Music as Sound: A Dynamic and Experiential Approach to Real-Time Musical Sense-Making

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Abstract: - Music has been studied traditionally in logocentric terms, using a propositional and disembodied approach to musical sense-making. This takes a discrete-symbolic stance that proceeds outside of the time of unfolding. Recently there has been a paradigm shift in music research that argues for a dynamic and experiential approach to musical meaning, taking account also of the richness of full perception. This entails a transition from a structural approach of music to a process-like description of the music as it unfolds overtime. Music, in this view, is not merely an artefact, but a vibrational phenomenon that impinges upon the body and the mind. Musical sense-making, accordingly, must be studied from analog-continuous point of view in a real-time listening situation. Central in this view is the concept of interactions between the listeners and the music, either at a physical or epistemic level of dealing with the sounds. The former are continuous in their unfolding, the latter are discrete to the extent that they reduce the continuous unfolding to successive assignments in a time-series. It is a major aim of this contribution to bypass this dichotomy by defining real-time musical sense-making as a combination of the continuous and discrete approach.

Key-Words: - Music, Sound generation, Sound propagation, Acoustics

1 Introduction

Music is a sounding art, which can be studied at several levels of description: the acoustic level of sound generation and propagation, the level of sensation and perception, and the level of sense-making, which embraces both cognition, bodily reactions and affect. All these levels are highly intertwined, but their study has often been characterized by a reductionist approach. There are, in fact, distinct areas of study, which present themselves as established and autonomous scientific disciplines, such as physics, acoustics, mathematics and psychology, but the process of musical sense-making cannot be reduced to the study of only some of them. Music, in fact, is an informationally rich structure, which can be dealt with at the level of physical description but also at the level of sense-making by the listener (Kersten, 2014). The acoustic level, however, is the starting point. It triggers all actual and possible reactions which music can induce. It is tempting, therefore, to search for causal relations between the music as an acoustic structure and the reactions by the listener, and this is indeed possible to some extent for the lower levels of sensation and psychophysical reactions to the sounds, which rely on innate dispositions for coping with the sounds. Examples are the processing of pitch content (melodic contour and tonal functions of typical pitch intervals), metric organization and rhythmic structure of successive durations of the sounds (Peretz & Coltheart, 2003). Yet there seems to be a lot of freedom at the higher levels of sense-making, but even at these levelsthere are biological dispositions, which can be translated in terms of biases and constraints. Listeners, in fact, are limited in the number of sensory modalities (aural, visual, tactile, olfactory, gustatory) and the range within these modalities to which they have access (see Reybrouck, 2017c for an overview). We see in different colors, hear in different frequency registers, and smell and savor different odors and tastes, but the particular experiential textures of things, their qualia, may vary considerably among individuals (Cariani, 1998). Within these biological constraints it is possible, in fact, to rely on dispositionalpossibilities that can be exploited to a lesser or greater degree and much depends here on the learning history of individual listeners, which determines to some extent the level of perceptual learning and attentional strategies. Musical sense-making, therefore, cannot be explained sufficiently on the basis of an acousticalor structural description of the music.It depends also on the possibilities of sensory experience as part of a richer kind of musical sense-making. It is an approach, which is somewhat analogous to Tagg's distinction between a musicogenic as against a logogenic or logocentric approach to musical sense-making (Tagg, 2013, see also Reybrouck 2017a, c). The musicogenic approach considers music as having properties that refer mainly to the music as it actually sounds, relying on the moment-to-moment experience of the unfolding over time; the logogenic approach, on the contrary, conceives of music-structural knowledge as being equated with pre-existing concepts and labels that are assigned to the sonorous unfolding. The distinction plainly echoes the difference between the lexico-semanticapproach to cognition, which espouses a propositional approach to sense-making and which is couched in the form of abstract and emotionally neutral cognitive representations in the form of verbal descriptions as against the experiential approach to musical sense-making, with a conceptual grounding in the discrete/continuous dichotomy (see below).

