Addendum #10. Theory of Music

by Chuan C, Chang
May 25, 2013

With Lessons & Illustrations from Beethoven's Sonatas

Return to Addendum

Return Home (Fundamentals of Piano Practice)
page numbers cited below refer to this book.

Contents

10.1 Prologue: the need to define music

A definition of music will help us to interpret and perform music and to compose. Most of today's music theory courses treat specialized subtopics of music and rarely explain why or how they "work". Here, I try to unify all these subtopics into a logical structure and provide as much cause and effect explanations behind those musical principles as possible because, without such explanations, there is no proof that those principles are correct and provide no guidance on how to advance our understanding and enhance our capabilities. Absent this type of understanding, the performer can easily miss musical constructs used by the composer that are essential to that music, or worse, use the wrong ones. The result is that we wonder why the music we perform doesn't always "come out right".

Of course, music theory, as you can easily find on the internet or music theory books (e.g., Scoggin) is the most useful tool today for analyzing music and composing. However, because most of these are empirical ("down-up"), or ad hoc interpretations by the authors, these analyses may not be optimum or even correct. Beethoven is famous of "breaking" these theoretical rules to compose better music, thus demonstrating that those rules are not correct. A "top down" theory of music derived from first principles does not exist today, but that does not mean that we shouldn't try; otherwise, we would never have been blessed with the greatest advances in human history such as in technology, science, biology, medicine, finance, etc.

10.2 What is music?

Music is a language. A language is used to communicate. In music the communication produces emotions, carries a message, or otherwise operates on the brain to produce a response. Emotions are brain reactions to inputs and they help us to decide what to do in response to inputs. There are numerous emotions, such as happiness, sadness, fear, joy, curiosity, anger, pleasure, etc., and each is associated with specific physical inputs:

Emotion	**Input**
happiness:	good news,
sadness:	bad news, tragedies
fear:	danger
joy:	success
curiosity:	mysteries, knowledge
anger:	injustices
pleasure:	satisfaction of a physical desire such as hunger, sex, etc.

Emotions are complex brain reactions and there are many more than those listed above (excitement, boredom, surprise, etc.).

Spoken languages consist of auditory (also visual or tactile) signals governed by complex conventions, such as words and sentences, that allow very precise communications. We can decipher those sentences to infer a meaning. Music communications use similar inputs, and our brains use instinctive or "hard-wired" brain responses to these inputs as well as learned responses, such as the recognition of classical or contemporary music, to generate our reactions to music. These properties make music more universal than spoken languages; in most cases the musical language does not need to be learned for the person to appreciate music.

Because spoken languages and music are both languages, they have much in common. Both use mostly auditory inputs and are most quickly learned under the age of about 15 (and even while a baby); thereafter learning becomes progressively more difficult because the process of forming new nerve connections slows down. Material learned during those early ages are almost never forgotten because the myelin sheaths build up and preserve this memory after the teen ages. This same reasoning predicts that forming new memories will become progressively more difficult with age because these sheaths make it more difficult to form new connections. In the very young, speech generally precedes reading or writing; similarly in music, memory and performance precede reading. Because the spoken language is so well understood, the close parallels between the two languages tell us that our knowledge of spoken languages is a good place to start our study of music.

10.3 Communications Media in Music: timing, volume, pitch, & logic

For simplicity, ***we shall discuss only the auditory music inputs here*** because similar principles apply to visual or tactile inputs, and they are much less important. Why is auditory so much more important? In tactile, physical contact is necessary for communications, which is not needed in auditory, so that auditory is easier, can cover a large area (thousands in the audience for outdoor events) and more universal. In vision, you need line-of-sight, and vision is generally a two-dimensional data set on the retina which requires a large bandwidth and tremendous amounts of signal processing in the brain, much, much more than auditory, so that auditory is far superior to visual.

The major communications media for auditory musical language are timing, volume, pitch, and logic. The first three are the physical response capabilities of the ear and the last is what the brain does with these responses. In music we evoke emotions, send messages, etc., using these auditory inputs, completely bypassing or replacing the physical inputs normally associated with them, such as those discussed above. In a way, we get something for almost nothing (in the same way that the spoken language does), which is one of the sources of the power and versatility of music; i.e., these advantages are the motivation for our use of music.

Timing is the time interval between notes or beats. We shall see that timing is the most important element of music because it is the basis for creating rhythm. In physics, we live in a four-dimensional space-time in which time is unique because it is the only dimension that cannot be reversed. The brain also appears to recognize that time is special because it cannot be reversed whereas volume, pitch, and logical structures can be traversed in any direction. Thus time forms the backbone around which all music is created. This is the basis for the statements in practically all music manuals that emphasize the importance of rhythm.

The importance of time can be immediately appreciated by the fact that drums, dancing and even primitive jungle communications based on beating hollow logs with sticks, are based almost entirely on rhythm. A single time signature can govern an entire movement of music. **Thus timing is the most important element of music.**

Volume is loud or soft. Information can be transmitted by changing the volume; an increasing volume might suggest that something is approaching; loud sounds may suggest danger such as explosions, and softer sounds may invite more attention or pique your curiosity. It is well known in piano pedagogy that, in order to arrive at FF, you must start with P so as to make the transition more apparent. When increasing or decreasing the volume, most of the change should come at the end. Why? Because mathematically, this approximates a logarithmic curve and the brain will recognize this functional dependence and instinctively extrapolate to even higher volumes even after you have played the last increasing note, giving you “a bigger bang for your buck”. Thus the recognition of a functional dependence communicates to the brain a specific message that is automatically and universally interpreted by every brain in a consistent way.

