

# **Connections between Musical and Logical-Mathematical intelligences**

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## Abstract

### Keywords:

multiple intelligences;  
rhythm; harmony,  
musical forms;  
education.

Music is both science and art. It is an important component of human nature, existing in all cultures, generating joy and pleasure by means of interpretation or listening. Music is scientifically explained from Pythagoras, while connections between mathematics and music have been signalled since ancient times. Furthermore, nowadays we are also studying possibilities to streamline the functioning of the brain which involves relationships between different types of intelligences, corresponding to different cortical areas.

Music is often referred to as the mathematics of sounds due to the numerous synapses that occur between the two fields of knowledge. The influence of mathematical concepts in music is mirrored by parameters such as musical rhythm, archetypal forms of musical creations as well as melody and harmony. However, the art of the musical sounds remains a universe with a strong presence of the emotional and of the creative side of the human being.

## Zusammenfassung

### Schlüsselworte:

multiple  
Intelligenzen;  
Rhythmus;  
Harmonie;  
musikalisches Form;  
Bildung.

Musik ist Wissenschaft und Kunst, sie ist ein wichtiger Teil der menschlichen Natur, sie existiert in allen Kulturen, generiert Freude und Vergnügen beim interpretieren und anhören. Musik ist wissenschaftlich erklärt von Pythagoras, Verbindungen zwischen Mathematik und Musik, überliefert seit der Antike bis heute, wo wir auch die Möglichkeiten zur Optimierung der Gehirnfunktionen studieren, welche die Beziehungen zwischen verschiedenen Arten von Intelligenzen, die kortikalen Bereichen entsprechen, beinhalten.

Musik wird oft als Mathematik des Klangs beschrieben, aufgrund der zahlreichen Verbindungen die sich zwischen den beiden Gebieten unseres Bewusstseins bilden. Der Einfluss von mathematischen Konzepten in der Musik zeigt sich in Parametern wie dem musikalischen Rhythmus, den archetypischen Formen musikalischer Werke, aber auch in den Melodien und Harmonien. Mit alledem bleibt die Kunst der musikalischen Klänge ein Universum, in dem die emotionale und subjektive Seite des Menschen überaus präsent ist.

## 1. Introduction

Conventional wisdom has it that music is present in everyday life. Ever since ancient times scientists stressed the importance of music throughout the process of human evolution due to its beneficial effect visible at an emotional level (the simple pleasure of singing, playing or listening to music), social (rituals that accompany the main events of a human's life and involve the presence of music) as well as at a cognitive level (the relationships that exist between music and other fields of science).

Along these lines, the great Greek philosopher and mathematician Pythagoras states that there is a certain geometry in the display of the mathematical sequences as music exists even in regard to the distancing of spheres. The symbiosis between these two fields is later on highlighted by opinions of researchers such as James Sylvester who considered that mathematics is the music of reason or Gottfried Wilhelm von Leibniz who thought

that music is the mathematics of the soul which does not know that it is counting.

Ever since those times the evolution of the human kind has been studied from different perspectives. The study of human cognition has been a concern for many fields of expertise such as psychology, pedagogy, philosophy as well as the medical field especially in the last century. The evolution of the human being, their cognitive development, the possibility to delineate and forge the directions of intellectual progress accompanied by solid scientific evidence, they all lead to surprising findings of which one must be aware in order to master and guide further on the scientific advances. Teachers must master these findings and continue the directions of research in order to ensure the optimal evolution of all the fields of knowledge by means of the school curriculum.

## 2. Multiple intelligences. Musical and logical-mathematical intelligence

Neuroscience (French *neurosciences*), a domain derived from the advanced study in the medical field, provides multiple explanations for a better understanding of the brain and the ability to have neuronal connections in an original manner. The concept was coined in the early 1970s and it defines the pool of brain sciences such as: neurobiology, psychophysiology, psychobiology, neuroethology, neuropsychology, neurophilosophy. There is an attempt to integrate other areas of expertise such as psychophysiology, psychobiology and neurobiology within the field of the cognitive psychology (Popa et. al. 1993-2009).

