Guerino Mazzola

COMPLEX TIME FOR CONSCIOUSNESS AND CREATIVITY IN MUSIC

Abstract
In this paper, I argue that complex time (with real plus imaginary components) could be a key to some of the most virulent problems in the artistic reality of music, namely the nature of artistic consciousness and creativity*, especially in the performing perspective of music. The performing musician faces a complex combination of memory, technique, gestures, and the balance in the famous temporal* καιρός *between past and future moments. Successful musical performance is a highly creative and complex activity. At the very center thereof is the sophisticated consciousness of the artist which manages the harmonious collaboration of the above components in real time. We are confronted with a big "space" of consciousness that occupies only a single point in the physical time line. How can it be understood that a rich processuality is construed in no physical time? We argue that this type of phenomena is enabled by the existence of a huge "space" of consciousness that is attached to every moment of physical time. We claim and discuss the following hypothesis:* Any workable concept of consciousness, and in particular artistic consciousness in the performing arts, must be construed upon a "space" that is added to the classical physical spatio-temporal ontology.

1. *Einstein's and Hawking's Time Concepts*

A dramatic ontological change in modern physics of the 20th century was the fundamental reconceptualization of time. It was initiated by Albert Einstein's special relativity, where he embedded time in a four-dimensional space-time. Einstein had adopted the space-time approach of Hermann Minkowski, who, in a famous statement, stated that "Henceforth, space for itself, and time for itself shall completely reduce to a mere shadow, and only some sort of union of the two shall preserve independence." Time then became a multiple variable where the Newtonian singular "divine" time was replaced by a plurality, one for every frame of reference, and different frame times being related to each other by the Lorentz transformation of space-time.
The second revolution of the time concept was introduced by Stephen Hawking (among others) in order to solve singularity problems of the Big Bang model of the evolution of our universe in the initial moment some 13.8 billion years ago. Hawking's concept of time switches from the real time axis to the plane of complex numbers: Time now has two real coordinates: the complex time $t=t_R+i\ t_I$ pronounces the real time t_R and the

imaginary time t_I. This complex ontology has also been proposed and studied by physicists Itzak Bar and John Terning[1].

These two revolutions of the time concept however did not apply to the human cognitive reality, except in Einstein's case for the metaphorical and vague popular statement that "everything is relative". In the case of complex time, I repeatedly emailed Hawking, but never got an answer, and now, it is too late. I also discussed the issue with other theoretical physicists, but they consistently think of the imaginary component as being a mathematical method, Wick rotation, not an ontological or even human cognitive topic.

2. *Musical Consciousness and Creativity*

In the following discourse, we will nevertheless argue that complex time could be a key to some of the most virulent problems in the artistic reality of music, namely the nature of *artistic consciousness and creativity*, especially in the performing perspective of music.

The performing musician, be it for the rendition of a given composition such as a classical score, or for the improvisatory more or less free expression, in jazz for example, faces a complex combination of memory, technique, gestures, and the balance in the famous temporal καιρός between past and future moments. Successful musical performance is a highly creative and complex activity. At the very center thereof is the sophisticated consciousness of the artist which manages the harmonious collaboration of the above components in real time.

"In real time" stands for in every moment of the performance, in other words: in every infinitesimal point of physical time. I know as a performing free jazz pianist what every good performer experiences: the complex processual unfolding of musical performance is a rich machinery that defines and is happening in a big space of presence in consciousness[2].

This well-known artistic complexification is a miraculous phenomenon since it happens in "no time", in the physical moment of presence. We are confronted with a big "space" of consciousness that occupies only a single point in the physical time line. This makes evident the problematic conceptual status of creative artistic consciousness, and of consciousness in general: How can it be understood that a rich processuality is construed in no physical time? It can be argued that this type of phenomena is enabled by the existence of a huge "space" of consciousness that is attached to every moment of physical time. This situation in its acute extremism in performing arts questions a classical rationale for understanding and even defining consciousness in cognitive and neuroscience. If no extra "space" is added to the classical physical ontology, consciousness cannot be conceived to meet its performative quality. Let us therefore claim the following hypothesis.