Beethoven used the extremes of loud and soft in the first movement of his Pathetique Sonata that illustrate this point. These extreme volume changes are absolutely necessary to this movement, without which most of the incredible effects of this movement would be lost. Details are given below under Pathetique.

Optimum volume variations are often difficult to explain. One easy rule to follow is that of the time signature, which often determines the rhythm and every rhythm has its set of volume changes. Beethoven’s music is known for almost violent accents that appear “irrational” yet are absolutely essential to the music; thus the time signatures in Beethoven’s music carry a heavier significance than time signatures of most other composers. By knowing exactly where these accents occur, you can more easily produce an “authentic Beethoven”.

Nobody has yet found a generally accepted explanation of why Beethoven’s accents work; yet, it is clear that one of the reasons why his music stands high above the others is the presence of these accents. There is little question in my mind that, eventually, the explanation(s) will be found. It probably resides in the realm of logic, the least understood component of music which is closely related to the most complex functions of the brain. Here again, Beethoven is teaching us a lesson: volume is an effective means of communication -- use it!

Pitch is the frequency of the sound. In music, pitch space is severely limited by how we produce pitch, such as by voice (a few octaves only) or by musical instruments (pianos have only 88 notes), and by our ability/inability to write the music on sheet music (although violins can produce an infinite number of notes, violin music is written mostly using the finite number of notes of the chromatic scale). These factors have conspired to result in the creation of scales and intervals, consisting of a relatively small number of notes, out of the infinity of notes that the human ear can hear. **In most “western” music (based on the chromatic scale), we throw away 99.999999 . . . . % of available pitch space to create our music!!!**

The notes of a scale are a subset of the ***chromatic scale*** (P. 223). The chromatic scale is a series of pitches that rise according to a logarithmic scale that provides a “best fit” to the largest number of harmonics within a reasonable number of notes (in terms of instrumental design such as keyboards, string, and wind instruments), and this best fit turned out to be 12 notes to the octave, which is just a mathematical quirk of nature (P. 224). Thus ***the chromatic scale is a human invention and does not exist in nature. This means that no one can be born with absolute pitch; the only way to acquire absolute pitch is to learn it.*** The chromatic scale is logarithmic because the logarithmic scale can accommodate a large frequency range; the ear takes advantage of this by also using a logarithmic detection mechanism (Psychoacoustics).

Although the historical developments that created the chromatic scale are tortuous, the logical reasons for its creation are simple to summarize. ***The scale is a compromise between the need for something that can represent all the conceivable musical constructs and a practical system that can be actually constructed in a useful way.*** The first compromise is that, although there is an infinite number of pitches, even within a finite interval (such as a semi-tone), there is no way to notate this infinity of notes so that someone else can reproduce your composition using this infinity of notes. For example, we still don't have a precise way of notating violin music because the violin can produce an infinite number of pitches. ***Thus our music scale must have a finite number of pitches.*** There are a few exceptions such as the violin glissando (slide), vibrato, etc. Even for these "exceptions", there is no way to notate exactly how to execute a slide or a vibrato.

Mathematicians are well aware of, and have solutions to, this infinity problem; it is called “completeness”, which measures the accuracy with which any notation approximates the real thing. The chromatic scale is logarithmic (P. 223 – also, see below); completeness asks the question, “given a specific composition, how well does this music notated using the notes of this scale, approximate the composition?” The answer is that it is sufficiently complete in a large number of cases, and for music confined to this scale, it is 100% complete. That is, ***the chromatic scale can approximate any music fairly accurately, and can notate music using only the chromatic scale with 100% accuracy.*** No better system has yet been found. There are scales with smaller intervals than the semi-tone of the chromatic scale, but the same “completeness” arguments apply to them. Thus the only remaining task is to construct this chromatic scale.

A scale must contain all the major intervals (octave, fifths, etc.), This requirement arises from the fact that a maximum number of notes will then harmonize with each other which makes it easier for the mind to keep track of the notes of music written in that scale. The other scales are not forbidden; the mind rejects them as inferior because of the extra effort required to decipher them. For example in C major, the important intervals are (see P. 224 for the mathematical ratios):

Octave = CC' (C' is an octave above C)
fifth = CG
Fourth = CF
Major Third = CE
Minor third = AC'

This requirement explains why the tonic (C in this case), is the most important note in a scale (because it is involved with every major interval) and also tells us how the brain keeps track of the tonic – by referencing every note to it. Thus, after you play a few notes of a scale, the brain quickly figures out the tonic because it is the only note closely "related" to all the others (via the intervals). ***The prominence of the tonic also explains (at least partly) how the brain keeps track of chord progressions*** (because each step of the progression is referenced to the tonic of the first scale used) and why the music must return to that starting scale at the end of the composition.

Now the smallest pitch difference in C major is the interval EF, which is called a semitone. What determines the value of a semi-tone? Answer: harmony (P. 223): the octave is exactly 12 semitones, and the intervals fifth, fourth, major third, and minor third are almost exactly 7, 5, 4, and 3 semitones, respectively, and it is easy to prove mathematically that these are the only essential intervals (p.224). These are all incredible mathematical coincidences and are unbelievably fortunate because a scale consisting of 12 semitones will contain all the necessary intervals with negligibly small errors. Little wonder that in early history, music was believed to be something closer to god than to man. We saw above that such a scale is mathematically pretty complete, and construction of musical instruments such as keyboards with 12 notes to a scale (octave) is eminently feasible. The essential intervals are "essential" because their notes harmonize, and harmony is special to the brain as explained in the preceding paragraph.

