concentration, and one of the other defining characteristics of human beings: self-awareness. You can see that the frontal lobe (put your hand up to your forehead—that's where the frontal lobe is) handles most of the things that make you, well… *you*. This is why traumatic injury to the frontal lobe from head-impact is often absolutely devastating to the individual. You can lose what it is to be you if that area is damaged. The parietal lobe processes senses of touch, pain, and temperature, and interprets signals from vision, hearing, motor input, memory, and spatial perception. It also plays a role in the interpretation of language and words. Moving further back, the temporal lobe handles the understanding of language (Wernicke's area), memory, hearing, sequencing, and organization. And finally, the occipital lobe interprets visual stimuli, including color, light, and movement. Whew! That was a lot of information about our highly complex human brain.

So let's go back to examine language processing a little more deeply. First, our ears take in sound waves and translate them into electrical impulses that travel through nerves to different parts of the brain. The first place they go is the auditory cortex in the temporal lobe, where the sound is translated into neuronal representations (basically, your brain's "image" of the sounds). The neuronal representations are then transmitted to the areas of the brain involved in interpreting them and deciding what to do with them. In the case of speech that is only heard, the auditory cortex and Werneike's area are primarily involved. In the case of language that is read and interpreted, the visual cortex and Werneike's area are primarily involved. In the case of speech that is produced, Werneike's area transmits neuronal representations to Broca's area, which converts them into spoken language with involvement in the motor cortex. But if language and music are so similar, what is different in the way that the brain processes language and music?

Well, to begin with, language processing is fairly isolated. As we've discussed, depending on the type of language activity a person is engaging with, there are a few areas primarily involved in processing the information. In the case of music cognition, however, the brain lights up like a Christmas tree. There is activity all over the place: in both hemispheres, in all four lobes, in the cerebellum, and even in the brain stem. With the advent of fMRI, we can see which areas of the brain light up as a person is engaging with music. As in the case of language, it depends upon the way in which you are engaging with music. But the one thing that is consistent is that no matter how you are engaging—whether you are listening passively, or listening actively (listening *and* thinking about what you are listening to), whether you are hearing music with or without words, whether you are playing music, reading music, writing and composing music, or improvising music—a unique neural network lights up all across the brain. Normally unrelated areas of the brain work in synchronicity to process music, even when they do not coordinate to process any other type of information. That is pretty crazy! Even the brain stem—the part of the brain that handles automatic and subconscious processes—assists in music cognition.

So here we come to the crux of it. The human brain is an incredibly complicated computer. It handles incomprehensible amounts of information every second, and is more complex than the brains of other animals. There are two primary things that separate us from all other animals on the planet: language and music. Our brains are structured differently than are those of other animals, and it is these specialized structures that allow us to engage in language and music. But while language processing is complex, music cognition is even more complex, involving more brain regions and involving activity in both hemispheres, all lobes, the cerebrum, and the brainstem.

Beyond this, music also activates the limbic system within which emotions and feelings are processed. It is capable of eliciting sympathetic emotional response from listeners even in the absence of words, and our memory systems are intrinsically woven into the brain's processing of music. This is why music can be used to "bring back" patients with Alzheimer's[5], and why you can remember a song even if you haven't heard it for 40 years. Suddenly, you'll find yourself singing along and wondering how in the world you still have that information in there—but it's in there because the retrieval pathways were laid down in more than one way. You won't remember a poem or a story, or any other information, the way you remember music. For this reason, it is a profound educational tool: information can be entrained quickly and permanently when connected to music. Think about how many things were taught to you as a child through song, beginning with learning your letters! The A-B-C song is the most commonly taught song in the U.S. (and many other places have their own version) because it is such an effective way of teaching children to remember otherwise unfamiliar and disconnected information (the sound of each letter and the order in which they occur in the alphabet). If it is such a profound educational tool because of the effects on memory and retention, how else can music be used?

5. This video details the experience of Henry, a man with Alzheimer's Disease, who remembers who he is through the use of music.

MUSIC AND HUMAN DEVELOPMENT, LEARNING, AND WELLNESS

Due to the information that we have gained from the field of neuroscience, the use of music therapy has exploded in the past decades. **Music therapy** is the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a licensed music therapist. And because music is processed all over the brain, music therapy can be utilized to rehabilitate patients suffering from a broad host of disorders, ranging from traumatic brain injury to cerebral palsy, from learning disabilities to Parkinson's Disease. It can be used to regain voluntary movement or return speech skills when they have been lost because of a blood clot or stroke. And the remarkable thing is how genuinely effective these interventions are.