[1] I. Bar-J. Terning, *Extra Dimensions in Space and Time*, Heidelberg: Springer, 2010.

[2] This configuration is described in G. Mazzola, *Musical Performance*, Heidelberg: Springer, 2011, Ch. 4.12.

Hypothesis: Any workable concept of consciousness, and in particular artistic consciousness in the performing arts, must be construed upon a "space" that is added to the classical physical spatio-temporal ontology.

3. *Descartes' Dualism*

The above hypothesis receives a prominent philosophical interpretation if we review the Cartesian dualism which was set up in Descartes' *Principia philosophiae*[3], where he describes the three substances of being: res extensa, res cogitans, and God. The human existence is comprised of res extensa and res cogitans, together with their arcane interaction. Res cogitans is strongly associated with consciousness. It is not clear how and where this interaction would take place (Descartes' idea of the pineal gland being the crossing locus is too naive). For Descartes a substance is something which can exist without the existence of any other substance, which means in particular that the substance of res cogitans is not comprised in the physical ontology of res extensa (and vice versa).

The Cartesian *dualism* is derived from this double substanciality of our human existence, we are "divided" into the physics of our embodiment and the mentality of consciousness. This complexion is not only related to a double ontology, but more specifically to a double locality: there is a physical as well as a mental space, and both space types are irreducibly separate from each other. Let us be clear about the still valid dualism that is opposed to the often erroneously propagated reduction of mentality to physics in the neurosciences. The partisans of radical neuroscience claim that ultimately, our thoughts are (however complex) neuronal activities, i.e., that thinking is the superficial appearance of physical activities. Such an argument is invalid for the following reason. Suppose we could, for example, explain mathematical thoughts by neuronal activities. Obviously, the description and analysis of such activities would necessarily be made possible by complex mathematical formulas, such as those difficult partial differential equations which describe the axonal transfer of electrical voltage. Attention: Of course, the physical entities, electrons, atoms, etc. don't need mathematics to work. But such an *analysis* is only realized using the complex language of mathematics. To *give a proof* of the validity of the claim that neuronal activities substantiate mathematical thoughts, we need the analytical work. This means that our *neuronal explanation* of mathematical thoughts would presuppose a sophisticated mathematical machinery, which is a vicious circle: explaining math by use of math does not generate added value.

For these reasons the Cartesian dualism is a second argument for our above hypothesis that consciousness in creative artistic performance has to take place in a "space" of consciousness that is added to the physical space-time ontology.

But it is evident that understanding this dualism is not the solution of the question about the ontology of consciousness, namely how the mental space is added to the physical reality.

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[3] R. Descartes, *Principia philosophiae (Principles of Philosophy)* [1644], transl. with explanatory notes by V. Rodger and R.P. Miller, Dordrecht: Reidel, 1982.

4. *Introducing Complex Time in Music*

Our proposal regarding the added mental space of consciousness relates to complex time. The basic idea is that time has a real and an imaginary coordinate, as suggested by theoretical physics. When we consider space-time with complex time, we get a five-dimensional real vector space ST = $\mathbb{R}^3 \oplus \mathbb{C}$ that is the sum of two four-dimensional subspaces, ST = RST+IST = $\mathbb{R}^3 \oplus \mathbb{R} + \mathbb{R}^3 \oplus i\mathbb{R}$, the physical space-time RST and the mental space-time IST, see Figure 1.