Past musicians and mathematicians have tried to find other scales with fewer or more notes to see if better scales (with more exact matches between the theoretical and actual intervals) can be created, but none have been found (P. 226).

Therefore, harmony, completeness, and practicality are three main reasons for the existence of the chromatic scale. The properties that all intervals are ratios and that the frequency doubles with each ascending octave are properties of a mathematical function called the logarithmic function. That is, the chromatic scale is a logarithmic scale. Here, we discover another amazing coincidence in that, as we saw above, the human ear uses a logarithmic scale for detecting and processing frequencies in the brain. This means that it is easy to construct a musical instrument that accommodates the entire frequency range of the human ear by adopting the chromatic scale. For example, if the chromatic scale were linear (not logarithmic), we would need a piano keyboard over half a mile wide! This is the meaning of "practical" above.

There is another astonishing property of a logarithmic chromatic scale: scales can be **transposed.** Starting with any note on the chromatic scale, you can construct another scale with exactly the same interval ratios as C major, without having to add any new notes. Musicians certainly know why this property is so useful.

The actual intervals in the logarithmic chromatic scale are not exact harmonies, which gives rise to the need for temperaments (P. 223). The mathematically simplest temperament is the **equal temperament** (ET), which is almost universally used today. ET is simply the strictly mathematical logarithmic scale; therefore, all semitones are exactly 1/12th of an octave. The disadvantages of ET are (1) it is difficult to tune and (2) except for the octave, none of the intervals are exact (perfect harmonies); i.e., they are slightly out of tune. One advantage of ET is that, because intervals are already out of tune, a piano that goes slightly out of tune is not as noticeable as with other temperaments in which many intervals are tuned exactly. Historically, from before Bach to about the time of Beethoven, a family of temperaments called **Well Temperaments** (WT) were used (this is over-simplified but further details are not needed here); these were based on tuning as many exact intervals as possible in "frequently used" scales and sending the errors into less frequently used scales. Because these tunings were based on exact intervals, they were generally easier to tune, a useful property at a time when most musicians tuned their own instruments. These adjustments (away from ET) made every scale (key) different from every other and gave rise to the concept of **key color.** An obvious disadvantage of WTs is that the intended key color changes (usually destroyed) when the music is transposed. Another disadvantage is that a piano only slightly out of tune becomes painfully obvious. **Music written for WT (from Bach to Beethoven) certainly sounds better in WT than ET.** Thus advanced musical sensitivity can be cultivated only by use of WT and by developing the ability to recognize key color; digital pianos solve this problem because you can choose the temperament with the flick of a switch. It is clear that temperament must be an integral part of music theory.

Logic: Timing, volume, and pitch, though infinitely complex, are relatively easy to understand. However, ***the logic part is not well understood***; we do not yet have any means of generating "great music" except for "inspiration". The only popular music that exist are ones some composer discovered which we perceive to be musical. Spoken languages have words with precise meanings, making it easy to decipher the logic (meaning of a sentence) and to construct “correct” sentences. Thus, we must inquire: what are the analogues to words and grammar in music? This question has not yet been answered in the sense that, although anyone can “understand” music when we hear it, we cannot generate music at will as we can with spoken sentences. This point may be controversial because any person can generate music, but only a few can compose music that becomes famous, just as anyone can write sentences but only a few, such as Shakespeare, can write the best literature. Thus the controversy is this: since it is not possible to generate a theory that distinguishes good literature from the ordinary, does it make sense to ask if we can come up with a theory for the generation of good music? My personal view is that the answer is “yes”, and it is called musical grammar; i.e., the structural rules of music. One example of this is chord progressions. Thus the least advanced sector of music theory is our understanding of musical logic.

The communications media of timing, volume, pitch, and logic are used to create the following musical “languages”.

10.4 Languages of music: Rhythm, Harmony, & Melody

Everything you do in music involves rhythm, harmony, and/or melody. These three “languages” use the media of timing, volume, pitch, and logic. Great composers used each of these elements to create their music and it is both educational and useful for interpretation and execution to know precisely what they are and how to use them.

Rhythm: Timing, volume and logic are combined to produce rhythm. The most prominent feature of almost any music is repetition, especially rhythmic repetition, which is much less important in spoken language. That does not mean that spoken language does not have rhythm; each language has its own characteristic rhythm. (In French, the last syllable is accented. In standard Japanese [Tokyo dialect], the accent comes at or near the last syllable of a phrase whereas in southern Japanese dialects, this accent is moved further up the phrase, near the beginning. In Hawaii, the accent is on the second last syllable, etc.)

The almost exclusive use in music of a single time signature for a given piece (or section) of music tells that a chosen unit of rhythm is repeated throughout the piece, with very few exceptions. This almost universal property of music gives us the deepest insight into the nature of music: the concept of expectation and reward. ***Music is based on creating an expectation and then satisfying it.*** By following a time signature, you immediately create an endless cycle of expectation and satisfaction. In order to compose music, we must use all the available resources (not only the time signature) to create expectations and then satisfy them. For example, it is absolutely essential to carefully connect each bar with the following bar; otherwise the repetitive rhythm will be broken. Try playing the 1st movement of Beethoven’s Moonlight Sonata, first, by playing each bar separately like independent units, and a second time, by carefully connecting the bars. You will see an immediate improvement in the music. By carefully observing other aspects of rhythm (check the time signature, etc., see below), you can improve it even more.

