard to recognize it as such. My purpose here has been to try to illustrate the prevalence of analogy-making in music cognition in hopes that future work in the field may be motivated by the centrality of analogy.

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