2 Music as Sounding Art: Presentational Immediacy and Sensory Modalities

Music, in its broadest definition, can be considered as a collection of time-varying vibratory events that have the possibility of being structured by a listener. These events are grafted on the sonorous articulation which acts as an anchoring thread of now moments, allowing a process-like description of the unfolding of the music rather than conceiving of it as being reified in a kind of static structure. Musical sense-making, in this view, calls forth the acoustic character of the music as a collection of sounding stimuli that impinge upon the body and the mind.As such, there is a level of processing that is situated at the sensory level of dealing with the sounds, but which enables subsequent and more elaborate levels of processing such as the perceptual, cognitive, sensory-motor and affective-emotional ones. Music, in this view, induces several reactions in the listener, which makes it possible to define musical meaning in terms of dispositions to react to stimuli rather than in terms of objective categories (Reybrouck & Eerola, 2017).These dispositions are partly innate— i.e. the biological constraints—and partly acquired as the result of an individual learning history. Listeners, then, do not merely pursue the information that is contained in the music but they also affect the content of the information by the constructionof knowledge on the base of sensory input and acquired experience (Kühl, 2008). The sensory input, however, is the starting point. It insures the richness and fullness of perception, by implying presentational immediacy as against representational distance. Actual perception, in fact, proceeds in real time; it is time-bound and reflects both the sensory qualities and the actual duration of the stimuli. As such, it may guarantee an immersion in the sound which is lost when listeners rely merely on mental replicas of the sound (Reybrouck, 2017c). The physical presentation of the acoustic qualities of the music, however, is no guarantee for their being picked up by the listener. There are, in fact, listening habits and strategies which may differ considerably across listeners.

It is arguable, therefore, to try to reduce the degrees of freedom in the process of musical sense-making by providing a fuller sensory depiction of the actual articulation of the sounding music. This can be done by adding sensory modalities such as the visual and tactile one to the description or depiction of the music, so as to offer the listener a kind of multisensorial embedding in the sound. There are actually a lot of music visualization programs that provide visual depictions of the music, both as a static depiction or as a dynamic rendering that unfolds along with the sounding music in real time. Waveform and spectrogram representations are typical examples of signal representations, respectively in the time domain and the frequency domain. An example is depicted in Figure 1, with a spectrogram that clearly shows the fundamental tones and overtones which together constitute the spectral richness of the sound. The middle fragment (from 0,2 to 6 seconds) can be conceptualized at a symbolic level as one single pitch. The performance by the singer, however, shows the richness of modulation that embraces a whole sonorous universe. It shows the tension between an analogous-continuous depiction (the spectrogram), which presents itself with gradual and continuous transitions, and a discrete-symbolicconceptualization (the pitch level or the note) which reduces the sensory richness and fullness to just one symbol by stripping away all the particularities of what sounds.

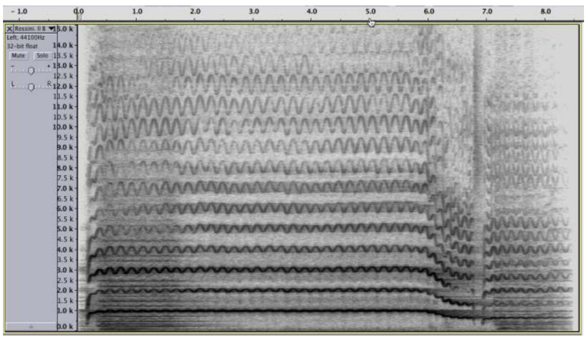

Figure 1. Spectrogram of the ending notes of “Una voce poco fa” from Rossini’s Barbiere di Seviglia, sung by the legendary opera singer Maria Callas.

The analog-continuous depiction makes it possible to explore in detail the variation of the musical signal, allowing a kind of microscopic depiction of the music as it unfolds over time. It allows listeners to mentally point at the music with a higher temporal and/or spatial resolution and even to interact with the music in a dynamic way.

The visualization algorithms, which translate the musical signal from the aural to the visual modality, moreover, can be used at several levels of dealing with the sound. There is the level of sound production as in the case of computer-aided composition, with the possibility of making visible self-generated sounds as well as pre-existing or newly recorded samples of music or sound.

But equally important is the level of sound perception and analysis of the musical signal. The visual interface, in this view, can be considered as an extension of the natural tools for listening, such as the ear and the auditory apparatus, by providing a kind of artificial prosthesis that allows listeners to extend their perceptual acuity by choosingadditional perceptual categories and to control the types of sensory information they can assess (Cariani, 1992).A distinction should be made, in this regard, between the auditory sense, which is very direct and penetrating and the visual sense which is more detached and disembodied (Hansen, 2004). The auditory sense impinges directly on the body and its tissues (skin, muscles, bones) and is to some extent also related to the tactile sense (Chauhan, 2013). It yields vibrotactile perception which proceeds in real time and which is very sensible in the audible range. The visual mode, on the other hand, can add information that was not audible at first hearing by focusing the listener's attention to what is more easily seen than being heard. The combination and/or expansion of the sensory modalities, however, can be helpful in providing a richer sensory experience.

