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A systematic and innovative model for identifying the psychological effects and states induced by musical rhythm and tempo, based on the four temperaments (the four humors)



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ABSTRACT

Rhythm, as a fundamental element of music, exerts a profound influence on the human being, and its characteristics can be systematically analyzed through mathematical relationships and numerical principles. This study aims to identify the psychological states and human impacts associated with specific musical time signatures and tempos; this is achieved by applying the ancient theory of the four human temperaments (***the four humors***) and integrating it with innovative numerical rules. Computational results indicate that the temperaments associated with the time signatures 6/4, 6/8, 5/8, 11/8, 15/8, 24/16, and 33/8 are "hot and dry"; those for 2/4, 8/8, and 18/16 are "hot and moist"; those for 3/4, 7/8, 12/4, 12/8, and 21/8 are "cold and moist"; and those for 4/4, 4/8, 9/4, 9/8, and 16/8 are "cold and dry." Furthermore, the model for identifying tempo-based temperament reveals how the psychological states associated with a specific rhythm vary according to the performance speed (***metronome setting***). Additionally, the computational methods presented for simple, compound, and irregular time signatures mutually validate one another; this cross-validation confirms the reliability of the identified rhythmic temperaments.

1. Introduction:

Music theory is a mathematics-based discipline that examines the consonance and dissonance of notes, as well as the timing of melodies, to establish the principles of composition [7]. One established approach in this field involves dividing the musical domain into six dimensions and studying and teaching each one precisely and independently. Among these dimensions, rhythm holds a position of fundamental importance and priority [10]. Rhythm is a vital essence that permeates all music, as it embodies the movement and continuity of music through time. In the realm of music, rhythm refers to the organization of the durations of sounds and silences [8]. Rhythm comprises several components that shape its overall structure: rhythmic patterns, meter, tempo (speed), and timing [5]. One regular temporal pattern in music is the meter; a musical measure consists of groups of two, three, or four sounds, with the first sound typically carrying an accent. Each "***beat***" encompasses one or more cycles of rhythmic patterns, naturally beginning with an accented beat. Measures are separated by "***bar lines***"—vertical lines drawn perpendicular to the staff lines. The beat is considered the unit of time in music—a unit that listeners often accompany with synchronized body movements or clapping, and which a conductor indicates through hand gestures. Indeed, the beat serves as the unit for

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measuring the rhythmic pulse of music [16]. The temporal structure of music is regarded as one of its most fascinating and complex aspects. In this structure, the beat plays a pivotal role, encompassing the perception of repetitions and temporal cycles (***periodicities***) while listening to music. The beat serves as the cornerstone of musical behavior and rhythmic movement (***dance***), providing a foundation for rhythmic coordination. Notably, even when music lacks strict, precise temporal periodicity, humans possess an innate ability to perceive periodic pulses and instinctively synchronize their bodies with these beats [11]. A "measure" consists of a specific number of beats grouped together. The numbers written at the beginning of a musical piece, immediately following the clef, relate to the piece's rhythmic structure and are known as the "***time signature***" [17]. Generally, measures are categorized into three types: simple, compound, and irregular. A simple measure is one that utilizes a single type of beat unit, which is typically subdivided into two parts (***or multiples of two***). In contrast, a compound measure differs from a simple measure in terms of rhythmic characteristics and structure [12]. Compound measures refer to meters where the number of beats can be evenly divided into three parts—such as 6/8, 9/4, and similar structures [15]. Irregular measures consist of a combination of two or more measures of unequal length (in terms of beat count) [2]. By examining both simple and compound measures, one can observe that converting a simple measure into a compound one is possible by multiplying it by the fraction 3/2; specifically, this involves multiplying the numerator by 3 and the denominator by 2. Conversely, to convert a compound ratio into a simple one, the reverse operation can be performed—namely, dividing the upper number by 3 and the lower number by 2 [13].

In 1405, research conducted by Masih Aslani examined modern numerical systems within musical modes and their relationship to temperaments and constellations [21–27]. Also in 1405, the artist Daniel Bikas presented research in the field of art [28]. Fatemeh Etemadi-Rad analyzed research concerning art and tourism in 1405 [29–31]. In 1400, Mohsen Poursheikhi conducted research investigating modern numerical systems and their connection to commodity production [32–33]. Batoul Shahriar examined frost damage, growth, and temperament in 1399 [34–35]. With the assistance of Reza Kakoulvand, research was conducted in 1401 investigating numerical systems through both computational and experimental fluid dynamics [36–45].