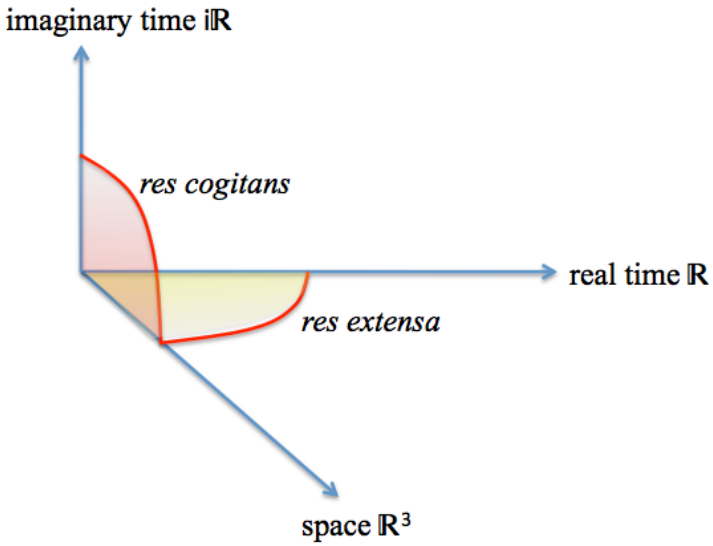

Figure 1: Descartes' dualism vanishes in a space-time with complex time.

The physical and mental subspaces have the spatial part in common: RST∩IST = $\mathbb{R}^3$. This connection would replace the Cartesian function of the pineal gland. Our configuration separates res extensa from res cogitans, but it also gives them a shared subspace.

The next step must be a theory of interaction of these four-dimensional subspaces which comprises the laws of physics and the dynamics of consciousness. To get off the ground, we have initiated research that models musical performance as a transformation of symbolic reality (of a score for example) to physical reality[4].

5. *Performing Symbols to Physical Gestures*

Our previous performance theory dealt with the transformation of note symbols, as given in a common score, to physical (acoustical) events. This is similar to the approach taken by contemporary performance theory as initiated by the school of Johan Sundberg

[4] See G. Mazzola et al., *The Topos of Music* (vol. I: *Theory*; vol. II: *Performance*; vol III: *Gestures*, vol. IV: *Roots*), Heidelberg: Springer 2018, vol. III.

in Stockholm. Our theory used standard methods of differential geometry[5]. It was one of the most important results of our research that the refinement process of performance involves Lie derivatives of performance vector fields, the tempo curve being the classical example of such a performance field.

In view of the union of physical and symbolic/mental realities as suggested by the above ST space-time, it became imperative to also view the performance process more embodied than by abstract note symbols and their acoustical realization in performance. In the third volume of *Gestures*, we set forth an embodied performance theory which instead of note sequences deals with musical gestures, configurations of curves in space-time that may be realized by the musician's movements of human body limbs, the vocal tract, arms, and hands.

This approach is paralleled by the elegant physical *theory of strings*, which does not describe elementary objects as points that move in space-time, but as parametrized curves which move through space-time and thereby trace a "world-sheet" (instead of the well-known "world-line" of traditional particle dynamics). In our musical performance theory, the string would correspond to a musical gesture, for example an up-down movement of a pianist's finger. Its world-sheet would be the surface that is spanned between the symbolic finger movement as described on the score and the physical movement in performance, where a real physical gesture is happening. Figure 2 shows such a world-sheet. The blue rectangular line to the left is the symbolic gesture, while the red curve to the right is the physical realization the symbolic gesture.