The Field of Music Therapy

It is important to talk about what music therapy *is*, and what it is *not*. Although all people can participate in music, and music teachers spend time creating music and working with students, board certified music therapists are the only individuals who participate in an allied health profession that is research-based, and that, in the words of the American Music Therapy Association, “actively applies supportive science to the creative, emotional, and energizing experiences of music for health treatment and educational goals.” Music therapy is applied in either an educational or clinical context, and music therapists must hold a music degree(s) and a degree in music therapy. The degree involves clinical internship and certification by the board of the American Music Therapy Association (AMTA). Licensing involves many hours of training in order to understand which musical activities to apply in a given context, and it may be used to improve individuals’ functioning, health, or wellbeing.

So why does music therapy work? Because it is a stimulus that activates every major region of the brain simultaneously. Because music processing occurs globally in the brain, it develops more comprehensive and stronger neurologic processes. According to Sharon Graham, founder and director of the Tampa Bay Institute for

Image 1.14: Here, a music therapist works with a patient who is recovering from traumatic brain injury.
Source: Military Health System
Attribution: Caitlin Russell
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Music Therapy, “Music is used as a stimulus when one encounters trauma, disease or disorder, and is the most powerful non-pharmacological tool we have to address any deficits that arise.”

What is music therapy used for? The possibilities are almost limitless! It may be used for physical rehabilitation and facilitating movement, because when we hear rhythmic information, the motor cortex in our brains is activated: It is for this reason that you are compelled to move on the beat when you hear a peppy song. Have you ever noticed how people unconsciously coordinate themselves in time when music is played? Pay attention when music is playing outdoors—nearly everyone will begin to walk at the same tempo as the music. The funny thing is that they don’t even realize they are doing it! The activation of the motor cortex can be utilized by music therapists to increase motor function and voluntary movement in people with Parkinson’s and Multiple Sclerosis and in physically injured veterans.

Music therapy may be used to facilitate improvement of mood and reduction of depression. This works for multiple reasons, not the least of which is that music is enjoyable. However, it also works because we have an immediate physiological response to the music we enjoy. Engaging with liked music causes the release of serotonin and dopamine- neurotransmitters in the brain, which leads to feelings of happiness and well-being. It also releases norepinephrine, which can result in a sense of alertness and euphoria. The act of singing, in particular, releases endorphins—the “feel good” chemicals in the brain. Choral singing (singing in a group with others) has been shown to cause the release of oxytocin, which enhances feelings of trust and bonding and results in reduction of depression and loneliness. One study recently indicated that choral singers have lower levels of cortisol, indicating lower stress, while multiple studies have indicated that singing relieves anxiety and contributes to quality of life. And the best part is, you don’t have to be a good singer to reap the rewards: A 2005 study indicated that group singing “can produce satisfying and therapeutic sensations even when the sound produced by the vocal instrument is of mediocre quality.”

Image 1.15: This music therapist is visiting Renown Children’s Hospital in Reno, Nevada.

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Studies have indicated that music can be used to reduce insomnia and to reduce the perception of pain, and it can be used as part of a rehabilitation protocol after injury or surgery. One study from the General Hospital of Salzburg found patients recovering from back surgery had higher rates of healing and less pain when exposed to music. Music therapy can be used with older adults to lessen the effects of dementia and Alzheimer's Disease and it can be used to restore speech when aphasia (loss of ability to speak) occurs as a result of injury or stroke. Congresswoman Gabrielle Giffords used music therapy to regain speech after surviving a gunshot wound to her brain. Interestingly, music can also be used to reduce the symptoms of asthma, can be used in premature infants to improve sleep patterns and to increase weight gain, and can be used to help people with Down's Syndrome or Autism when speech is limited. In fact, it seems that there is little that music therapy cannot be utilized to improve. So what should we take away from all of this? That music is awesome, of course, and that everyone should engage with music actively throughout the course of their lives.

Why do (and should) humans make music?

If music can help rewire a brain that has been damaged or is limited in some way, it can also be used to create new brain growth and increase processing efficiency in all students. This is why there is a strong correlation (relationship) between studying music and higher grades in other subject areas. In 2015, the

Image 1.16: Studying music can lead to higher achievement in other areas.
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Every Student Succeeds Act replaced No Child Left Behind, and for the first time codified music as part of a core, well-rounded academic experience with which all children should be provided. The current academic environment focuses on and prizes primarily STEM subjects, but we have learned that it is actually the A in STEAM (Arts) that provides training ground for the things employers say they prize more than subject-matter knowledge: creativity, initiative, and the ability to generate new solutions to problems not previously encountered. No child should go through school without access to these subjects.

Humans have engaged in music for as long as we have written history. Even before humans had the ability to write down the music they were creating and performing, they produced written descriptions documenting the fact that they valued music. The Biblical authors wrote about people engaging in music by playing instruments, dancing, and singing. Clearly, music was a part of those ancient cultures. We don't know what that music sounded like, because they didn't have a system to write it down, but we know they were doing it.