Music has a profound impact on mood and can influence helping behavior [4]. Temperament is closely linked to behavioral issues and encompasses a wide range of internalizing and externalizing problems [20]. Music can play a pivotal role in helping students cultivate their temperament, foster continuous personal growth, and generate a sense of happiness. Music therapy has been introduced as a component of mental health education; by harnessing the power of rhythm and melody, it evokes emotional experiences and alleviates psychological barriers and challenges [19]. In the Persian language, the term "***temperament***" (**mezaj**) signifies "***mixing***" or "***blending***"; in traditional Iranian medicine, it refers to a quality arising from the interaction of the opposing characteristics of the four elements—water, earth, air, and fire [9]. The elements upon which the bodies of living beings (***both human and non-human***) are constructed are four indivisible substances—meaning they cannot be broken down into components possessing different natures or temperaments. These pillars are: fire (***hot and dry***), air (hot and moist), water (***cold and moist***), and earth (***cold and dry***) [3]. Music therapy is a holistic approach that utilizes music within a therapeutic context to promote mental health and well-being [18]. A skilled physician is one who understands the effects of various musical pieces in terms of rhythm and melody, even if they are not themselves a music specialist or performer; collaboration with a proficient musician can be of great assistance to the physician in this regard [6]. An individual who has mastered the science of music and possesses a sound understanding of medical science can undoubtedly use music to eradicate disease from the human body [1].

2. The Numerical-Rhythmic System of Music

The numerical-rhythmic system in music is a field of study that examines the relationships between numbers, rhythm, tempo (speed), and the four temperaments in order to identify the psychological effects and states induced by musical rhythm and tempo. However, there is no comprehensive body of research in this area—neither from a historical perspective nor within contemporary studies. Therefore, the present article serves as the first study to address these issues.

Computational Notation

The computational symbols presented in this article have been established in accordance with ***Table 1***.

Table 1: Arithmetic symbols of the Rhythm numeral system

Explanation	Notation
Number of the element	Re
Upper number of time signature	a
Lower number of time signature	b
Sum of upper and lower numbers of time signature	c
Extracted number	e
Answers to calculations in the first, second	a_1, a_2
Obtained number from total calculations	TC

Determining the Rhythm Element

Before determining the rhythm element, calculations are performed for each type of time signature. The resulting figure is then divided by 4, and the remainder identifies the element number.

$TC/4 \equiv Re$

where Re is the remainder of *TC* divided by 4.

Each element is also associated with a temperament. The numerical symbol for each element and its corresponding temperament are presented in ***Table 2***:

Table 2: Numerical symbols for each element and their temperaments

Element	Fire	Wind	Water	Earth
Temper	Warm and dry	Warm and moist	Cold and moist	Cold and dry
Notation	1	2	3	0

Note: When the remainder is zero, "Re" represents the earth element; however, ancient peoples regarded the number 4 as its symbol.

Combination of Elements

In ancient times, it was believed that the combination of elements gave rise to states possessing various effects and characteristics. Terms such as compatibility, desirability, opposition, and contrast were used to describe these states and articulate their properties (as shown in ***Table 3***).

Table 3: Elemental composition

union	desirable	opposition	contradictory
Fire and Fire	Wind and Fire	Fire and Earth	Water and Fire
Wind and Wind	Fire and Wind	Earth and Fire	Fire and Water
Water and Water	Earth and Water	Water and Wind	Earth and Wind
Earth and Earth	Water and Earth	Wind and Water	Wind and Earth

3. Calculations and Findings Regarding the Rhythmic Numerical System in Music

The objective of the numerical system applied to musical rhythm is to determine the "***temperamental quality***" of the rhythm. This is achieved through an extensive computational process based on trial and error. The following rules have been formulated as a result of this process.

Simple Time Signature

The "***temperamental number***" of a simple time signature is determined by dividing the sum of its upper and lower numbers by 4; the remainder of this division represents the temperamental number for that simple time signature. Table 4 illustrates this explanation.

$TC := a + b;\ TC \div 4 \equiv Re$. (Remainder)

Note 1: Since all time signatures are evaluated based on the four temperaments, this calculation method applies to simple time signatures where the lower number is 4 or a multiple of 4; it is not applicable to time signatures with a lower number of 1 or 2.