3 Acoustics and Beyond: From Perception to Conception

The definition of music as sound raises ontological questions.It can be questioned, first, whether this definition is a symmetrical one: is it possible todefine music as sound and sound as music, or is there a narrowing down from sound to music? Is music only a subset of the more encompassing sonic universe, and if this is the case, what are the criteria for conceiving of music in terms of a normative category? A possible answer could lie in the definition of music as an epistemological category and substituting an "operational" definition for a "normative" approach. There is, in fact, a whole universe of sounds and noises that can be qualified as music, dependent on the deliberate intentions of the listener who can raise the sonic environment to the status of music. This holds true for sounds in general but also for noises and all kinds of noise music (Cassidy & Einbond, 2013; Cumming, 2000; Voegeli, 2010). Music, in that view, is not to be considered merely in terms of historic or geographic styles or genres, but rather in terms of sound, stressing the materiality of music-as-heard with sound as its major defining category. The transition from sound to music, however, is not arbitrary. Even if the underlying mechanisms may differ considerably among listeners, there must be at least some common ground that motivates the translation from a collection ofauditory signals to music as a qualified category.

A possible answer to this grounding is to conceive of music as a sounding environment and of listeners as organisms that "cope" with this environment (Reybrouck, 2005; 2015a). This is an ecological approach to listening that takes as a starting point the dynamic relationship between organisms and the environment, as coined already by Haeckel, who conceived of ecology as the science of the relations between the organisms and the environmental outer world (Haeckel, 1988 [1866]). Translated to the realm of music, this should mean that we substitute the listener for the organism and music for the environment. The process of musical sense-making, accordingly, should be defined in terms of interactions with the sounds, be it at a physical level of interaction or at an epistemic level of mental operations. Examples of the former are the movements that are involved in playing an instrument or singing; examples of the latter are processes such as exploring, observing, measuring, comparing and even labeling. Contrary to physical interactions which proceed in real time, and which are irreversible due to the inexorable character of the unfolding of time, mental operations are characterized by plasticity and reversibility (Piaget,1967, 1968). They go beyond the inexorable character of time by having the possibility to return to a starting point in imagery. The act of cutting an apple in two pieces, e.g., is irreversible; it proceeds in inexorable time and cannot be undone. The two pieces cannot be assembled again to build one apple. On a symbolic level, however, it is possible to equate an apple with the number 1 and half an apple with ½. The number 1 equals two times ½ and the addition of two times ½ yields the number 1 again. This is the reversibility of mental or cognitive operations, which have the possibility to return to their starting point. They are not restrained by the constraints of time and space and are exemplary of the opportunities and possibilities of symbolic play, which make it possible to operate on “symbolic replicas” rather than on “physical realia”. It is exemplified most typically in elementary mathematical activities which can be reduced to the basic logico-mathematical operations of classifying, seriating, putting in correspondence and combining, as abstractions of more concrete operations such as collecting, ordering and putting things together (Piaget, 1967, see also Reybrouck, 2016a, b).

Such mental operations can be performed in real time, relying on the actual presentation of auditorysignals to the ears, but it is also possible to take distance with respect to the actual sonorous unfolding and to rely on representations in memory and imagination. Thiscalls fortha transition from real-time interaction to representation at a virtual level in imagery, with a corresponding distinction between “in time” and “outside of time” processing of the sounds: in time processing keeps track with the actual unfolding and calls forth a moment-to-moment engagement with the sounds as they are presented to the senses; outside of time processing makes it possible to recollect previous sounds in memory and to anticipatefuture sounds that are yet to come, allowinga kind of virtual simultaneity which is so typical of symbolic play.