We also know that humans have been "musicking" since *long before* written history, as evidenced by prehistoric bone flutes found in various parts of the world. The existence of these instruments suggests that music may actually have preceded formalized spoken language as we understand it, and certainly preceded writing. To put this in perspective, humans were creating and playing instruments when wooly mammoths and saber tooth tigers roamed the earth. And to make that fact even more intriguing, when researchers blew through those flutes, they heard the pentatonic scale still in use in elementary school music today. Why would those early humans have created music, when the primary objectives were to eat, not die from the elements, and not be eaten? We can't answer this question definitively, but one theory is that they were imitating the sounds they heard in nature. Another is that humans utilized music to coordinate themselves in time together (think: *one, two, three - pull!*). Yet another is that music simply feels good and touches something spiritual in humans. We will likely never know. All we can say for certain is that music is one of the things that separates us from every other animal on the planet, including our closest relatives, and that it was part of human experience before modern humans existed.

One final consideration is that it appears as though music and language acquisition skills are innately learned by humans. No one sits down with children and attempts to formally teach them to produce language or music. They simply learn those things by listening to and imitating the sounds being used in their environment. All humans in all cultures the world over uniformly amass both language and music skills simply by being immersed in an environment in which those systems are being used. And this tells us that our brains are *hardwired* for success with those two systems. Even if we didn't have fMRI scans to show us that, we can deduce it from the informal experiences of babies. Studies have even shown that newborn infants who have had no experience in the world whatsoever recognize and respond to essential musical elements. These elements, which will be described and discussed in the next section, include tonic and dominant (I and V in the scale—the two most important chords) and meter (the way beats are grouped and divided). How is it that babies' brains are able to do this with no training? *It's hardwired!*

Music and Innate Aptitude

We have all seen that some people seem naturally to have more musical ability than others. Some children seem born singing beautifully, while others struggle to develop musical skills. We tend to look at children who sing early and well, and think, "Oh, she's so *talented*." But that perception can be a little misleading, and here's why.

Researchers have indicated that there are two primary things that contribute to musical ability. One of them is **aptitude**, which is defined as the ease and speed with which your brain processes certain kinds of information. Aptitude is innate. You're born with it. It is woven into the development of the grey matter in your brain as you are developing in your mother's womb. Strangely, research indicates that aptitude is developmental until somewhere around age eight or nine. In other words, the ease and speed with which your brain is able to process certain types of information is formative until you reach age nine, at which time it stabilizes. From that point forward, you will be reliant on whatever aptitude you developed during your earliest years. This doesn't mean you can't learn to do new things or develop new skills. We can all learn to do things within whatever aptitude we possess. It just means that the ease and speed with which we work doesn't fundamentally change beyond that point.

Image 1.17: Everyone has an aptitude for music, even though some people have a greater aptitude than others.
Source: Wikimedia Commons
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Interestingly, the same is true of aptitude for language, which makes sense, because the two systems are so intrinsically similar. Research has indicated that the same developmental window (birth to age nine) exists for language aptitude. For both of these, early exposure, and early development, are critical for the rest of the life of a human being. How do we know language aptitude stabilizes at that age? Obviously, it would be horribly unethical to lock children up for the first nine years of their lives and expose them to little or no language to see what would happen. We can't do that. We do, however, have multiple stories of severe neglect that shine some light on what happens when children don't develop language aptitude while they are young.

In one particularly famous case, a young girl was born to an abusive father who kept her chained to a potty chair or in a crib, and rarely let anyone speak to her or interact with her. Because there was no interactivity with the sound system, this child did not learn to speak. When she was rescued, around age 12, she was immediately taken into custody, and teams of researchers attempted to teach her to speak. She learned the use of some nouns and verbs and was able to communicate simple things, but she never learned the complex grammar that all children innately learn simply by hearing language spoken around them and having people interact with them using language. In fact, researchers estimate that all she could achieve was the basic communicative ability of Koko the gorilla (who had limited ability to form compound or complex thoughts, and did so with sign language). Why was this? Because a child's aptitude for certain kinds of processing is developmental, and is developed, during the first years of life. Once that developmental window closes, the child is working with established aptitude.

In another famous case, a child was kept contained in a room with a television on all day. The child was hearing language spoken regularly, but by abstract people on the television. In other words, no one was interacting with the child while using language. Interactivity is critical—just *hearing* language isn't enough. That child did not learn to speak just by listening. In the same way, music aptitude is not developed simply by listening. Children must hear others around them singing and see them moving rhythmically, and others must interact with them as they do these things.