Note 2: Simple time signatures with a lower number of 1 or 2 are evaluated based on the standard of a lower number of 4.

Table 4: Calculations regarding the simple visibility index

Time signature	Calculations	Temperament
$\frac{2}{4}$	$TC = 2+4 = 6,\quad 6 \overset{4}{\equiv} 2$	warm and moist
$\frac{3}{4}$	$TC = 3+4 = 7,\quad 7 \overset{4}{\equiv} 3$	cold and moist
$\frac{4}{4}$	$TC = 4+4 = 8,\quad 8 \overset{4}{\equiv} 0$	cold and dry

Compound time signature

Method A: In simple time signatures, the ratio of each beat to its compound equivalent is 3:2. (For example, a quarter-note beat in simple time corresponds to a dotted quarter-note beat in compound time.) To determine the temperament number of a compound time signature, follow these steps:

1. Add the top number (3) and the bottom number (2) of the compound time signature; the result is 5:

e := 3 + 2 = 5

2. Subtract the sum of the top and bottom numbers of the compound time signature from 5.
3. Divide the result by 4; the remainder of this division will be the temperament number

of the compound time signature (according to ***Table 5***).

$c = a + b,\ TC := c - e,\ TC/4 \equiv Re$.

Table 5:Calculations for the composite index using Method A

Time signature	e	Calculations	Temperament
$\frac{6}{4}$	5	$c = 6+4 = 10,\quad TC = 10-5 = 5,\quad 5 \overset{4}{\equiv} 1$	warm and dry
$\frac{6}{8}$	5	$c = 6+8 = 14,\quad TC = 14-5 = 9,\quad 9 \overset{4}{\equiv} 1$	warm and dry
$\frac{9}{8}$	5	$c = 9+8 = 17,\quad TC = 17-5 = 12,\quad 12 \overset{4}{\equiv} 0$	cold and dry
$\frac{12}{8}$	5	$c = 12+8 = 20,\quad TC = 20-5 = 15,\quad 15 \overset{4}{\equiv} 3$	cold and moist
$\frac{12}{16}$	5	$c = 12+16 = 28,\quad TC = 28-5 = 23,\quad 23 \overset{4}{\equiv} 3$	cold and moist

Method B: Subtract the sum of the top and bottom numbers from the set {1, 2, 3, 4} until a single-digit number is obtained. If the resulting number falls within the range of 1 to 4, that number is taken as the result. However, if the number is between 5 and 9, divide it by 4; the remainder of this division represents the "temperament number" corresponding to the time signature, as listed in ***Table 6***.

Notes:

1. The final result must be a single-digit number.

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2. Two-digit numbers with a leading digit of 1 are not included in calculations pertaining to the number 1.
3. Two-digit numbers with a leading digit of 2 are not included in calculations pertaining to the number 2.

Table 6:Calculations for the composite index using Method B

Time signature	c	Calculations	Temperament
$\frac{6}{4}$	$6+4=10$	$TC=10-(2+3+4)=1$	warm and dry
$\frac{6}{8}$	$6+8=14$	$TC=14-(2+3+4)=5$, $5 \overset{4}{\equiv} 1$	warm and dry
$\frac{9}{8}$	$9+8=17$	$TC=17-(2+3+4)=8$, $8 \overset{4}{\equiv} 0$	cold and dry
$\frac{12}{8}$	$12+8=20$	$20-(1+3+4)=12$, $TC=12-(2+3+4)=3$	cold and moist
$\frac{12}{16}$	$12+16=28$	$28-(1+3+4)=20$, $20-(1+3+4)=12$, $TC=12-(2+3+4)=3$	cold and moist

Irregular Time Signature

1. Irregular time signatures formed by combining multiple simple beats are calculated using the following method:

Since irregular time signatures result from combining two or more time signatures (in terms of the number of beat groups), the top and bottom numbers of each beat group are first added together. Then, the sums of these results are added together, and the final total is divided by 4. The remainder of this division represents the "***temperament number***" of the time signatures (according to ***Table 7***).

a_1, a_2, ... := a + b, TC = a_1 + a_2 + ... TC/4 = Re.

2. Irregular time signature with compound beats:

If the irregular time signature includes compound beats, the calculations are performed similarly to the methods used for compound time signatures. The difference is that the calculation results for each section of the compound time signature (based on the number of beat groups) are summed, and the total is then divided by 4. The remainder of this division determines the temperament number of the time signatures (according to Tables 8 and 9).