Rhythm is an entire language in itself, as illustrated by drummers. You can accelerate, decelerate, syncopate, use tempo rubato. Therefore, when analyzing a specific piece of music, its rhythm should be analyzed separately -- rhythm is everywhere. One excellent example is Beethoven’s Appassionata Sonata (Op. 57), 1st movement: the time signature is 12/8 (not 6/4, in spite of the fact that the major notes of the beginning “arpeggio” are quarter notes). We find out exactly why in bar 17, where every eighth-note FF chord (alternating quarter notes) is equally important. Clearly, in order to play any music correctly, we must pay meticulous attention to rhythm, and this starts with understanding the reasoning behind the time signature.

Changing speed is another rhythmic device. A good example is the beginning Grave section of his Pathetique (Op. 13), where he contrasts the very slow over-all speed (Grave) of this section with runs using 1/64th and even 1/128th (impossible) speeds! This knowledge, of course, tells you exactly how to play it, and why. He uses this extreme contrast with other extreme contrasts, as illustrated below, to create this incredible sonata.

Harmony: is the relationship between two pitches. Examples of "good" harmonies are intervals such as fifths, fourths, and thirds. Appreciation of harmony is closely related to how frequencies are detected in the ear and processed in the brain. ***Harmonics (sounds that are integer multiples of a single frequency) produce a static result when played together*** -- a sound that does not change with time, and can be more easily characterized and processed in the brain which explains why we perceive them as harmonious. Harmonics with smaller integers are especially special because their sound structures are simpler and "cleaner sounds" are more readily produced. Notes differing only slightly in frequency produce oscillating sounds (beats). When this beat frequency exceeds about 30 Hz, our ears do not recognize them as beats but as another low frequency sound and the totality of these sounds are called dissonances. Thus ***dissonances can also be static, but have much more complex sound structures*** and therefore are recognized as different from harmonies and disliked by the brain because of the difficulty of processing the more complex sound structure.

We saw that harmony plays a fundamental role in the creation of the chromatic scale (see Pitch section). Understanding of harmony culminated in the struggles of Bach with cataloguing the key colors associated with the temperaments. Today, together with advances in Eastern music, harmony has developed into a complex, specialized field of music (Mathieu).

Melody: Rhythm is combined with pitch and logic to produce melodies. What governs the logic in melodies is not completely understood, although we know a lot about the logical structures of most known melodies. One complicating factor in analyzing music is that part of musical recognition depends on the environment of the person; i.e., part of musical appreciation is acquired. However, this fact tells us something very important about music: that ***music is heavily dependent upon memory***. Recall that music can be a process of creating expectations and satisfying them; now ***we conclude that part of musical satisfaction process is related to memory***. ***Thus music can also be associative.*** This means that, when we recognize a great melody, the brain is associating it with something already in the brain. However, we have not always been able to identify what this association is, and this identification is the main motivation in my writing this article. In theory, by following first principles, if we understand everything along the way, we should be able to produce a road map that leads us to this identification.

Melodies have certain characteristics:

(1) They are easily remembered and this memory can persist for a very long time.

(2) They can evoke emotions, such as beauty, excitement, pleasantness, etc.

(3) These effects are fairly universal; two people listening to the same music will react similarly, unless previously conditioned to react differently.

(4) People can be conditioned to react in certain ways to specific melodies or music.

Again, ***it is clear from these properties that melodies are associative.*** This is why they are so easy to remember, and is very useful as an algorithm for memorizing music. In cases of conditioned responses to certain music, such as a national anthem, we know the associations (national pride, etc.). But melodies can move us in complex ways without any conditioning -- this is the part that is not yet well understood. In many cases, we can't even define what the brain's reaction is, but these cases are probably complex cases that are difficult, but not impossible, to analyze. In most cases, the build-up of tension and its release (and related processes) can explain the musical property of the composition.

An example of this association is the beginning "arpeggio" of Beethoven's Appassionata, which is a schematized, distilled, and inverted form of the main theme that starts on bar 35. Many analysts consider them to be two themes (Gutmann), but I believe that they are variations of a single theme - an interpretation that unifies all the elements of the 1st movement into a progression of thematic development representing the pinnacle of Beethoven's achievements in thematic development. The similarities between these constructs (the beginning "arpeggio" and bar 35) have already been noted in the literature (Gutmann).

The most important component of logic is the musical logic that creates a melody. The brain associates this "memorable" melody with something already in the brain, and this association makes it memorable. What we cannot always find definitively is what the brain is associating the melody with.

It is entirely possible that, because the brain is so complex, there are innumerable accidents of nature within the brain that produce memorable associations (as well as non-memorable or unpleasant ones) when certain inputs, such as aural, are encountered. In this situation, there is no physical explanation for why it is memorable. Since all humans share over 99% of identical genes, it is plausible that these accidents are also shared. In that case, the job of a musician is to play various combinations of music media in the mind and search for those patterns that match the accidents. Then any attempt to find an understanding of how to discover rules for creating music would be futile because music would depend solely on accidents of nature.

Another possible theory of musical logic (specifically, melody) is that every memorable music has a logic that can be associated with some known property of the brain. In this case, research into those relevant properties of the brain will explain how that music was created and may even help us create more memorable music. It will certainly help us to perform/interpret the music. We already saw one example: the creation of an expectation and then satisfying it (rhythm), or creating tension and then resolving it. We see this in the Appassionata: the incessant triplets starting at bar 24 --- it goes on interminably for 10 bars until bar 34. This series of staccato triplets forebodes the arrival of something --- it can't just end. Beethoven's ending of this long series of triplets is astounding: it ends with the Fate Motif of his 5th symphony! The last 3 notes of bar 34 and the first note of bar 35 form the fate motif, and creates, at the same time, a seamless transition from the triplets into the main theme of this movement. This revelation explains many things: why the fate motive was used earlier (to familiarize us with it) and why the long triplets were used (so that the building tension of the staccato triplets could be ended with the familiar motif).