In addition to aptitude, the thing that most determines a person's skill is **achievement**. This is what an individual *does* with the aptitude they have. Do they learn to sing and play an instrument? Do they learn to read and write? Do they regularly engage in creating music? If the answer is yes, then chances are, their achievement (or skill) will be relatively high. Does high innate aptitude automatically mean a person will have high achievement? No. There exists only a correlation between the two variables—not a causative relationship. A child may be born with lower aptitude but work her entire life and emerge as a person with relatively high skill after years of training. By the same token, a child may be born with relatively high aptitude but never engage with it or use it. That child is likely to have much lower achievement than the one who worked at it. Interestingly, the same seems to be true of language.

And in both cases, there is no such thing as a person with *no* aptitude. I've frequently heard people say: "Oh, I can't sing." My usual response is: "Yes, you can. Everyone can." Usually when people make statements like that, what they actually mean is: "I don't sing *well*." But our society has robbed so many people of their birthright by fooling us into thinking that music is something only the most talented and skilled should do while everyone else watches, and, as a result, these people believe their aptitude is so low that they just shouldn't do it. Knowing what we do about music and the brain, and about the benefits of engaging in music over the course of a lifetime, this is a pretty tragic thing! If I told you that simply singing, reading music, playing an instrument, or writing music over the course of a lifetime could decrease the likelihood of developing Alzheimer's when you are older, would you change your mind about whether or not you should pursue it? (I hope so!) All humans have aptitude for music and for language. This aptitude is generally distributed along a bell curve. There are people with higher aptitude and people with lower aptitude. But none of us have no aptitude, because it is a matter of our brain structure.

In fact, they had to search the world over to find only ten or so people to participate in a study in *amusia* (a condition in which the brain simply doesn't organize musical sounds into meaningful patterns). In people with amusia, the brain takes in sound, but it is disorganized and the individual can't perceive the structure. In other words, they don't hear music, they hear *noise*. While a normal individual might hear a beautiful symphony, an individual with amusia might perceive the sounds of New York City on a busy day. Obviously, both people *hear* the same thing, but one person's brain organizes the sound meaningfully into melody, harmony, phrases, meter, and other elements, while the other's brain doesn't organize it at all. What a terrible thing! Can you imagine not being able to listen to and enjoy music? Not being able to play a song back in your mind? Not being able to tap on a beat because your brain doesn't perceive the organization of meter and rhythm? Imagine how colorless life would be! Fundamentally, what I am telling you is this: *Of course you can sing and learn to play an instrument, and learn to read or write music.* Do you know how I know? Because you can listen to and enjoy music. Your brain is organizing the sound, which means you have the fundamental capacity to engage with it.

Music and Human Flourishing

So what does all of this together tell us? Music is important to the human species and always has been. Though you may remember a poem or a story, the way you remember words differs from the way you remember music. This difference is why music, like literature, belongs in the curriculum. Because information can be entrained quickly and permanently when connected to it, music is a profound educational tool. It is something that engages all areas of the brain at once, and no other activity does that.

Image 1.18: It's never too late to get involved in music!
Source: Flickr
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Music can be used to train and grow the brain and build connections between areas, or to rehabilitate and heal individuals. It assists in the formation of long-term memories and in the retrieval of stored information, increases processing efficiency in other modes of cognition, and assists the brain in coordinating normally unrelated brain regions. It is for these reasons that music is one of life's most miraculous phenomena. It has probably been with us for the totality of our existence as a species. And despite the fact that there are a limited number of pitches and rhythmic patterns, people throughout history, in every corner of the globe and every culture ever recorded, have engaged in the creation and performance of music that is unique to them. It truly is part of our human birthright and deserves to again take its place as a *critical curricular offering* in all of our schools.

And you know what else? Even if you didn't learn to read music, sing, or play an instrument while you were in school, it's not too late! Researchers tell us that you can begin at literally any point in life and still see benefits. It truly isn't about how well you do it—it is that you regularly do it over time. So go join an ensemble or find some private lessons!

RESOURCES FOR FURTHER LEARNING

Print

Knight, Andrew J., A. Blythe LaGasse, and Alicia Ann Clair. *Music Therapy: An Introduction to the Profession*. American Music Therapy Association, 2018.

Murph, Megan Elizabeth. "Max Neuhaus, R. Murray Schafer, and the Challenges of Noise." Ph.D. dissertation, University of Kentucky, 2018.

Patel, Aniruddh D. *Music, Language, and the Brain*. Oxford University Press, 2010.

Sacks, Oliver. *Musicophilia: Tales of Music and the Brain*. Revised and expanded edition. Vintage, 2008.