Note 1: In calculations for irregular time signatures (whether simple or compound), identical numbers in the numerators (top numbers) of the time signatures are cancelled out in pairs. Refer to the 8/8, 11/8, and 16/8 time signatures in ***Table 7.***

Note 2: Since simple and compound rhythms do not practically feature single-beat time signatures—as time signatures begin with two or more beats—the number 1 is subtracted from the result in the first method for compound irregular time signatures (in the single-beat case). Refer to time signature 18/16 in ***Table 8***.

Table 7: Calculations for irregular time signatures with simple beats.

Table 7: Calculations regarding the irregular facade ratio using simple multipliers.

Time signature	Calculations	Temperament
$\frac{5^{(3+2)}}{8}$	$a_1=3+8=11$, $a_2=2+8=10$, $TC=11+10=21$, $21 \overset{4}{\equiv} 1$	warm and dry
$\frac{7^{(3+4)}}{8}$	$a_1=3+8=11$, $a_2=4+8=12$, $TC=11+12=23$, $23 \overset{4}{\equiv} 3$	cold and moist
$\frac{8^{(3+3+2)}}{8}$	$(\cancel{3}+\cancel{3}+2)$, $TC=2+8=10$, $10 \overset{4}{\equiv} 2$	warm and moist
$\frac{11^{(3+3+3+2)}}{8}$	$(\cancel{3}+\cancel{3}+3+2)$, $a_1=3+8=11$, $a_2=2+8=10$ $TC=11+10=21$, $21 \overset{4}{\equiv} 1$	warm and dry
$\frac{16^{(4+3+4+5)}}{8}$	$(\cancel{4}+3+\cancel{4}+5)$, $a_1=3+8=11$, $a_2=5+8=13$ $TC=11+13=24$, $24 \overset{4}{\equiv} 0$	cold and dry

Table 8: Calculations for irregular meter with compound beats using Method A

Time signature	e	Calculations	Temperament
$\frac{15^{(3+2)}}{8}$	5	$a_1=9+8=17$, $17-5=12$, $a_2=6+8=14$, $14-5=9$, $TC=12+9=21$, $21 \overset{4}{\equiv} 1$	warm and dry
$\frac{21^{(3+4)}}{8}$	5	$a_1=9+8=17$, $17-5=12$, $a_2=12+8=20$, $20-5=15$, $TC=12+15=27$, $27 \overset{4}{\equiv} 3$	cold and moist
$\frac{24^{(3+3+2)}}{16}$	5	$(\cancel{3}+\cancel{3}+2)$, $a_1=6+16=22$, $TC=22-5=17$, $17 \overset{4}{\equiv} 1$	warm and dry
$\frac{18^{(3+2+1)}}{16}$	5	$a_1=9+16=25$, $25-5=20$, $a_2=6+16=22$, $22-5=17$, $a_3=3+16=19$, $19-5=14$, $14-1=13$, $TC=20+17+13=50$, $50 \overset{4}{\equiv} 2$	warm and moist
$\frac{33^{(3+3+3+2)}}{8}$	5	$(\cancel{3}+\cancel{3}+3+2)$, $a_1=9+8=17$, $17-5=12$, $a_2=6+8=14$, $14-5=9$, $TC=12+9=21$, $21 \overset{4}{\equiv} 1$	warm and dry