Both modes of processing are complementary to some extent and are illustrative of the way how listeners make sense of what they hear. The acoustic environment is objectively there, presenting itself in its full sensory richness, but what listeners actually hear is also dependent on their listening strategies, embracing aspects of selection, delimitation, denotation and attentional focus. Listeners, in this view, are the designers of their own phenomenal sonic universe, which means that, as observers, they are part of the observing system. This is one of the basic claims of second order cybernetics, which has introduced the observer as an active agent in the semiotization of the environmental world and the same idea is to be found also in the basic principles of ecological psychology and radical constructivism. “Second-order cybernetics”, which is also known as the cybernetics of cybernetics, is the application of cybernetics to itself. It is known as the cybernetics of “observing systems”, as against the cybernetics of the “observed systems” and is closely allied to the claims of radical constructivism (Pask, 1961, 1992; von Foerster, 1974, 1984; Maturana & Varela, 1980; Luhmann, 1990). The “ecological approach” to perception addresses the world not merely at a physical level of description but in functional terms, stressing the role of interaction between an organism and its environmental outer world. What matters is not the physical world in its objective qualities, but the world-as-perceived by an organism. Ecological perception, in this view, studies cognition and perception in the service of survival and orientation in the environment (Shepard 1984) and the role of interaction with the world is of primary importance here. As such, it is possible to conceive of the process of dealing with the music in terms of “coping” with the sounds. There is, as yet, no established tradition of thinking of music in ecological terms (see Clarke, 2005; Gaver, 1993a, b; Godøy, 2014; Reybrouck, 2005, 2012) but the ecological program, as a broader framework has been mapped out by Gibson (1966, 1979) who claimed that perceivers search out actively information, which becomes obtained information by leaning on perceptual systems rather than on their senses. Senses, in this view, do not simply function to arouse sensations but pick up information, which is already structured and ordered as part of an organism-environment ecosystem. As such perceivers—and also music listeners—, should be conceived as perceptual systems, which are tuned to the information that is considered to be useful. It is a conception that stresses the reciprocity of an organism and its environment, stressing the major role of key concepts such as attunement, reciprocity and resonance, and the corresponding perceptual processes of detection, discrimination, recognition and identification. A full description of the environmental world, therefore, cannot be given by analyzing only the organism or the environment (organism-environment dualism). What is needed, on the contrary, is an approach which is not “organism-neutral” or and which treats the environment “as perceived”. The “constructivist approach”, finally, does not espouse an objectivist stance on perception either. It claims that knowledge is the result of a learner’s activity rather than being the passive reception of information. Going back to the revolutionary attitude pioneered by Piaget, who redefined the concept of knowledge as an adaptive function, it states that the results of our cognitive efforts have the purpose of helping us to cope with the world of our experience. As such, it confronts the traditional goal of furnishing an objective representation of a world that might exist apart from the actual experience in favor of knowledge construction that has the mark of the cognizer (von Glasersfeld, 1966, 1991, see also Reybrouck, 2017b).

Applied to the realm of music, thismeansthat listeners shouldbe considered as autonomous agents who construct their knowledge as the result of manifest or epistemic interactions with the sounds. What is called knowledge, in this view, is the result of their own construction and how they make the world they experience. It is a conception that relinquishes the idea of knowledge as representation of an independent and autonomous reality in favor of a way of knowing as a repertoire of actions and thought which in past and previous experiences have turned out to be successful.

As such, it is possible to introduce an "operational approach" to the definition of music as a subset of the sonic universe, by conceiving of it as the sum of elements that have acquired meaning and salience as the result of interactions, both at a physical or epistemic level. Sucha dynamic conception of sense-making makes it possible to update the number of elements that constitute the music which isactually listened to. There is, however, a distinction between the elements that are constructed in the course of the actual unfolding of the music and the knowledge that is the outcome of this construction. It is the distinction between "knowledge-as-acquaintance" and knowledge as a "conceptual category"that is constructed post hoc, by taking distancefrom the actual unfolding of time.

The conceptual approach is not constrained by the limits of presentationalimmediacy. As such, it can be characterized in terms of a set-theoretical approachby defining a set of elements which exist in a virtual space along with some operations to be performed on them. This is a conception that calls forth the mathematical concept of spaceor sample space to be worked on by the listener by matching the music as a sonic (sub)universe against a limited number of categories that represent his/her psychological space.

A central problem,in this approach, is the definition of the elements which are to be delimited as the outcome of interactions with the sounds. But also the definition of the space can be problematic to some extent, as there may be distinctions between theoretical, geometrical and algebraic claims. It is arguable, however, to try to combine the geometrical and the algebraic approach, more in particular by conceiving of music in terms of an algebraic structure, i.e. a non-empty set A together with a collection of (at least one) operations on A and a collection of relations on A (Smith, Eggen & St.André, 1986). The geometrical approach, on the other hand, conceives of space as a set of points, and figures in this space can be considered as configurations of points, which can undergo transformations by going from one configuration to another. It is possible, further, to conceive of a matching of a geometrical space and a corresponding number space, with each point corresponding to a number. The geometrical space, then, is figuring as a framework to be chosen according to two criteria: every possible point must have an allocation in the space and every transition from one configuration must be possible.

