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The Sound/Music Dilemma: Why Is It That All Music Is Sound but Only Some Sounds Are Music?

Introduction

Musicians, musicologists and philosophers have always tried to understand the relationships between music and sound[1]. Most of the time, they have asked themselves two fundamental questions: is all music made up of sound? Can all sound be considered as music? To answer these questions, in this paper, I use an interdisciplinary approach which combines traditional ideas derived from musicology and music theory with new concepts derived from music cognition. In particular, I try to solve the sound/music dilemma by providing a theoretical model based on cognition called the Circle of Sound, which organizes sound based on complexity. This model could be adopted as an empirical tool which measures the complexity of a piece of music, and places it within an abstract space of music. To understand the relationships between sound and music, I also explore the relationships between musical understanding and musical enjoyment. The main objective of the paper is to provide a unified theoretical model, which solves the sound/music dilemma, accounting for different mani-

1 E. Varèse, Ch. Wen-Chung, *The Liberation of Sound.* "Perspectives of New Music", vol. 5 (1966), no. 1, pp. 11–19; I. Xenakis, *Formalized Music: Thought and Mathematics in Composition*. Bloomington 1971.

festations of sound as well as for the phenomena of musical understanding and musical enjoyment. Moreover, the paper provides an operational definition of music, which directly derives from the model of the Circle of Sound.

The remainder of the paper is organized as follows. First, I set out the problem introducing the sound-music double implication. Then, I delve into the three levels of sound, present the model of the Circle of Sound and explain how musical understanding and musical enjoyment are related. Finally, I give the conclusions.

The sound-music double implication

The relationship between sound and music has been studied for many years in several different fields, such as musicology, theory of music and music cognition. The relationship has always been synthesized by a question, which asks whether or not all music is made up of sound and whether all sound can be considered as music. This question, in turn, can be translated into a double implication which claims that "all music is sound and vice versa all sound is music". If the double implication was true, then music and sound would be interchangeable. However, demonstrating the truth of the sound-music double implication is difficult, since it considers too many variables simultaneously.

To simplify the task, we can divide the double implication into two separate implications, which are: "all music is sound" and "all sound is music". Once we have defined these implications, we can study them separately. The implication "all music is sound" relates the music to the physicality of sound. On the other hand, the implication "all sound is music" claims that the physical level of sound necessarily implies the artistic phenomenon of music. These are two different philosophical positions about the definition of music. The first implication indirectly claims that some sounds might become music, while the second states that every sound should necessarily be interpreted as music. If we demonstrate that both implications are true, then we can deduce that the sound-music double implication is true as well. As we will see, in order to solve those implications we should provide an operational definition of music, based on the cognitive capacities of human beings.

Solving the implication "all music is sound" is relatively straightforward. Music is always made up of some forms of sound. Most music theorists and musicologists agree with this position, since, by definition, music is a form of art strictly related to sound. However, there are some counterexamples that seem to invalidate this idea. For instance, *4'33"* by John Cage superficially appears as a negation of sound, but in the end it demonstrates the overall pervasive ex-

istence of sound. Indeed, Cage rejected the idea of silence, and thought that sound could be found anywhere and we, as humans, could never avoid it, even if we did[2]. Also, visual music and music without sound seem to oppose the validity of the implication "all music is sound". For instance, some works by the Austrian composer Peter Ablinger, such as the Second String Quartet and *Hommage a Godard* are visual installations defined by the composer as music. However, almost everyone would agree that these works pertain to visual arts rather than music. Both the Second String Quartet and *Hommage a Godard* are emotional visual experiences, which Ablinger arbitrarily defines as pieces of music, even if they clearly are visual-based.

On the other hand, it is quite difficult to demonstrate the reverse implication: "all sound is music". Some people accept the idea that every sound is music[3], whereas others do not[4]. It seems a simple matter of definition, but I argue that there is more to it than that.