Online

American Music Therapy Association: https://www.musictherapy.org/

Alive Inside documentary: http://www.aliveinside.us/

2 The Elements of Music

Esther M. Morgan-Ellis

THE DIMENSIONS OF SOUND

All sound—not just music—has certain characteristics. The distinction between music and non-musical sounds, in most cases, is one of organization: sounds that we describe as noise tend to be irregular and unpredictable, while sounds that we describe as music are more likely to exhibit patterns. This is not always the case. A jackhammer, for instance, makes a regular and patterned noise, while certain composers create patternless music.

Whether we are listening to noise or music, we will perceive the same elements: **rhythm**, **pitch**, **volume**, **articulation**, and **timbre**. These elements will combine in time to produce a sonic object of a given **texture** that either exhibits or lacks **form**. In the following sections, we will define each of these dimensions and explore the roles that each plays in the creation and perception of music.

Rhythm

Rhythm is the temporal aspect of sound. It is the pattern of "on" and "off" states exhibited by any sound as time passes. Rhythm is by no means unique to music. When you speak, the consonants of your words produce rhythm. When a car drives by, the oscillating sounds of the tires and engines create rhythm.

Music often (although not always) features rhythmic patterns. The most basic of these is the **pulse**[1], which—like the pulse produced by your own heart—is a sequence of regularly-spaced sounds. The frequency of the pulses determines **tempo**[2], which can range from very slow to very fast. It makes sense that music should tend to be organized around a pulse, since our very existence is organized around pulses. Our hearts beat to a pulse, we often breathe to a pulse, we walk to a pulse, and we organize time into pulses (seconds). It is usually not difficult to detect the pulse in a musical work: simply tap your foot or clap your hands, and there it is.

1.		This video demonstrates pulse.
2.		This video demonstrates tempo.

Pulses, however, are usually not all of equal weight. Some have a greater musical significance than others. When pulses are organized into groups containing strong and weak beats, **meter** is established. Each metrical group is called a **measure** or **bar**. In notated music, these groups are physically separated by **bar lines**, which help performers to easily perceive how the pulses are grouped and to identify which is the strongest. While measures can contain any number of pulses, the most common grouping are two, three, and four. These groupings are termed **duple**, **triple**, and **quadruple meter**. Each measure in all three of these meters will begin with a strong pulse, termed the **downbeat**. In duple meter, the pattern of pulses is [strong-weak]. In triple, it is [strong-weak-weak]. And in quadruple, it is [strong-weak-medium-weak].

Pitch

Pitch[3] refers to the "highness" or "lowness" of sound. Sound, of course, is not physically located in high or low spaces, but most listeners can easily perceive the difference between a high-pitched sound and a low-pitched sound. Our use of the terms high and low to describe pitch reflects the characteristics of sound waves.

3.		This video introduces the concept of pitch in the context of a familiar melody.

All sounds are produced by vibrating bodies, which in turn produce sound waves that can be perceived by mechanisms in your ear and decoded by your brain. Pitch[4] is determined by the frequency of those sound waves. A high pitch is produced by a high-frequency sound wave, and a low pitch is produced by a low-frequency sound wave. The frequency of sound waves is in turn determined by the characteristics of the vibrating body that sparks them into action. All other parameters being equal, a long string, once plucked and set into motion, will produce a lower pitch than a short string[5]. Likewise, a thick string will produce a lower pitch than a thin string of the same length. The same principles apply when you blow across the ends of tubes, strike bells, or beat drums: the larger, longer, and heavier the vibrating body, the lower the sound it will produce.

4.	This online oscilloscope allows you to visualize sounds. Pitch is reflected in the distance between waves, which will decrease as pitch level increases. Volume is reflected by the size of the waves, which will grow in amplitude as dynamic level increases.
5.	This video demonstrates the relationship between pitch frequency and wave form.

Music is usually characterized by the careful organization of pitches. To begin with, most musical systems recognize what is termed **octave equivalence**[6]. This is the consensus that you can halve or double the frequency of the pitch without changing its essential identity. To see this principle in action, attend any birthday party at which both women and men are present. When the guests sing "Happy Birthday," they will not sing exactly the same pitches. Instead, the women will tend to sing in a high octave, and the men will tend to sing in a low octave. In technical terms, this means that the women will probably sing pitches that have frequencies equal to twice that of those sung by the men. However, all participants will agree that they are all singing the same pitches, or in **unison**. An octave is an example of an **interval**, which is the distance between two pitches.

In the Western system, we acknowledge this phenomenon by using the same letter names to designate pitches in different octaves. For example, pitches at the frequencies of 110 hz, 220 hz, 440 hz, 880 hz, and 1,760 hz are all called "A." However, specific frequencies are still important. Music that contains mostly high pitches has a different effect on listeners than music containing mostly low pitches, even if the rhythms and sequence of pitches are the same. Additionally, **melodic range**[7] (the distance between low and high pitches) and changes in **register** (the use of high or low pitches) can be important musical elements.