Intelligence is defined by scholars as the psychological function or pool of functions due to which the organism adjusts to the environment elaborating original combinations of behaviors, acquires and employs new knowledge and eventually reasons and solves problems according to the rules that result from the information received by means of logic (Doron & Parot, 2006).

Romanian scholars in the field of psychology (Popescu-Neveanu 1978) explain the concept of intelligence as a *real fact as well as a potential one both in terms of it as a process and as aptitude or capacity, both as form and attribute of mental and behavioral organization.*

Being intelligent can be exteriorized in different ways due to the multiple abilities that people often manifest and employ in daily activities. The Intelligence Quotient (IQ) measured by means of standardized tests (aiming at language and logical-mathematical intelligence) usually targets intellectual dexterities related to words and numbers, skills used to memorize them and to relay different patterns, stressing lesser extent the social perspective, art, and nature.

Dr. Howard Gardner, Professor at Harvard University, concerned with the process of human learning (in young children as well as adults) proves that the concept of homogeneous school, i.e. a unidimensional vision of assessing human mind based on IQ is limited and he advocates for a new approach to learning completely different from the previous one which also generates a

different conception of the school system. The new alternative is grounded in eight different types of intelligence and it encompasses a wide spectrum of the human cognition, as follows: linguistic, logical-mathematical, spatial, musical, naturalist, bodily kinaesthetic, interpersonal, intrapersonal (Gardner 2006).

Later on, Gardner explained the possibility of the existence of other types of intelligence, existential and naturalist, but these do not yet benefit from sufficient scientific underpinnings.

Regarding the two types of intelligences, Gardner briefly describes each one: logical mathematical intelligence is an ability to develop equations and proofs, make calculations, and solve abstract problems and music intelligence is an ability to produce, remember, and make sense of different pattern of sound. When describing the types of intelligence Gardner emphasizes the fact that they are independent the one from the other in the sense that a high level of mathematical intelligence does not also involve an enhanced musical intelligence which contrasts with the traditional standardized IQ tests, actually a correct assessment of human intelligence (Gardner 2006).

In order to render this explanation even more comprehensive, the author introduces the concept of cultural role which requires a plurality of intelligences. Therefore, a good violinist also needs, besides musical intelligence which provides him / her qualitative training, other types of intelligence as the interpersonal one, in order to create a bond with the audience as well as bodily-kinaesthetic skills in view of a better coordination of the movement of the hands, fingers and body.

In his turn, Dr. Thomas Armstrong (2011), conducting research in the field of human intelligence, wrote his book entitled *You're Smarter Than You Think*, which sets out to be a true educational guide in the field of self-awareness, for children as well as for teachers or parents. The book reveals some important aspects in the field of human intelligences:

- The categories of intelligence are different but equally important;
- Every dimension can be explored, developed, amplified;

- Intelligence expresses itself differently for each type;
- The human being is not limited to one type of intelligence, even though he/she might excel in one direction;
- There is an ongoing cooperation between the types of intelligence in our activities;
- The eight dimensions are to be found in all the cultures and at all ages.

The theory of the multiple intelligences broadens the spectrum of the possibilities of knowledge beyond the conventional methods employed in education (verbal and logical-mathematical).

Musical intelligence is affirmed when you truly love and appreciate music. It represents the ability to recognize and analyze sounds, rhythms, melodies, patterns, to be sensitive to the tones, to the qualities of the musical sound (intensity, duration, height and timbre), the ability to create and reproduce music, using musical instruments or the voice. This type of intelligence involves active listening, increased sensitivity to environmental sounds and requires a strong connection between music and the ability to respond emotionally to it. Musical intelligence is present when a person discovers the *melos* in the songs of the birds, in the rhythm and noises of the city, in the sounds produced by the machines in the factories, by the train ride but especially in the vocal song or an instrument interpretation (Armstrong 2011).

Logic-mathematical intelligence comes in two distinct forms. The first one, the logical dimension, is related to processes, reasoning (inductive or deductive), orders, classifications, cause-effect relations and problem solving, and it surfaces when a person makes certain deductions easily, formulates hypotheses and conclusions, even without following all the algorithmic process. The second, the mathematical dimension, refers to numbers, working easily with them, guaranteed success in activities involving numbers, and is evident when those who manifest this type of intelligence can easily make the process of calculating in their mind, they quickly notice certain relationships between numbers, they like to work with numbers.