Three levels of sound

A major issue with the implication "all sound is music" is that it completely ignores the role of the listener. The implication directly passes from the physical level of sound to the aesthetic level of music. By doing that, the implication assumes that listeners have no role in the musical process, and, therefore, can be considered as passive agents who receive sound information. However, many researchers suggest that listeners actively participate in the process of transforming raw physical sound information into aesthetic musical experiences[5]. In particular, listeners process sound, extract relevant musical structures and make comparisons between what they are listening to and what they have already stored in their brains[6]. If we consider all these aspects, we should improve the implication "all sound is music" by introducing the listener. As a consequence, the refined version of the implication should account for three levels of sound, i.e., *physical* sound, *processed* sound and *music*. The implication "all sound is music" should therefore be replaced by the chain of implications: "all sounds are processed sound, and all processed sounds are music". At first

2 J. Cage, *Silence: Lectures and Writings*. Middletown 1973.

3 J. Cage, *op. cit.*; L. Berio, R. Dalmonte, B.A. Vargas, *Two Interviews*. London 1985.

4 J.-J. Nattiez, *Music and Discourse: Toward a Semiology of Music*. Princeton 1990.

5 C.K. Madsen, R.V. Brittin, D.A. Capperella-Sheldon, *An Empirical Method for Measuring the Aesthetic Experience to Music*. "Journal of Research in Music Education", vol. 41(1993), no. 1, pp. 57–69; A. Patel, *Music, Language, and the Brain.* Oxford 2010.

6 B. Snyder, *Music and Memory: an Introduction*. Cambridge 2000.

glance, the new implication might seem sound, but it is not. Indeed, it is not possible to claim that all sounds are necessarily music, since listeners select only some sounds, which become music, while rejecting others. As a consequence, the correct chain of implication is "some sounds can become processed sound, and some processed sounds can become music". The chain of implications acts as a funnel, which filters the sound information. Starting from the physical level, sound information passes through the perceptual level and arrives at the aesthetic level.

Initially, sound may be merely considered at the physical level and described by a pressure wave. Physical sound is the result of a vibration that propagates through a medium, such as air and water. This level deals with objective measurable features of sound such as frequency, timbre and loudness. At the physical level, listeners are not yet involved. Physical sound exists in nature beyond the psychological domain.

Physical sound is then perceived by the listener, who processes it in their own mind, and becomes processed sound. The processing is affected by two aspects: cognitive constraints and cultural pressure. Cognitive constraints are the specifications of the processing hardware shared by all humans. For example, they include the threefold structure of memory made up of *working*, *short* and *long-term memories* and their time-space processing capabilities[7]. Cognitive constraints indirectly determine a set of musical universals shared by all mankind. These are cross-cultural musical features such as the use of scales, octave equivalence and discrete pitch[8]. On the other hand, cultural pressure affects how we perceive sound based on our training and exposure to a certain musical environment[9]. Obviously, cultural pressure is culture specific and it is different from person to person.

When processed sound enters the aesthetic level it is conceived as music. However, in order to be considered as music, processed sound should be *understood*. *Musical understanding* is the capacity to efficiently parse, process and store the main features of a group of sounds. In other words, musical understanding is the capacity to identify relevant musical structures, trace the relationships between them and dynamically create a mental representation of the piece. Musical understanding depends both on cognitive constraints and cultural pressure. Human beings have a limited processing capacity, thus, they can

7 B. Synder, *op. cit.*

8 S. Brown, J. Jordania, *Universals in the World's Musics*. "Psychology of Music", vol. 41 (2013), no. 2, pp. 229–248; I. Peretz, *The Nature of Music from a Biological Perspective*. "Cognition", vol. 100 (2006), no.1, pp. 1–32.

9 S.J. Morrison, S.M. Demorest. *Cultural Constraints on Music Perception and Cognition.* "Progress in Brain Research", vol. 178 (2009), pp. 67–77.

understand only a tiny subset of the infinite number of physical sounds they might be exposed to. Also, the specific musical environment a person lives in affects their capacity to understand some musical pieces better than others. Musical understanding is a subjective trait based on musical experience and training.

To summarize, sound has three levels organized in the chain of implications consisting of physical sound, processed sound and music. These reflect the physical, perceptual and aesthetic levels, which act as a filter. The passage from processed sound to music is guaranteed by musical understanding.

The Circle of Sound

A relevant feature of sound is complexity. I define *sound complexity* as the amount of sound information a group of physical sounds carries, measured against the cognitive constraints. Sound complexity is not only an index of the amount of sound information, but also of the quality of that information. The more a piece of music violates basic cognitive constraints, the more complex it is to understand. Sound complexity is strictly related to musical understanding. Indeed, the more complex a group of sounds are, the more difficult it is to understand them. In other words, the amount of complexity of a piece determines how easy/difficult it is for listeners to experience the piece as music, rather than a stream of unorganized sound.