Logical structures in music follow certain restrictions or rules. One prominent rule is chord progressions. Thus we must understand what chords are and then progress to examining "allowed" progressions. Chords are the major notes that define a scale (also called a key), such as C Major.

However, staying within one scale can become boring because if you can use other notes, you have many more possibilities to explore. The way to avoid boredom is to change scale. But which one? If you make a random jump to another scale, that change can be so jarring and difficult for the brain to process, that the jump becomes unacceptable to the brain; put it differently, there are certain scales that the brain prefers -- let's see why. If you transpose all the notes of C major up a fifth, you get another sequence of notes that sounds just like C major, except for one note; the F must be changed to F# in order for this new scale to follow all the same rules we used to create C major. Thus by introducing only one new note, you find yourself in a completely different key (G major)! The brain likes this because almost all the notes are familiar, yet you now have a completely new set of intervals that breaks up the monotony. This hopping from scale to preferred scale is called a ***chord progression***. Knowing the basic chord progressions is one key to learning how to improvise and compose (P. 220).

This process of transposing by a fifth to create new scales gives rise to the "circle of fifths" (P. 225). One "preferred" chord progression is to travel along the circle of fifths. What is so mysterious about chord progressions is that, unless you create a special musical device, you must return to the starting scale of the music, at the end; otherwise, the brain will conclude that the music has not ended and should keep on going. The mystery here is, even if the music is 20 minutes long or longer, with numerous key changes, the brain remembers the starting scale without any conscious effort on the part of the listener. Not only that, but the brain concludes that something is missing unless the music returns to that starting key. This is why, unless the composer decides to produce a special effect (such as suspense or mystery), every piece of music begins and ends in the same key. The precise psychological mechanism for this brain behavior is not known, although in music theory, it is recognized that tension is generally increased as you move away along the circle of fifths from the starting key which is released when you return to it. But this does not answer the question of why moving away from the starting key creates tension, and how the brain keeps track of the starting key after so many key changes. Why does the brain need to keep track of where the chord progression came from, and why does it need to return to the originating chord, all this without any conscious effort from the listener?

Composers have various objectives in mind, when they are composing. This is because, without a meaningful objective, you cannot have meaningful music. For example, every composer wants to compose as much music as possible; after all, composing takes a lot of time and life is too short. This desire gives rise to frequent use of repetitions; Mozart's repetition formulas generally multiplied any theme he composed by about a factor of about 10 (P. 206). This use of repetition is not trivial because repetitions have a special place in the logic of music. Thus any composer must master the art of repetition.

Summary

In summary, music is a language which uses mostly auditory inputs, with secondary inputs such as visual and tactile. The media for auditory inputs are timing, volume, pitch, and logic. The first three are mostly understood, but the logic elements behind music are not fully understood; some known ones are: (1) the creation of an expectation and its satisfaction (tension and its resolution, etc.), (2) associations: conditioned (learned) and natural (inborn, or "hardwired" in the brain), (3) creating specific messages, just as in spoken languages, and (4) brain responses (harmony, chord progressions, etc.). Understanding these elements of the definition of music helps us to interpret/perform, and to compose music. We now visit some applications of these approaches to understanding music.

10.5 Interpreting the Beethoven Sonatas: Moonlight, Pathetique, Appassionata

Beethoven's compositions are probably the best music with which to study and illustrate musical principles because he used everything and almost never wasted anything, so that all the principles appear and apply everywhere; usually, several of them simultaneously. Thus his music contains the densest examples of these principles/structures and has the lowest risk of giving us misleading clues because there is minimum guessing: his instructions are CLEAR. Another reason why his music is so useful for discussing musical principles is that he always strove to produce extremes. Thus when he applies a principle, you can't miss it if you know what to look for; what is so interesting is that for the casual listener who is not analyzing his music, these principles are basically INVISIBLE. This, of course, amplifies their effectiveness because they mysteriously control the audience without their knowledge. Part of deep music is the use of principles that affect the audience without their knowledge -- this type of musical principle is what is included in "logic" structure. Moreover, Beethoven often "broke the rules" to produce glorious music. Why did "breaking the rules" produce better music? Simply because those rules were wrong! Without a proper understanding of music, it is too easy to deduce "musical laws" that are incorrect. Thus Beethoven teaches us not only what is right, but also what is wrong. Since bits and pieces of references to different sonatas are intermingled above, all the comments (and more) for each sonata movement are assembled below.

We now show how Beethoven used timing, volume, pitch, logic, rhythm, harmony, and melody to produce his music.

Moonlight Sonata, Op. 27, No. 2, First Movement

The major consideration about this movement is the pedaling. The "conventional pedaling" generally accepted today ignores the original instructions by Beethoven ("senza sordini" – don't lift the pedal for the entire piece!) and applies conventional pedaling rules, as amply described elsewhere (Wikipedia, Chapman [click on "Moonlight print version"]). My view of this matter is that the pianist has two options for playing this piece; either take Beethoven's indication literally, or use conventional pedaling as practically every pianist has done historically – the two methods will result in totally different music. A lot of the evidence points to the conventional pedaling as the one Beethoven had in mind (Chapman). After all this piece is easy enough for anyone to play it, and was widely played during Beethoven's time, probably using conventional pedaling, yet there is no record of Beethoven commenting on the pedaling. Thus, the conventional interpretation of "senza sordini" is that it was a short hand way for Beethoven to say that the pedal should be used throughout, but can be lifted judiciously as needed.