6.	This video demonstrates octave equivalence in the context of "Happy Birthday."
7.	This video introduces the concept of melodic range.

The Western system—that is to say, the system of musical organization that was first developed in medieval Europe and continues to dominate global listening today—goes quite a bit further in its efforts to organize pitch. Let us return to the octave. Between the A at 220 Hz and the A at 440 Hz, there are a near-infinite assortment of possible frequencies at which an intermediary pitch might sound. However, we do not use all of those pitches when we create music. Instead, we identify a limited number of specific pitches to be used. The Western system is best represented by the piano keyboard, which is both familiar and useful.

Image 2.1: Each white key on a piano is assigned a letter name. Those letter names repeat at each octave, reflecting our agreement that every A (for example), whether high or low, is in some sense the "same" note. The black keys are named after the adjoining white keys: simply add "flat" to the name of the white key to the right or "sharp" to the name of the white key to the left.
Source: Public Domain Pictures
Attribution: Karen Arnold

As you can see, the space between the A at 220 Hz and the A at 440 Hz is divided across twelve piano keys. This is called the **chromatic**[8] pitch set, and it includes all of the pitches used in Western music. However, composers only rarely use the entire chromatic pitch set. When you do hear music that uses every available note, you will probably find that it makes you uncomfortable. This is because we are used to hearing music built using a set of only seven pitches that is called a **scale**. Most music is based on one of two scales: the **major** scale[9] and the **minor** scale[10]. If the pitches in a piece of music are drawn from a major scale, it is described as being in the **major mode**. Likewise, if the pitches are drawn from a minor scale, it is in the **minor mode**. A scale can start on any pitch, which then determines the **key** of music that is based on that scale. For example, music created using pitches drawn from the A major scale is in the key of A major.

8.		This video demonstrates the chromatic pitch set.
9.		This video demonstrates a major scale.

10.	This video demonstrates a minor scale.

In most pieces of music, pitches are assigned to two different roles: **melody**[11] and **harmony**[12 & 13]. Melodies are constructed out of a sequence of pitches. This is the part of a musical work that you might sing along with or that might get stuck in your head. Melodies have various characteristics, including **shape**[14] and **motion**[15], which can be **conjunct** (in which the melody primarily moves up and down the scale) and **disjunct** (in which the melody contains larger intervals and leaps). Harmonies are constructed out of groups of pitches that are usually sounded simultaneously and constitute **chords**[16], while a sequence of harmonies is termed a **chord progression**. In a musical work, the harmony is usually unobtrusive and might be repetitive. A melody and a harmony sound good together when they are based on the same scale and contain some of the same pitches. However, every melody can be harmonized in many different ways, using various chords. Likewise, a single harmony can be used to accompany many different melodies.

11.	This video demonstrates the melody to Beethoven's "Ode to Joy."
12.	This video demonstrates melody and a possible harmony to Beethoven's "Ode to Joy."
13.	Here, you can hear Beethoven's melody and harmony in the context of his original composition.
14.	This video introduces the concept of melodic shape.
15.	This video introduces the concept of melodic motion.

16.	This video demonstrates chords, which are used to harmonize melodies.

Although this text will not offer a technical explanation of harmony (which can become very complicated indeed), it is often central to the listening experience. A certain chord progression can surprise you, or excite you, or break your heart. It is not necessary to understand harmonies from a theoretical perspective to feel their impact. You also don't need a theoretical background to understand the role harmony plays in establishing and then satisfying or frustrating expectations. As long as a piece of music is in a key, one chord—the chord built on the note that the key is named after—will serve as a home base, while other chords in the key will facilitate journeys away from or back towards that home base. We get used to hearing certain chord progressions and come to expect them, so we often have a sense of where the music is going to go. If we hear an unexpected chord or—most shocking of all—a chord that is not in the key of the piece of music, we tend to respond emotionally.

Volume

Like pitch, volume—the loudness or softness of a sound—is a parameter of every soundwave. **Volume** is determined by the amplitude of the wave, such that waves with a large amplitude produce high-volume sound and waves with a small amplitude produce low-volume sounds. While volume is simple to understand and assess (we can all tell whether music is "loud" or "soft"), its significance in the creation of musical meaning cannot be overlooked. On the one hand, certain genres of music depend on volume for their identity. You cannot appreciate the impact of heavy metal by listening to it with the dial turned down, just as you cannot sing a baby to sleep at the top of your voice. Changes in volume can also communicate meaning in music. A gradual increase in volume can indicate growing excitement, while a sudden change in volume can indicate a dramatic mood shift.