The Circle of Sound, which will help us in finding a solution to the sound/music dilemma, is directly based on the concept of sound complexity. The Circle of Sound ideally represents the space of all the pieces of music already or yet potentially to be written. Every point in the circle is a piece of music, and every piece of music is a point in the circle. Complexity in the centre of the circle is 0, and increases moving along the radius in any direction. The direction is an approximate measure of musical style and genre. The bigger the angular distance between two points, the bigger the stylistic difference between two pieces. As we can see in figure 1 (p. 16), the Circle of Sound is actually made up of three concentric circles which delimitate three separate regions. Region 1 contains pieces which have very low sound complexity. Region 2 is characterised by low to high complex pieces. The pieces contained in region 3 are far too complex for humans to understand.

Region 1 contains pieces of music which are very simple. These musical works are almost entirely based on musical universals and have few references to specific cultures. The pieces contained within region 1 can be understood by all human beings, since they are based on easy musical structures which totally respect cognitive constraints. Usually, these musical structures are constantly repeated throughout the piece, and are organized in a symmetrical fashion; so

Figure 1. The Circle of Sound divided into three concentric circles

that it is easy for listeners to parse those pieces and to create a mental representation of them. Examples of musical works within region 1 are lullabies, simple folk songs and simple pop music.

Region 2 contains pieces which have low to very high sound complexity. These pieces are culture specific and understanding them deeply depends on the specific musical environment the listener was exposed to. Also, understanding these works depends on the amount of musical expertise specific to a certain culture a listener has. As a consequence, it is possible that some listeners can understand very complex works in one part of region 2, while not being capable of understanding easier works pertaining to other parts. Furthermore, the farther one gets from the centre, the more difficult it becomes to understand the pieces. Hence, fewer people can understand them. However, in theory, every person, if exposed to the specific culture and provided with the proper training, can understand all of the pieces within region 2. This is possible, since this region, although complex and highly culture-specific, still respects the musical cognitive constraints. Most of the music ever written is contained here. For example, Western and Indian classical music as well as jazz all belong to region 2.

Between region 2 and 3 we have the *horizon of unintelligibility*. The horizon of unintelligibility is a blurred line that demarcates the boundary between pieces which can be potentially understood and pieces which simply cannot. Of course, the horizon of unintelligibility depends on individuals; however, since

all humans have a limited processing capacity, it is possible to claim that even the most talented musicians can manage only a limited amount of sound complexity.

Region 3 contains all of the pieces which are far too complex for our mind to be understood. Here, the physical sound information is so complex that it exceeds human auditory processing capabilities, becoming unintelligible sound. No one can possibly understand pieces of music within region 3. Nonetheless, some contemporary composers such as Boulez or Stockhausen sometimes compose works which belong to this region. It is interesting to note that region 3 is by far the biggest of the three regions within the Circle of Sounds. Cognitive constraints act as a filter, which allows only a minor part of the physical sound information to be understood as music. Therefore, what we experience as music is highly constrained by our cognitive capabilities. If we had different cognitive constraints, we would deem as music different streams of physical sounds. This, in turn, implies that the evolution of musical style over time has always happened within the boundaries dictated by cognitive constraints.

Understanding footprint and aesthetic footprint

Even though we have already introduced a model which organizes pieces of music based on their complexity, i.e., the Circle of Sound, we still have to explain how people understand/enjoy musical works. Moreover, we have to describe the relationships between understanding and enjoying a piece of music. To do that, I introduce two new constructs: the *understanding footprint* and the *aesthetic footprint*.

The understanding footprint is the subset of the Circle of Sound which is understood by a person (see figure 2, p. 18). In other words, every musical work within the understanding footprint can be understood by a given listener. The understanding footprint contains all region 1 and a subset of region 2, but never contains parts of region 3, since pieces here are unintelligible. The understanding footprint depends on cognition but also on musical environment and training. As a consequence, it is very subjective, and everyone develops a different footprint. This means that the definition of music, based on the capacity to understand physical sound information is different for each human being. If we accept this operational definition of music, we should abandon the idea that it is possible to provide an absolute definition of music, which is valid for all human beings. In fact, the definition of music based on the understanding footprint claims just the opposite: music is a loose phenomenon, which has as many definitions as the number of people on the planet Earth.