Here, I explore the view that "senza sordini" can be taken literally and point out some wonderful consequences of that interpretation. My opinion is that every pianist should try both ways of playing and explore the advantages/disadvantages of each. Most pianists have argued that the continuous pedal worked for Beethoven because the pianos of his time did not have the sustain of today's good grands and that continuous pedal on today's grands would "muddy" the music (Wikipedia, section on "Beethoven's Pedal Mark"). If this argument were true, then we should be able to use continuous pedal on an upright or other inferior piano with less sustain – of course, it STILL muddies the music with such pianos. Therefore, one interpretation is that this "muddiness" was INTENTIONAL. It produces a constant, dissonant, background "roar", which not only creates an ominous, ever present, sadness, but also a stark CONTRAST against the beautiful harmonies of the piece. In that case**, this use of the pedal is an invention by Beethoven, and this sonata represents a unique innovation in the universe of piano music.** Extreme contrasts are a hallmark of Beethoven (see elsewhere in this article for numerous examples). Although it is the pianist's prerogative to play a "beautiful, clear" moonlight, I have much more greatly enjoyed playing according to Beethoven's intention of a sad, painful piece with much deeper emotions.

The first bar presents the clearest harmony. Then Beethoven jars you with the first dissonance (full tone down from C#), a B octave in the LH in bar 2, producing the start of a dissonant "background roar". **Thus in just 2 bars, he has introduced his concept of the contrast between harmony and dissonance;** i.e., harmony is much more meaningful when contrasted with dissonance. Bars 3 & 4 complete this introduction, with clear harmonies riding on a background of growing dissonance because of the pedal.

By bar 5, the dissonant background is complete, and he introduces his 3-note theme – the same note repeated three times – you can't have a clearer harmony than a note with itself (works even if the piano is out of tune!). **It is now clear why he used this 3-note theme with the most perfect harmony possible – to contrast harmony with the dissonant background roar.** If by this time, the pianist is not convinced that Beethoven is playing with the concept of dissonance vs harmony, I can't think of any clearer way of demonstrating it! Note that there is a PP marking only on those three notes – the audience must search for those notes amongst the constant background dissonance.

He explores this harmony-dissonance contrast with some beautiful, but sad, melodies and harmonies, until, in bar 16, he introduces the concept of pain with the dissonant 9th in the RH. **This is the only Beethoven composition that I know of, in which he used pain; therefore, this sonata is unique not only because of the use of a dissonant background, but also because it contains a musical description of pain.** Thus, the dark background roar and the sad harmonies make it clear that this is a sad piece, but true sadness is painful, and Beethoven inserts pain by punctuating this composition with dissonant 9ths at the deepest depths of despair. Note that, at the same time, there is the repeated "tolling of the bell" – the almost endless repetition of the B in the RH, which then proceeds to descend in the following bars, further increasing the desperate sadness.

Immediately following the dissonant 9th in bar 16 is the cresc.-decresc. in the LH, which supports the emphasis on the 9th and confirms its prominent role.

As if these instructions were not clear enough, there is a "cresc." on bar 48 and a sudden P on 49. If you don't lift the pedal in between, the inescapable effect is a harmonious P passage buried in the loud, dissonant background produced by the preceding bars. Under "senza sordini", this produces a much more dramatic effect than if the pedal were cut to play the P. If there were any previous doubts about the use of the "background roar" these two bars should put an end to those doubts, because you can't escape those effects if played according to the markings. These two bars could be Beethoven's way of saying, "if you still don't get it, I can't help you".

Bar 60 is a "false ending"; an ordinary composer would have ended the movement here by returning to the tonic, but Beethoven nostalgically picks up the repeated-note theme again, and gradually ends the piece, softer and softer, to the final PP (you might add the soft pedal for the very last chord, as it must be the softest sound in the entire piece). **Most of Beethoven's compositions have this "double ending" a very effective device for ending a composition with conviction.** Most composers have difficulty finding ONE good ending; Beethoven usually gives us TWO, and the final one is a marvel of originality.

In summary, this composition is an example of the use of harmony and melodies in music theory. The language of volume plays a major part. Pitch is also important because of the use of chromatic (semi-tone) intervals. Played "senza sordini", this sonata is an unique example in the history of piano because of the use of a dissonant background created by the pedal and a musical description of pain, attesting to the inventiveness of Beethoven.

See also my original comments on this movement on P. 57 for more details.

Pathetique Sonata, Op. 13, First Movement

This movement is perhaps one of the best examples of Beethoven's use of extreme contrasts. Because of the extreme nature, it is easy to identify the contrasts definitively. The starting Grave section is almost devoid of rhythm, wheres the following Allegro is the height of rhythmic music.

The most obvious contrast in the Grave is volume. The first chord of bar 1 is F and all the remaining notes are P. Because even this most obvious concept is not always understood, there has been some controversy on how to make the transition from F to P, especially as regards the use of the pedal (Beethoven did not indicate any pedal markings, so a purist should play the entire sonata without pedal; however, if you choose to use the pedal, it should be used in such a way that it cannot be noticed). Some have advocated fluttering the pedal. But this is wrong because it does not produce maximum contrast. The real solution is simplicity itself. You simply cut the pedal and immediately play the P. Maximum volume contrast!

The second, equally important contrast, is speed. Grave is a slow tempo. Yet there are runs at 1/128 speed! Set to a metronome, these fastest runs are humanly impossible to execute accurately. It is obvious what Beethoven is telling us: "this section is of slow tempo, but play the fast runs as fast as you can". Thus the concept of rhythm has clearly been thrown out the window.