A few terms will help us to talk about volume, which is also referred to as **dynamic level**. An increase in volume is referred to as a **crescendo**, while a decrease is termed a **decrescendo** or **diminuendo**. Musicians in orchestras, bands, and choirs describe volume using Italian terms including **fortissimo** (very loud), **forte** (loud), **mezzo forte** (medium loud), **mezzo piano** (medium soft), **piano** (soft), and **pianissimo** (very soft). While this book will not employ these terms, you might encounter them elsewhere.

Articulation

Articulation has to do with how pitches are begun, sustained, and released, and it is driven primarily by changes in dynamic level. In music production language, this dimension of sound is referred to as the envelope[17]. The envelope is independent of pitch, but it determines the character of that pitch. For example, a pitch might begin with a gentle increase in volume, or a sudden decrease, or no dynamic change. Once it has begun to sound, a pitch might be sustained for a long time, or it might be abruptly cut off. And when it is ended, it might be released with a decrease in volume, and increase in volume, or no dynamic change.

17. This video explains the four elements of the envelope: attack, decay, sustain, and release.

Although the preceding description was highly technical, the effects of articulation are easy to perceive. At one end of the spectrum, a series of pitches might be heavily punctuated, with forceful onsets and no sustain. The traditional Italian term for this articulation is **staccato**—a term that means short and accented, and which is difficult to replace with an English equivalent. At the other end, a series of pitches might be smoothly connected, with gentle onsets and a great deal of sustain. The term for this articulation is **legato**. Between these extremes are an enormous variety of approaches to beginning, sustaining, and releasing notes, many of which are unique to the instruments that produce them.

Timbre

The final characteristic that is universal to all sounds is **timbre** (TAM-ber), which describes the quality of a sound. Whether one has no musical training or is an accomplished performer, we are all skilled at identifying minor variations in timbre. This ability lets you know that your mother is calling you from the other room, not your sister. It helps you to tell the difference between a guitar and a piano. Not only does every voice and every instrument exhibit a unique timbre, but performers can alter the timbre they produce by changing their technique. Timbre is also integral to genre and style: A symphony orchestra produces one range of timbres, while a rock band produces another.

Variations in timbre are made possible by the existence of the **overtone series**, which is a sequence of higher-pitched frequencies that are activated every time a pitch is produced. When you strike a key on the piano, for example, you are not only sounding the pitch associated with that key, you are also activating dozens of pitches at set intervals above that pitch, each of which might sound at a relatively high or low volume. The combination of these **overtones** produces timbre. Two instruments playing the same pitch sound different, therefore, because they are activating different pitches in the overtone series at different volumes. The complexity of this process allows for near-infinite variety in timbres.

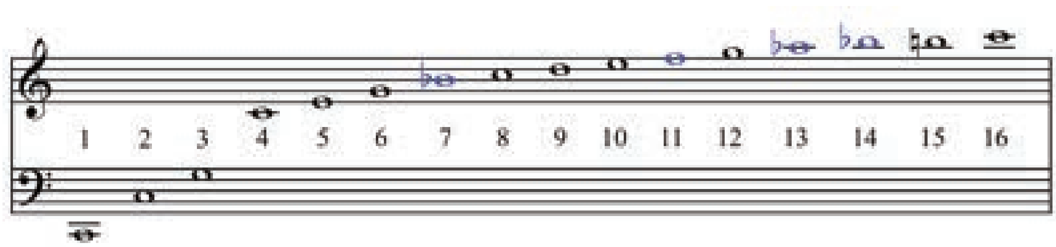

Image 2.2: These are the pitches of the overtone series as they might be notated on a staff. Even if you cannot read notation, you can see that the pitches get closer together as they get higher. When one plays a low C on any instrument, most of these pitches are sounded to some degree. The pitches in blue will be out of tune.
Source: Wikimedia Commons
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If you engage with every example in this volume, you will experience an extraordinary range of contrasting timbres. Audiences for various genres develop unique preferences and expectations for timbre, and timbre is often one of the most distinctive characteristics of a musical tradition. Variations in timbre are often not hard to identify: A piano trio, for example, had a different sound quality than a thrash metal band. These differences, however, can be very difficult to put in to words. While timbre is easy to perceive and measure, it is hard to describe.

For the most part, we will consider timbre in the context of individual examples. We will investigate different ways of producing sound with the human voice (which is capable of extraordinary diversity), the various instruments that are responsible for the characteristic sounds of non-Western classical traditions, and the electric instruments and sound processing techniques that have contributed to popular music of the last seventy years. There is one sound source in particular, however, that pervades this volume: the symphony orchestra. For an overview of the instruments that make up the orchestra, please see Appendix A.