As such, there is the challenge of combininga geometrical approachthat relies on the concepts of space and operations, which are a priori, with empirical subject matter. The problem has been stipulated already by Wiener, who stated that the study of an idealized or schematized experience differs from that of a raw experience by its reliance on two factors, namely the "experience" and the "mode of schematizations" that is employed. The geometrical view combines deductive reasoning andempirical work. What matters arenot mainly the direct objects of experience, but the way of collecting andarranging them. Space, in this context, constitutes a kind of tabulation of the experiences of our senses and geometry, as an a priori rather than an experimental science, is the science of form into which we cast our spatial experiences." (Wiener, 1976, pp. 18-20)

There is, as such, a tension between the objective and the subjective space, but the description of the elements of music as a subset of the sonic universe, and its conversion in terms of a geometrical and numerical space, makes it possible to deal with them at a conceptual level in virtual space with all possible applications in terms of computational modeling and imaginary trajectories in state spaces (Reybrouck, 2016b).

4 Real-Time Listening and the Analog-Digital Dichotomy

The definition of music as a set of elements which can be considered a subset of the sonic universe is only a starting point. Relying on processes as selection and assigning salience to vibratory events, it can delimit a sample space with elements upon which to perform operations. The selection, however, can be considered both as a process and as a product. The process-like approach calls forth ongoing processes of attentional focus and epistemic interactions with the sounds, which result in the semiotization of a sonorous environment. It is a time-varying process of sense-making, proceeding in real time and being constrained by the perceptual flux which offers the auditory input, as a succession of now moments that function as temporal windows on the sonic world (see Godøy, 2010, for a gestural analogy). Such a way of processing calls forth a continuous-analog decoding of the music, which is rate-dependent and time-consuming. It provides a phenomenological description of the sounds in terms of their continuous acoustic qualities. It is possible, however, to take distance with respect to this continuous auditory stream and to process the incoming acoustic signals in a more economical way by reducing the temporal unfolding to single representations with an all-or-none character, which lean themselves more easily to symbolic representations. This is the discrete-symbolic representation, which conceives of the temporal windows in (quasi)propositional terms, by assigning one discrete meaning to an event that is evolving over time. As such, it involves a "quantal" aspect of perception which makes it possible to conceive of music as a distributed substrate with discontinuities and focal allocations of semantic weight (Godøy, 1997). There is, as yet, no agreement as to the length or temporal extension of these focal allocations, which can vary between very short durations in terms of milliseconds to longer durations in terms of seconds (Wittmann & Pöppel, 1999-2000). An interesting starting point is the so-called subjective present, which has been termed thespacious presentor psychical presentby James (1950/1890) and Stern (1987), as a kind of temporal window that defines the demarcation of a moment of time that sharply divides past from future, but which is clearly distinct from both of them. Several durations have been proposed in time perception studies (Roeckelein, 2000) with a gradual transition from just noticeable differences to larger spans of time which can be considered as a kind of extended present (Kühl, 2008, p. 104).

The discrete approach thus reduces the continuous temporal flux to a succession of separate entities with unit character—hence the term digital—that go beyond the inexorability of time. They can be represented at an abstract level in imagery, allowing listeners to manipulate virtual replicas of the sound outside of the time of actual unfolding. This is the symbolic level of processing, which relies on "symbols" rather than on "sensory realia". The continuous approach, on the contrary, is perceptually bound in the sense that it is constrained by the auditory flux that unfolds in real time. It relies on a moment-to-moment scanning of the sonorous articulation with the listener keeping step with the music in a continuous process of manifest or epistemic interactions with the sounds (see Reybrouck, 2015b, 2016a for an overview).