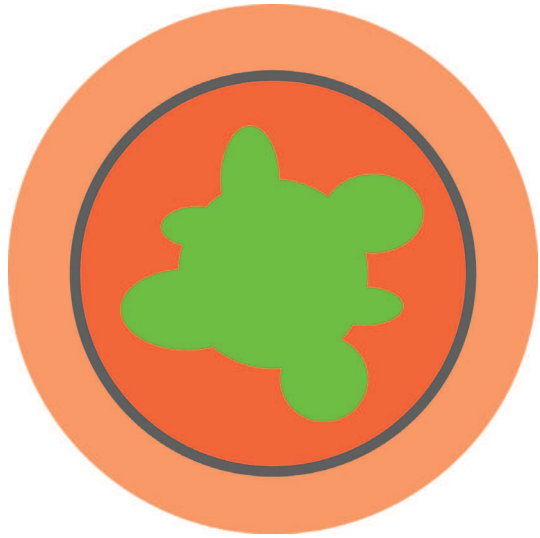

Figure 2. The understanding footprint (green) – the subset of the Circle of Sound understood by a person

The understanding footprint is not static; rather it is a dynamic construct which changes over time. When a person listens to new pieces of music, their understanding footprint changes, in order to harmonize with new sound information they were exposed to. The understanding footprint directly reflects the musical experience and training a person has had throughout their lifetime. The understanding footprint of a person might reach new subsets of the Circle of Sound, while abandoning other subsets.

The understanding footprint has to account for different degrees of comprehension a person might have of a musical work. Indeed, it is never the case that a listener either completely understands a piece or does not understand it at all. Understanding is not a binary process; rather, it is a *fuzzy* process, which involves many, likely infinite, degrees of comprehension. For instance, a person can have a low, a good or an excellent understanding of a piece of music. To account for this phenomenon, the understanding footprint can be seen as a non-uniform surface. Associated to each point of the understanding footprint there is a parameter, which expresses the percentage of comprehension a person has of a specific piece of music. This parameter can assume any value between 0 (i.e., absolutely no understanding) and 100 (i.e., perfect understanding). Nevertheless, some processes can change the value of comprehension of a point within the Circle of Sound. For example, iterated listening helps people to strengthen their understanding of a piece of music. Indeed, the more a per-

son listens to a musical work, the more capable they are of organizing a mental structure of the piece, by extracting relevant musical structures and comparing them with the musical structures they previously stored in their brain.

While the understanding footprint deals with comprehension of a piece of music, the aesthetic footprint deals with the process of enjoying a musical work. In particular, the aesthetic footprint is the portion of the Circle of Sound enjoyed by a person (see figure 3). The aesthetic footprint has a strong correlation with the understanding footprint. The aesthetic footprint appears in two forms: the *normal* and the *special*. When in normal form, the aesthetic footprint is a subset of the understanding footprint. This can be practically summarised by the sentence "I like (some of) what I understand".

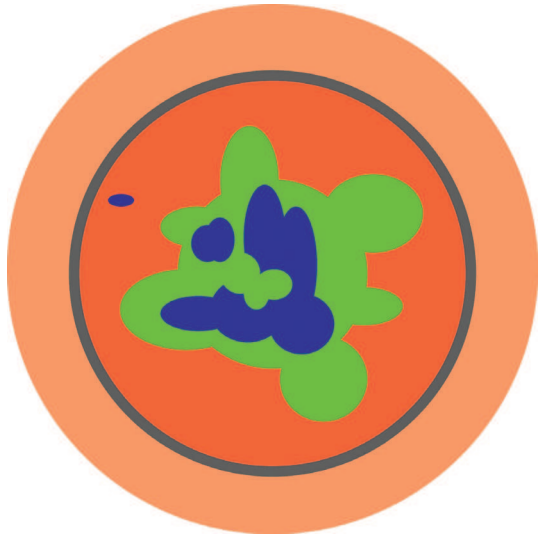

Figure 3. The aesthetic footprint (violet) – the subset of the Circle of Sound enjoyed by a person

The normal aesthetic footprint is shaped by ECCO and COMBO effects. ECCO stands for *expertise calls for complexity effect*, which claims that the more of an expert a person is, the less likely they are to enjoy simple musical structures. This effect accounts for the almost continual appearance of musical complexity in Western classical music over time. COMBO stands for *complex but not too complex effect*, which states that we usually do not like pieces which are at the edge of our understanding footprint, because they push our processing system to the limit. ECCO and COMBO effects suggest that we usually enjoy pieces that are not too easy but not too complex as well, based on our personal

capacity to understand music. In other words, we like musical cognitive challenges which are not too stressful.