Table 9: Calculations for irregular meter with compound beats using Method B

Time signature	Calculations	Temperament
$\frac{15^{(3+2)}}{8}$	$a_1 = 9+8 = 17, \quad 17-(2+3+4) = 8,$ $a_2 = 6+8 = 14, \quad 14-(2+3+4) = 5,$ $TC = 8+5 = 13,$ $13 \overset{4}{\equiv} 1$	warm and dry
$\frac{21^{(3+4)}}{8}$	$a_1 = 9+8 = 17, \quad 17-(2+3+4) = 8,$ $a_2 = 12+8 = 20, \quad 20-(1+3+4) = 12,$ $12-(2+3+4) = 3, \quad TC = 8+3 = 11,$ $11 \overset{4}{\equiv} 3$	cold and moist
$\frac{18^{(3+2+1)}}{16}$	$a_1 = 9+16 = 25, \quad 25-(1+3+4) = 17,$ $17-(2+3+4) = 8, \quad a_2 = 6+16 = 22,$ $22-(1+3+4) = 14, \; 14-(2+3+4) = 5,$ $a_3 = 3+16 = 19, \; 19-(2+3+4) = 10,$ $10-(2+3+4) = 1, \quad TC = 8+5+1 = 14,$ $14 \overset{4}{\equiv} 2$	warm and moist
$\frac{24^{(3+3+2)}}{16}$	$(\not{3}+\not{3}+2), \quad a_1 = 6+16 = 22,$ $22-(1+3+4) = 14, \quad 14-(2+3+4) = 5,$ $5 \overset{4}{\equiv} 1$	warm and dry
$\frac{33^{(3+3+3+2)}}{8}$	$(\not{3}+\not{3}+3+2),$ $a_1 = 9+8 = 17, \quad 17-(2+3+4) = 8,$ $a_2 = 6+8 = 14, \quad 14-(2+3+4) = 5$ $TC = 8+5 = 13,$ $13 \overset{4}{\equiv} 1$	warm and dry

4. Musical Tempo

Musical tempo is one of the factors influencing rhythmic temperament. The tempo range is assumed to be divided into four equal segments, extending from the lowest to the highest metronome speeds. These categories are defined as "***cold-dry***," "***cold-moist***," "***warm-moist***," and "***warm-dry***."

Assigning a value of 10 to each simple or compound beat and taking 20 as the starting metronome value, the numerical ranges for the "***cold-dry***" category are 20–40 for duple meters, 20–50 for triple meters, and 20–60 for quadruple meters. Similarly, in the "***cold-moist***" range, the numerical value of each beat (initially set at 10) is added to the value from the preceding stage.

During the transition from the "***cold***" stage to the "***warm***" stage, each beat takes on a numerical value of 20. Consequently, in the "***warm-moist***" zone, the numerical ranges are as follows: 62–102 for duple meters, 82–142 for triple meters, and 102–182 for quadruple meters. In the "warm-dry" category, the highest value from the preceding section ("***warm-moist***") serves as the baseline. The final performance values are presented in ***Table 10***:

Table 10: Temporal characteristics (tempo and temperament) in the meter recognition model for simple and compound meters.

Temperament ⇒	cold and dry	cold and moist	warm and moist	warm and dry
duplet time	40 to down	41 to 61	62 to 102	103 to up
triple time	50 to down	51 to 81	82 to 142	143 to up
quadruple time	60 to down	61 to 101	102 to 182	183 to up
Quintupling time	70 to down	71 to 121	122 to 222	223 to up
Sixfold time	80 to down	81 to 141	142 to 262	263 to up
Sevenfold time	90 to down	91 to 161	162 to 302	303 to up
Eightfold time	100 to down	101 to 181	182 to 342	343 to up

Note: There are exceptions regarding the nature (temperament) of the tempo for certain time signatures (such as 6/4).

Although the nature of the 6/4 time signature is calculated based on the "compound meter" method, determining its tempo nature proceeds on the assumption that there are six beats.

5- Discussion

The foundation of modern knowledge regarding numerical systems in music rests on reasoning and numerical logic, aiming to understand the effects of music on living beings. Understanding the nature of rhythm and tempo, along with their benefits, is a significant topic in the science of music therapy. While four common types of natures (temperaments) have been identified, the proportions of their components (heat, cold, moisture, dryness) can produce varying qualities depending on the diversity of rhythmic notes.

The nature of time signatures—much like human temperaments—can be classified into two forms: innate and acquired.

Innate nature refers to the primary nature an individual possesses from birth, whereas acquired nature relates to factors that induce changes in one's nature over time.

The innate nature of a rhythm is more or less preserved even as an acquired nature emerges.

For instance, an individual with a specific innate nature and defined structural characteristics (such as body parts, skeletal structure, skin tone, hair texture, etc., relative to other innate types) largely retains the effects of that innate nature throughout their life, even if they develop a new acquired nature. Similarly, regarding time signatures, the innate nature—determined via the formulas presented in this article—undergoes changes upon the introduction of an acquired nature known as the "tempo factor." The tempo factor acts as an acquired quality for the time signature, altering its intrinsic nature.

For instance, the 2/4 time signature possesses an inherently "***warm and moist***" nature.