The Allegro, by contrast, is driven by a lively rhythm controlled by the LH. He starts by using the simplest device, and octave tremolo. See p. 77 for how to practice it. Beethoven had a special place in his heart for the octave and used it extensively and effectively. Mathematically, the octave holds a special place within the chromatic scale because it is the ONLY interval that is just (perfect harmony) EVERYWHERE ON THE PIANO, regardless of temperament (tuning) or key signature. Beethoven almost certainly knew this and took full advantage of it. Music written with maximum perfect harmony!

Speed is also an important element of the Allegro. This speed contrasts with the slow movement of the Grave; thus the Grave is there so that you will recognize the speed of the Allegro. But a deeper reason is that Beethoven wanted to control the emotions of the audience before they could figure out how he was doing it. Getting 10 fingers to move faster than the human brain is quite a challenge. By converting the LH octaves into a tremolo, he immediately doubled the speed, a simple device for any accomplished pianist. Later on, he uses the Alberti construct (bar 89) with similar effects. Because of these types of devices, it is usually not possible to arbitrarily slow down a Beethoven composition without destroying the original intents of the composer. Another device he used is to let the LH control the emotions while the RH played a decoy "melody" that attracted attention away from the LH. Thus musically, the LH is more important than the RH in this Allegro.

Another important device used in this Allegro is volume control. Note that the volume is P until bar 15, then slowly increases until bar 18 (most of the increase within bar 18) and suddenly returns to P in bar 19. These volume changes must be controlled more by the LH than the RH. Beethoven was a master of these volume changes that seem to have no logical explanation, yet "work" musically. Many students make the amateur mistake (amateur because that is not what Beethoven wanted, and musically correct) of starting the cresc. in bar 12, reaching a maximum at bar15.

Another volume accent is used in the MIDDLE of bars 27 and 28, a totally surprising RH syncopation that appears out of nowhere. I suspect that this was inserted to rivet the audiences' attention to the RH, thereby allowing the LH to control the emotions while the audience is pre-occupied with the "melody" in the RH.

A very important volume increase occurs in the LH at bar 37 (and similarly at 41) where the preceding cresc. indicates that the LH tremolo volume must increase rapidly in anticipation of the sf in bar 38 (and again in 42). These are unique volume accents so prevalent in Beethoven compositions. Thus to make the music "sound like Beethoven", these volume accents must be carefully observed.

Although speed is essential in this Allegro, it is too often played too fast. Such speeds result in the almost total loss of the deeper concepts that saturate Beethoven's music, making them immortal. Certainly, it is possible to drive the audience to delirium by mere speed and that device is a legitimate alternative – after all, this is entertainment, but that is not the real Beethoven, in which every note is important and must be heard.

Examples are, of course, the LH octave tremolo, and the Alberti structures starting at bar 89. As explained above, these bars contain so many notes that they allow exquisite control of the emotions in a way that the audience is unable to figure out. **This makes the music timeless.** Fast playing may be exciting at first, but quickly loses its appeal; the real Beethoven is always exciting because the audience is never able to figure out everything that is going on in the music. I am certain in my mind that this immortality is what Beethoven struggled to achieve.

Volume (FF) is used in this piece to indicate the ending. As usual, he gives us a false ending in bar 294, which then leads to the real ending (FF) in bar 309. This FF must be distinctly louder than anything else for the ending to be convincing and final. The final two chords are exact quarter notes, unlike the gaudy full notes of the false ending – it is like Beethoven is ridiculing such "typical endings".

Appassionata, Op. 57, First Movement

This movement is all about rhythm. Beethoven has abstracted the rhythm of the "fate motif" of his 5th symphony, and used it in all the forms his mind could conjure. Thus what appears to be the first 3 notes of an arpeggio that starts this movement is actually a modified form of the fate motif, ending with the accent on the final (third) “surprise” note, F. He tells you directly that he is using the fate motif in bar 10 by actually using it, un-modified. For those not analyzing this movement in detail, it seems as if he just stuck this motif here because it “fit”; the reality is that the entire movement is based on it. This sonata is just the piano version of his 5th symphony! Both were written at about the same time.

One use he found for this motif is as a conjunction to connect musical phrases or sections or even bars. The first use as a conjunction is to connect the introductory 3 notes to the first bar. Then he uses it to connect the beginning of the introduction (bars 0-11), with its ending (bars 14-15): the conjunction is the repeated fate motifs in bars 12-13.

The second use as conjunction occurs at the end of bar 16, where it is used to launch bar 17.

The third use as conjunction is very clever, and it connects bar 34 to bar 35; the last triplet of bar 34 and the first note of bar 35 form the fate motif. This is incredibly clever because the preceding long series of triplets creates a tension that is finally resolved by the motif. Not only that, but also, by acting as a conjunction, it immediately launches you into the main theme of this movement, one of the most beautiful musical passages ever composed.

The fourth use as conjunction appears between bars 78 and 79, where is it used to launch an entirely new section; there are similar applications elsewhere in this movement.

In bars 130-134, the fate motif is spelled out without modification. These bars again serve as a conjunction between major sections.

By far the most interesting conjunction application appears in bars 235-240, where he uses the “group theory” method (see p. 209) to create a long conjunction. He used the “space group” to compose the 5th symphony (p. 209), but here, he adds the “time space” – the main device he uses is to gradually slow down the fate motif, and then suddenly accelerates it (transition into bar 239) to launch the final section of this movement. Of course, he also uses the volume and pitch spaces to great effect. It is clear that Beethoven was aware of “group theory” type concepts – a true genius.