Sometimes, when in special form, the aesthetic footprint can contain parts of the Circle of Sound which are outside the understanding footprint, and can even be within region 3 of unintelligible sound. This means that sometimes we might like something we do not understand. In this case, the aesthetic experience is based on a real-time enjoyment of a piece of music, which is analysed and experienced bit by bit. This surely goes against the cognitive process we normally adopt to experience things, which consists of extracting structures, making comparisons between structures and identifying the big picture. Certainly, the special aesthetic form is unusual and often adopted just by a tiny portion of highly musically trained people.

Also the aesthetic footprint changes over time, thanks to musical exposure. The aesthetic footprint of a person is affected by the musical pieces they listen to. Moreover, the aesthetic footprint as well as the understanding footprint can be regarded as a non-uniform surface. Each point of the aesthetic footprint is characterised by a value, which expresses the percentage of enjoyment a person obtains from a specific piece of music. The rationale behind this is that enjoying a musical work, as well as understanding it, is not a binary process; rather, it is a fuzzy process, which can involve infinite degrees of enjoyment.

Conclusions

In this paper, I have tried to solve the sound/music dilemma by providing a model called the Circle of Sound, based on music cognition. In particular, I have answered the following two questions: is all music made up of sound? can all sound be considered as music? The answer to the first question is yes, whereas the answer to the second is no. Indeed, the implication "all sound is music" does not consider the perceptual level and goes straight from the physical to the aesthetic level of sound. To avoid that issue, I have introduced three different levels of sound, i.e., the physical, the perceptual and the aesthetic. Afterwards, I have changed the wrong implication "all sound is music" into a new one, which considers the role of the listener: "some sounds can become processed sound, and some processed sounds can become music".

Then, I have presented the Circle of Sound, which is the space of all musical pieces organized in three concentric circles. Region 1 has very low complexity pieces understandable by everyone. Region 2 is characterised by low to high complex pieces, which are culturally specific and which can potentially be understood with the proper training/exposure to the specific music environment.

Finally, region 3 contains pieces which are inherently impossible to understand, since they overwhelm the processing capabilities of the human mind.

To explain how people understand and enjoy music I have introduced the understanding footprint and the aesthetic footprint. The understanding footprint is the subset of the Circle of Sound understood by a person. The aesthetic footprint is the subset of the Circle of Sound enjoyed by a listener. Both footprints depend on cognitive constraints and cultural pressure, and can change over time, thanks to musical exposure.

According to the model of the Circle of Sound, I have also demonstrated that there is no single definition of music, since there are as many definitions as the number of people and cultures in the world. Hence, I have claimed that music is not a universal language at all, apart from a tiny fraction of very simple musical pieces, confined within region 1 of the Circle of Sound.

Where should composers go from here? I suggest composers focus on creating compelling new music which is by all means complex and interesting, but which stays within the boundaries of intelligibility, respecting our limited cognitive capacities.

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Dylemat dźwięk/muzyka: dlaczego muzyka zawsze jest dźwiękiem, lecz nie każdy dźwięk jest muzyką?

Streszczenie

Nawet jeśli dźwięk i muzyka są zjawiskami ściśle ze sobą powiązanymi, kwestią dyskusyjną pozostaje pytanie, czy muzyka zawsze składa się z dźwięków i – przeciwnie – czy każdy dźwięk może być uważany za muzykę. Badacze różnych specjalności proponują rozmaite rozwiązania wspomnianego dylematu, jednak większość z nich analizuje muzykę i dźwięk poza ich naturalnym kontekstem, ignorując istotne czynniki, takie jak słuchacz i ograniczenia związane z procesami poznawczymi.

W artykule zaprezentowano model teoretyczny zwany *Circle of Sound* [Okrąg dźwięku] w celu rozwiązania dylematu dźwięk/muzyka. *Circle of Sound* opiera się na procesach poznawczych i został stworzony zgodnie z pojęciami złożoności muzycznej, rozumienia muzyki oraz przyjemności płynącej z muzyki. Dzięki połączeniu wymienionych pojęć zaproponowano nową definicję operacyjną muzyki. Zastosowana podbudowa teoretyczna może stanowić podstawę dalszych badań nad rozumieniem muzyki.