Despite its intrinsic "cold and moist" nature, this time signature takes on an acquired "cold and dry" quality at tempos of 40 or lower; at tempos between 41 and 61, it acquires a "cold and moist" quality; and at tempos of 103 and above, it acquires a "***warm and dry***" quality. However, within the 62–102 tempo range—where the performance speed aligns with its intrinsic nature—its "warm and moist" temperament is reinforced, and that tempo is likewise considered intrinsic. Consequently, despite structural differences, 4/4 time bears a strong resemblance to 2/4 time when performed within the "***warm and moist***" tempo range (102–182). Based on the temperamental characteristics of elements in Iranian traditional medicine, the temperamental traits of the 2/4 time signature are

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presented in ***Table 11***.

The concept of classifying rhythmic speed according to the four temperaments aligns psychologically with observed similarities in the molecular motion of the elements. Just as the slow movement of molecules in the earth element fosters stability, melodies with slower tempos tend to persist longer in the mind and memory.

Table 11: Characteristics of the 2/4 time signature at various tempos

Temperaments tempos	personality trait
cold and dry	It enhances patience, endurance, and to some extent, a sign of thoughtful and cautious courage.
cold and moist	It strengthens introversion and behavioral calmness along with willpower and almost courage
warm and moist	It greatly strengthens strong will and reasonable courage
warm and dry	The sharpness of intelligence and quick reactions enhance one's willpower and foster a sense of courageous boldness.

In contrast, faster molecular motion—which shares the nature of the Fire element—is lighter and shorter in duration. Consequently, fast-paced melodies (unless repeated) may leave a less lasting impression on the mind and memory, yet they evoke greater fervor and excitement. Each element possesses distinct characteristics that can be likened to the "tempo" (speed) of a rhythm. By examining molecular motion alongside musical effects, a logical connection emerges between rhythmic tempo classifications and the four temperaments (or four humors).

To illustrate this concept further, consider a therapeutic application: the 6/8 time signature—embodying the qualities of the Fire element (characterized by a hot and dry temperament)—is effective in alleviating depression and fostering psychological vitality; however, selecting the appropriate tempo is crucial for maintaining the balance of an individual's temperament. Thus, for a young person with a hot and dry temperament, a tempo reflecting cool and moist qualities is suitable, whereas for an elderly person with a cold and dry temperament, a tempo with warm and moist qualities is more appropriate.

Analyses regarding the relationships between the four elements reveal that multiplying both the numerator and the denominator of the fraction by 2 yields inconsistent results; conversely, multiplying the numerator by 4 and the denominator by 2 produces results that are mutually consistent and harmonious (as demonstrated in ***Tables 12 and 13***).

Table 12: Ratio of rhythm elements (contradictory)

Time Signature	Temperament	Element	Multiply by	Time Signature	Temperament	Element
$\frac{2}{4}$	warm and moist	Wind	$\frac{2}{2}$	$\frac{4}{8}$	cold and dry	Earth
$\frac{3}{4}$	cold and moist	Water	$\frac{2}{2}$	$\frac{6}{8}$	warm and dry	Fire
$\frac{4}{4}$	cold and dry	Earth	$\frac{2}{2}$	$\frac{8}{8}$	warm and moist	Wind
$\frac{6}{8}$	warm and dry	Fire	$\frac{2}{2}$	$\frac{12}{16}$	cold and moist	Water
$\frac{9}{8}$	cold and dry	Earth	$\frac{2}{2}$	$\frac{18}{16}$	warm and moist	Wind
$\frac{12}{8}$	cold and moist	Water	$\frac{2}{2}$	$\frac{24}{16}$	warm and dry	Fire

Table 13: Ratio of rhythm elements (unity)

Time Signature	Temperament	Element	Multiply by	Time Signature	Temperament	Element
$\frac{2}{4}$	warm and moist	Wind	$\frac{4}{2}$	$\frac{8}{8}$	warm and moist	Wind
$\frac{3}{4}$	cold and moist	Water	$\frac{4}{2}$	$\frac{12}{8}$	cold and moist	Water
$\frac{4}{4}$	cold and dry	Earth	$\frac{4}{2}$	$\frac{16}{8}$	cold and dry	Earth
$\frac{6}{8}$	warm and dry	Fire	$\frac{4}{2}$	$\frac{24}{16}$	warm and dry	Fire

One might ask whether all rhythmic patterns within an irregular time signature share the same "***temperament***" (***or character***). The answer appears to be affirmative; however, the reason for differences in their mood—or emotional resonance—lies in the placement of accents on the beats.