Texture

We are now really to move from sound to music, which usually exhibits some additional characteristics. One of these is **texture**[18], which concerns the contents of and interactions between various layers or voices in a musical work. We use four basic terms to describe texture, although these terms can tell us little about what a piece of music actually sounds like. **Monophonic**[19] music has a single melody line, performed by a soloist or in unison, with no accompaniment. If you add an accompaniment that has different pitches (probably chords) but that is secondary to the melody, you have **homophonic** music. In **polyphonic** music, every voice is independent but equally important, and there is no distinction between melody and harmony. And in **heterophonic** music, multiple instruments or voices each perform a unique version of the same melody, such that unison is not achieved. We will encounter these terms in the context of specific examples throughout this volume.

18.	This video introduces the concept of texture.
19.	This video explores variation in texture.

In addition, texture can be described using qualitative terms. It can be thick or dense, meaning perhaps that there are many independent and highly-active parts, or it can be thin or sparse, meaning perhaps that there are few instruments, each of which can be clearly identified and tracked. Consider, for example, two songs from *Sgt. Pepper's Lonely Hearts Club Band*, discussed in Chapter 8. The concluding thirty seconds of "Being for the Benefit of Mr. Kite" are irrefutably dense: There is so much going on that it is difficult to identify individual sources of sound, and the listener's focus is constantly attracted by new and varied voices. The first verse of "A Day in the Life," on the other hand, has a thin texture, made up only of guitar, bass, and shaker. It is possible to focus on individual instrumental parts and to hear the unique articulation of each.

Form

Finally, we need a way to talk about how music unfolds over time. This element is known as **form**. Most musical compositions exhibit formal characteristics, although some pieces are very amorphous or difficult to describe in terms of form. At the very least, creators of music usually plan the formal dimensions of their work. John Cage's *4'33"* doesn't have form, per se, since its sonic contents are always different, but at least the composer decided how long the piece was going to last.

In most cases, the creators of music rely on three organizational principles that produce form. These are **repetition**, **variation**, and **contrast**. Repetition occurs when we hear the same thing twice, whether it is a long and complicated melody, a short melodic fragment, a rhythm, or a harmonic pattern. Variation occurs when musical material returns, but with alterations. Contrast, naturally, refers to musical material that has not been heard before.

Repetition is key to our ability to understand and enjoy music. When we hear something new, internal repetition allows the music to quickly become familiar and helps us to predict what is going to happen next. For this reason, all popular music features repetition of various kinds. When an unfamiliar song comes on the radio, you can expect to hear the chorus (the catchy part with words and melody that both repeat) several times. Most popular songs also have repetitive chord progressions and some sort of repeating accompaniment, known formally as an

ostinato[20]. Ostinatos are important in many types of music and will play a role throughout this book.

20.	The bass line at the beginning of White Stripe's "Seven Nation Army" provides a good example of an ostinato. This seven-note melodic figure is heard throughout the song.

Variation and contrast are what make music interesting. We enjoy and rely upon repetition, but we can only take so much. However, music that contains constant variation or lacks repetition altogether requires more of the listener. Most people cannot relax and enjoy music that is constantly changing and that offers something new and different with each passing moment. At the same time, such music can communicate a great deal and be particularly rewarding for an engaged listener.

The degree to which music relies on repetition or contrast is often linked to its purpose. Dance music, for example, tends to be repetitive. When people are dancing, they don't want much contrast. They want the music to maintain a constant tempo, rhythmic character, and mood. Minor variations might make dancing more interesting, but major changes can make dancing impossible. In addition, when you're dancing you don't pay careful attention to the nuances of the music. Music belonging to a sung theater tradition, however, is much more likely to exhibit contrast. In the first place, it is probably being used to express emotions or to portray a nuanced character. Variation and contrast allow for more complex and meaningful communication. In the second, audience members are paying full attention to the music, and, therefore, have a higher tolerance for contrast and change.

MUSIC IN THE WORLD

With the exception of its opening passages, which considered the problem of defining what music even is, this unit has so far emphasized the empirical qualities of music. We have acknowledged the documented effects of music on the human brain, and we have acquired a variety of terms and concepts that can be used to understand and describe music as a physical phenomenon. Now it is time to address some of the messier aspects of talking and writing about music.

Categories

What kinds of music do you like to listen to? Country? Hip-hop? Classical? EDM? Top 40? Whether we are talking to a friend, using a streaming service, or browsing records in a store, we like to think about music in terms of categories. These categories can be very useful. They can help us pick a radio station we might enjoy, or decide whether or not to buy tickets to hear an unfamiliar band. At the same time, these categories are both artificial and extremely limiting.