### 3. The expression of the logical-mathematical elements in the musical field

The musical universe is an extremely prolific and strongly connected area with numerous scientific field and this implies different perspectives of approach.

Connections to the field of mathematics are made at many levels, as illustrated in the descriptions below. Musicologist Iosiv Sava, speaking to composer and mathematician Ștefan Niculescu, highlights the presence of mathematics in the composition process and talks about its strong involvement in musical compositions (Niculescu, 1980). Later, as it happens in many areas, the human being was replaced by the computer and, based on special programs, musical compositions were generated. Of course, in the artistic field, the presence of the creative side of the human being is compulsory.

Niculescu (1980), speaking of the extension of the sound material, from the sinusoidal sound to electro-acoustic conglomerates, from the sounds of traditional instruments to everyday city noises (horn, screams), emphasizes the presence of some compartments of mathematical research, regarding the structure of the sound matter as well as the development of this sound variety in time.

#### 3.1. Musical rhythm and mathematics

A fundamental dimension of music is the rhythm (along with the melody, intensity, tempo). Rhythm has been defined and studied extensively by specialists from different fields. Professor Constantin Rîpă analyzes and identifies *rhythm* (based on the Greek origin *reo* which designates *flow*) with the movement as a process or succession, everything happening in time, and formulates two definitions of it, at a macrostructural and a microstructural level (Rîpă, 2002).

Regarding the first category, rhythm appears as a perception of all the components of an entire movement. Transferred to the musical field, rhythm refers to the entire process of movement, incorporating all the musical parameters (duration, height, tempo, dynamics, timbre, harmony) in their complexity of forms. At a microstructural level, rhythm is reduced to durations, which implies establishing relationships in time from the musical development.

The study of the musical durations and their corresponding rests is made in strong connection with

numbers and with the field of mathematics. As shown in the next image, the mathematical links between durations

can be easily established. On each line the total number of times calculated is four:

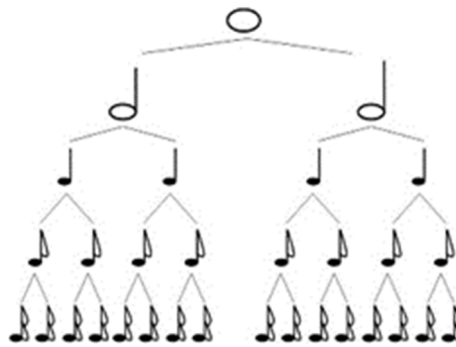


Figure no. 1. Musical durations

The same happens in the musical meter, known as measuring the succession of accents and durations, which is based on the musical rhythm, but the meter refers to a programmed succession of these musical accents. Thus, in the 2/4 time signatures the accent comes with every

second beat, while in the 3/4 time signatures the accent comes with every third beat and the 4/4 time signatures have two accents: a main accent that repeats at every four beat and a secondary one, the third beat of each measure.



Figure no. 2. 3/4 time signatures

As illustrated in figure 2, at the beginning of each staff the time signature is written after the clef and key signature. The image of time signatures looks like two numbers arranged like a fraction. This sign tells us how the music construction is to be counted. The top number 3, which is written above tells us how many beats to count. The bottom number 4 tells us what kind of note to count in each measure.

By changing a variable, the same ternary bar can have number 8 as a type of note to count (number 8 below, which is half of the quarter), which implies new organizations of the rhythmic material. Adding another change, number 6 on top, the system will be different, and a time signature of 6/8 means count 6 eighth notes to each bar. Suddenly the system changes, the initial data, and the music is organized from a different perspective: 6/8 is grouped into 2 groups of 3 eighth notes and 3/4 time would be grouped into 3 groups of 2 eighth notes. The people characterized by a high level of mathematical intelligence will easily find opportunities to combine durations and rests or to think in this new system.

### 3.2. Involving numbers in musical harmony

Musical harmony approaches the musical field at a technological level. Its object is the study of the chords and their succession, as well as the learning of the technique of harmonizing a song (Marcu, 2014).