For instance, in a 5/8 time signature (structured as 2+3), a duple pattern with a "warm" character precedes a triple pattern with a "cool" character; consequently, a sense of warmth is conveyed to the listener at the outset. As a result, this pattern evokes a greater sense of warmth compared to the 5/8 configuration structured as 3+2.

2.Result and Discussion:

6. Conclusion:

The findings indicate that the identified rhythmic temperaments align with psychological observations. Musicians often employ simple triple time signatures to evoke a sense of calm. In military contexts, simple duple time is used during parades to bolster soldiers' courage, whereas simple quadruple time is utilized to sustain their endurance during long marches. Compound duple rhythms are also employed in dance and celebratory events. Furthermore, it is observed that increasing the tempo enhances the rhythm's extroverted quality, while slower tempos tend to evoke a more introverted feel. Additionally, the computational methods presented for simple, compound, and irregular time signatures corroborate one another; this mutual validation reinforces the validity of the methods and strengthens the reliability of the identified rhythmic temperaments. Given the nature of the rhythms found in the results, it is evident that the relationship between simple and compound time signatures (derived by multiplying by 2/3) yields the desirable elements presented in ***Table 14***.

Table 14: Ratio of elements of common simple rhythms to compound rhythms

Time Signature	Temperament	Element	Multiply by	Time Signature	Temperament	Element
$\frac{2}{4}$	warm and moist	Wind	$\frac{3}{2}$	$\frac{6}{8}$	warm and dry	Fire
$\frac{3}{4}$	cold and moist	Water	$\frac{3}{2}$	$\frac{9}{8}$	cold and dry	Earth
$\frac{4}{4}$	cold and dry	Earth	$\frac{3}{2}$	$\frac{12}{8}$	cold and moist	Water

It is interesting to note that when the "***nature***" (or structural characteristics) of compound time signatures

such as 6/4, 9/4, and 12/4 is calculated, the result is identical to that of compound time signatures like 6/8, 9/8, and 12/8 (as shown in Tables 15 and 16).

This highlights the significance of the beat-related numbers within the time signature; consequently, it can be concluded that the nature of simple time signatures with a denominator of 1 or 2 (such as 2/1 and 2/2)is the same as that of simple time signatures with a denominator of 4 (consistent with the data presented in ***Tables 15 and 16***).

Table 15: Calculations for Composite Index 4.9

Method	c	Calculations	Temperament	Element
First	$9+4=13$	$TC=13-5=8,\quad 8\overset{4}{\equiv}0$	cold and dry	Earth
secend	$9+4=13$	$TC=13-(2+3+4)=4$	cold and dry	Earth

Table 16: Calculations for the 12/4 composite index

Method	c	Calculations	Temperament	Element
First	$12+4=16$	$TC=16-5=11,\quad 11\overset{4}{\equiv}3$	cold and moist	Water
secend	$12+4=16$	$TC=16-(2+3+4)=7,\quad 7\overset{4}{\equiv}3$	cold and moist	Water

The results indicate that the meter signatures 6/4, 6/8, 5/8, 11/8, 15/8, 24/16, and 33/8 possess a "***hot and dry***" temperament; 2/4, 8/8, and 18/16 possess a "hot and moist" temperament; 3/4, 7/8, 12/4, 12/8, and 21/8 possess a "***cold and moist***" temperament; and 4/4, 4/8, 9/4, 9/8, and 16/8 possess a "***cold and dry***" temperament. The theory regarding the temperamental characteristics of rhythm and tempo represents a novel approach that offers valuable avenues of study for those interested in biomedical engineering; it is also noteworthy that certain complex scientific issues can be resolved using simple computational methods. These numerical systems and their governing rules constitute a contemporary approach to understanding and elucidating theoretical connections in music therapy, grounded in logical reasoning and numerical calculation. This methodology employs numbers and calculations to articulate results, thereby allowing for the re-evaluation and refinement of various subjective and preference-based perspectives. Any logical theory or approach in music therapy opens pathways for research and exploration aimed at achieving optimal outcomes for the benefit of humanity and all living beings. Undoubtedly, the findings presented in this article—derived through the application of medical and engineering tools and techniques—will shed light on both the validity and the limitations of these theories.

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