For many years, I wondered about the mysterious trills that appear in this movement, such as at bars 3 (and similar), and 44-46. They were mysterious to me because they weren't simple trills but carried some thematic value. Without understanding the role of the trills, it wasn't clear how to play them, and there was no consistent interpretation among different pianists. I “solved” the mystery when I realized that the trills, followed by a succeeding note, was a modified form of the fate motif. This interpretation gave a clear indication of how to play them – the succeeding note needed to be emphasized, which provides the thematic input.

The beautiful section starting at bar 35 is the main theme of this movement. The material from the beginning to bar 35 is the introduction leading to it. This introduction tells us that the theme is constructed out of modified versions of the fate motif in the 5th symphony. Thus in the “arpeggio” at the very beginning, the accent is on the third note (corresponding to the “surprise note in the fate motif), not the first, as it usually is, in a standard arpeggio. The similarity between the beginning arpeggio and the theme starting at bar 35 is well recognized (Gutmann). Closer examination reveals that the arpeggio is a schematized form of the main theme, so as to ensure that the correct RHYTHM is implanted in the audiences' mind, and the schematic is inverted, so that the audience does not recognize that the arpeggio and theme are related. This is an incredibly clever psychological device in which Beethoven accomplishes his objective, but the audience is completely unaware of it. Thus, when the main theme appears, we feel familiar with it, because we recognize its rhythm. Beethoven does not indicate a special accent on the third note of the arpeggio (the time signature takes care of that!), which is intentional because this accent must appear natural and should not be overdone – THAT is reserved for a special place near the end!

This final section near the end starts with an accelerated version of the main theme; ie, it is the final, exaggerated version. In bar 243, there is (finally!) the sf on that “third note of the arpeggio”. Beethoven is asking the pianist, “NOW do you see where the accent is?” Not only accented, but the interval jump to the accented note is expanded compared to the main theme, to produce an unmistakeable exaggeration. After this, and IMMEDIATELY following the series of the fate motif, there should be no doubt about the rhythmic structure and origin of this main theme.

Speed is obviously important in this composition, and it is technically difficult. So why did Glenn Gould play it so slowly? My suspicion is that he couldn't play this composition at speed to his satisfaction. Being the perfectionist that he is, he “solved” his “problem” by playing ridiculously slowly. This means that most pianists will be playing it at their top speed. But at bar 81, Beethoven needed a slight acceleration (as recognized by Chapman – click on “Sonatas for the Piano”). How did Beethoven solve this problem, when, probably, he himself couldn't play any faster? He deleted one note from the previous six-note groups of phrases, so that, playing at the same speed between notes, the tempo is accelerated by 20%, the EXACT acceleration he wanted! You can't be any more mathematically precise and concise! Some might argue that this acceleration “violates the time signature”, and that the correct way to play is to keep the over-all tempo constant but to slow down the 5-note group. This is one of the best examples of how Beethoven “broke the rules” to compose great music, proving that many “established rules of music” are wrong. If “accel.” is permissible, why not an increase in speed of 20%? Of course, the final decision is up to the pianist because either way, you are breaking some kind of rule. That's the beauty and origin of the infinite possibilities of a live performance.

This innocuous-looking bar 81 is an example of how Beethoven composed deep, or immortal music. Of course, musicality, something that can't be quantified yet, is a large part of immortality. But there is an amazing amount of complexity that can be quantified practically everywhere you look in Beethoven's works. This complexity certainly contributes to depth in music because no audience can figure out all the complexities at once and these complexities change rapidly as the music progresses. Let's list some of the complexities built into bar 81:

I. the 20% acceleration discussed above

2. the 5-note grouping, which introduces an aura of uncertainty and mystery absent in the “standard” 6-note groupings of the preceding bars

3. the change in key signature from F minor to C major at bar 67

4. the clear RH melodic line of the familiar “arpeggio” heard at the very beginning (this is what the audience is supposed to be “following”), while

5. the actual emotions are controlled by the rapid LH notes

6. nothing is unfamiliar here because the rapid LH grouping is derived from the “arpeggio” at the beginning, played at break-neck speed

etc.,

thus there are frequently 5 or more musical elements crammed into every bar. This must be why, no matter how many times you listen to Beethoven, you can hear something new. This depth of content creates immortal music that amazes you every time you listen to it.

In conclusion, music is a language that uses the media of timing, volume, pitch, and logic to create rhythm, harmony, and melody. This approach to music theory can be used to analyze and interpret music. Beethoven's music, considered to be the most “immortal” music ever written, is most amenable to this type of analysis.

Does this mean that Beethoven used this type of approach to compose his music? There seems little doubt that he did. But are such elements the only secrets behind his glorious music? Only time and further research can answer that question. I think that Beethoven found music that somehow resonated in the human brain, in addition to the musical devices listed above. In other words, music doesn't either resonate or not, there are different degrees of resonance, and adding more elements can make incremental improvements in resonance.

References (links for purchasing listed books at Amazon)

Chapman, Brian, in Ludwig Van Beethoven, Moonlight Sonata,
and in Beethoven, Sonatas for the Piano.

Gutmann, Peter, in *Classical Notes, Ludvig Van Beethoven Piano Sonata #23, Op. 57, "Appassionata".*

Mathieu, W. A., Harmonic Experience.

Scoggin, Nancy, *Barron's AP Music Theory*, Barron's Educational Series, Inc., 2010.

Wikipedia, Piano Sonata No. 14 (Beethoven)