The second great dimension of music, together with rhythm, is the melody. Studying the pitch of musical sounds is an important part of music, representing the basis for practicing music. Mathematics is already involved by establishing the level of pitch between sounds. Pitch in music is the position of a single sound in the complete range of sound. Sounds are higher or lower in pitch according to the frequency of vibration of the sound waves producing them, a phenomenon that is based on many mathematical and physical concepts.

After acquiring the musical notes, the musical intervals are learned, which implies the succession (melodic interval) or the overlap (harmonic interval) of two sounds.

Intervals involve high level of mathematical knowledge. Musical consecrated notes (do, re, mi, fa, sol, la, si and do repeated at octave) are numbered with Roman numerals from I to VIII and the musical intervals, the distance from one note to another, with Arabic numerals.

Intervals stand for special distances between any two notes. Each interval will have a number - 1, 2, 3, 4, 5, 6, 7, 8. These numbers are the distance between two notes, based upon counting the lines and spaces on the staff (De Voto, 2007).



Figure no. 3. Musical Intervals

In music, the chords involve playing three sounds (at least) simultaneously, arranged as third (root position, fourth or second).

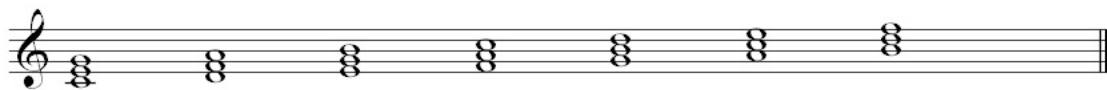


Figure no. 4. Chords in Do major scales

A chord is said to be in its root position when its root is the lowest note. A three-note chord or triad may also stand in its first or second inversion. A chord stands in its first inversion when its third is the lowest note. It is in

second inversion when its fifth is the lowest note. In the following example, the major triad of C stands in its root position and first and second inversion respectively:

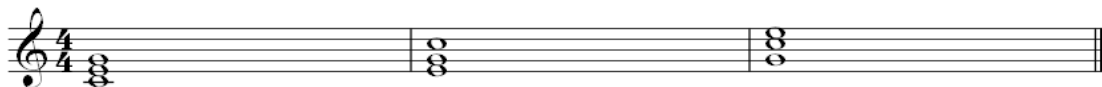


Figure no. 5. Chords-root position, first and second inversion

All these organizations of the sound material require an increased ability to work with figures, series, strings all of them being core mathematical concepts.

#### 4. Conclusions

Music is both science and art, it is an important component of human nature, existing in all cultures, generating joy and pleasure by means of interpretation or listening. Music is scientifically explained from Pythagoras, while connections between mathematics and music have been signalled since ancient times. Furthermore, nowadays we are also studying possibilities to streamline the functioning of the brain which involves relationships between different types of intelligences, corresponding to different cortical areas.

Music is often referred to as the mathematics of sounds due to the numerous synapses that occur between the two fields of knowledge. Thus, it becomes a valuable tool for the analysis of some essential structural elements of the

human personality, as cognition, the affectivity, by highlighting some brain mechanisms. The neuropsychological investigations realized in the last century guided us to the development of maps of the brain areas and their functions and the identification of the areas responsible for certain cognitive operations (Levitin, 2010). These areas correspond to different types of information.

Mathematical sciences benefit from strong transfer qualities with high applicability. Based on the elements of mathematical thinking, children (adults as well) develop certain general faculties used for learning: the capacity of logical thinking and of creative initiative (Csire, 1998), which demonstrate the presence of a high level of mathematical intelligence. This transfer effect applies to



several areas of knowledge, including music, and it's visible in parameters such as musical rhythm, melody, harmony.

However, the art of the musical sounds is still a universe which embodied at the highest level the emotional and subjective side of the human being and the mathematical field doesn't provide qualities such as musical imagination, a specific human characteristic (Niculescu 1980).

In order to ensure the progress of a society, the need for multiple intelligences arises, due to the variety of our activities. It can start from the approach of education in school. It is important to balance the use of multiple intelligences, to pay more attention to children with artistic or naturalistic skills, but also to children often described as having learning problems or attention issues during activities. All of them, because of their special thinking, should be encouraged to express themselves in their special areas in order to obtain optimum performance.

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