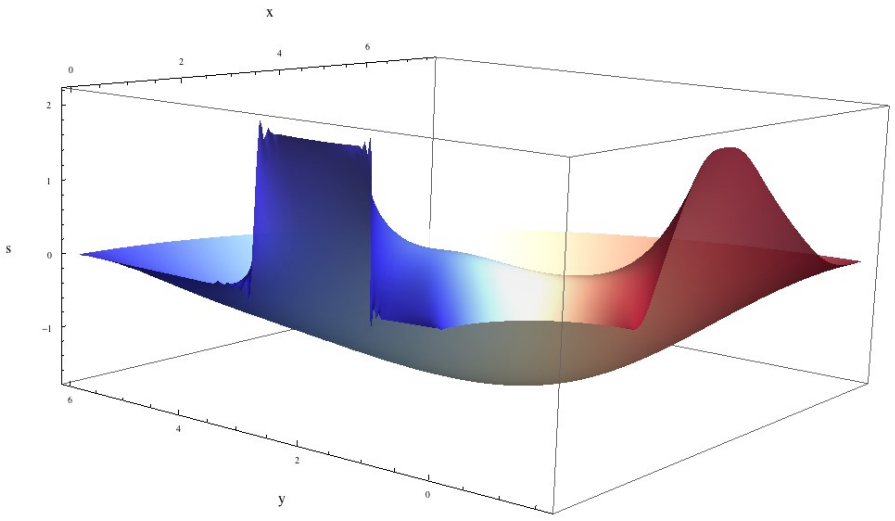

Figure 2: World-sheet of the passage from symbols (blue) a physical up-down movement of a pianist's finger.

The performance theory of musical gesture strings parallels the physical theory in that the shape of such a world-sheet is determined by the minimization of a Lagrange potential that is associated with a world-sheet[6].

[5] See *ibidem*, Part VIII.
[6] See *ibidem*, vol. III.

In this model, the symbolic gesture evolves in imaginary time of consciousness, while the physical one evolves in physical time. This means that we have a world-sheet of time from the symbolic/mental time line to the physical one. This world-sheet turns out to be a conformal mapping in complex space. Figure 3 shows the temporal world-sheet and its intermediate levels when understood as a function of real/physical time.

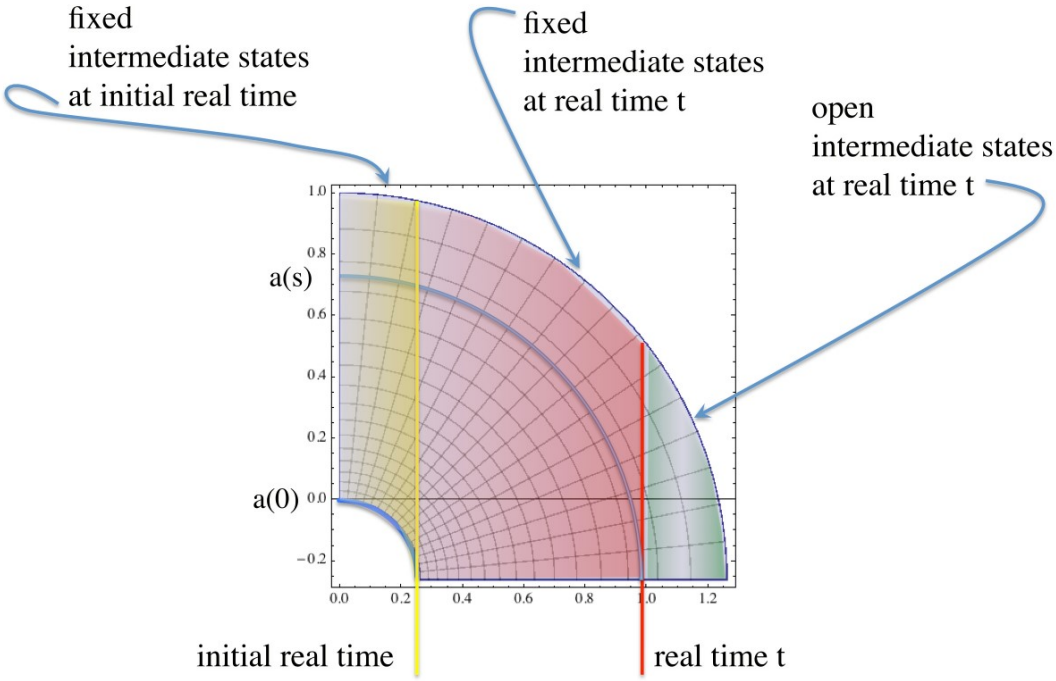

Figure 3: The world-sheet of complex time of a gesture and its intermediate states.

Here we face a completely new research in consciousness when morphing from mental to physical time.

An important new results of this theory is perfectly parallel to the above mentioned result of classical performance theory about role of the Lie derivative in the refinement process of performance vector fields. Again, in the gestural setup, there is an operator of Lie derivative type that captures refinements of gestural performance.