The symbolic approach has proven to be fruitful to some extent. It is one of the basic characteristics of the symbol-processing point of view of information processing and of the computational approach to cognition in general. The basic idea is formal manipulation by axiomatic rules with a complete conceptual separation between the symbols used and their physical embodiment. Such formal computation is by definition independent of its physical implementation in the sense that it handles discrete symbols and discrete steps by rewriting them to and from memory to a sequence of rules (Pattee, 1995). The steps can be defined by a measurement process and the symbols can be considered the records of these measurements. Computations, in this view, can be described as a dynamical system that regularly performs a sequence of measurements that are recorded in memory. The time of measurement, however, has no coherence with the time of the dynamics, which means that the sequence of computational steps is rate-independent. In this "formal" conception of computation, the symbols and rules must be free of all influence other than their internal syntax. To have meaning, however, they must be informally interpreted, measured and grounded or selected from the outside and this involves a transition from rate-independent computation to a rate-dependent dynamic analog, where no memory is necessary as the measurements are proceeding in real time.

Dealing with music, accordingly, can be considered from a computational point of view. This is the "outside of time" approach, which is rate-independent to some extent. Musical sense-making in a real-time listening situation, however, relies on interactions with the sounds and these are rate-dependent. The interactional and experiential approach to musical sense-making, therefore, is somewhat opposed to the syntactization of semantics which started in the 1930s with the logical semantics by Carnap (1934a,b) and the model-theoretic semantics by Tarski (1956). It is an approach which is characterized by completely encoding the world with symbols being seen in a completely logical-symbolic structure and which make it possible to postulate sets of possible worlds and world-states without having to specify any specific observable things or events and without having the need to verify any truth values with respect to the external world (Cariani, 1989, 2001). In a real-time sense-making situation, however, such a model is only workable when it relies on a limited number of "observables", leaving an uncoded world external to the encoded realm. It makes sense, therefore, to conceive of the symbol-relationships which can be distinguished according to their directionality: from world to symbol, or from symbol to world. If the external world determines the symbolic outcome, there is relation of measurement; if the symbol determines an effect in the world, the relation is one of control. It is thus possible to change the semantic relations with the world with a possible transition from internal semantics, where the symbols are without relations to the external world, to real or external semantics, where the symbols establish a relation to the outer world.

Musical sense-making relies on both of them. Even if the mental operations and epistemic interactions can be performed outside of the time of unfolding, relying on some elementary logico-mathematical operations, they are always also related to the sensory realia for which they function as virtual replicas in a symbolic space. Dealing with music, in this view, calls forth both internal and external semantics, proceeding both in time and outside of time, being rate-dependent and rate-independent. Music, in this view, is then processed both “in praesentia” and “in absentia” which makes it possible to rely on presentational immediacy as well as on memory and anticipation. As such, two mechanisms of sense-making seem to be at work: an analogous process which acts as a continuous scanning process and a digital process that reduces the continuous stream to discrete slices which can be represented at a virtual level of simultaneity in imagery and representation. The latter process is helpful in organizing the sensory input in chunks with some temporal extension, in the sense that it is more economical for the brain to handle packaged events than to control an amorphous mass of separate minuscule events (Kühl, 2008, p. 107). According to such a theory of chunking the brain produces representations of a certain size in order to reduce or compress the sensory input to a format that is manageable for higher cognition. It represents, so to say, a meeting point between perception and experience, allowing to conceptualize the incoming events by transforming the perceptual flow of evens into significant wholes. This is, in nutshell, also the event perception hypothesis (Gibson, 1966, 1977; Bransford & McCarrell, 1977; see also Reybrouck, 2005), which claims that there is no clear dividing line between the units of perception and memory, with this distinction that they are fast in perception and slow in memory (Bartlett, 1984). Event perception, in this view, can be considered as a kind of top-down processing of the music with schematic or conceptual units that are imposed on the continuous unfolding of the sounds (Godøy, 2008).

5 Conclusion and Perspectives

Traditional approaches to musical sense-making have espoused mostly a logocentric point of view. By relying on verbal or symbolic descriptions, however, they often have neglected the richness and fullness of sensory perception. Verbal labels, though useful, are characterized by a disembodied and detached stance to the sonorous articulation. They are discrete-symbolic rather than analog-continuous. Musical semiotics, on the other hand, has seen recently a paradigm shift, stressing the experiential and dynamic approach to musical sense-making (Maeder & Reybrouck, 2015, 2016, 2017), with a corresponding shift from a structural description of the musical “work” to a “process-like” approach to the musical experience. This experiential approach echoes the earlier theoretical contributions by pragmatic philosophers as Dewey and James, but it has also received new impetus from the pragmatic turn in semiotics and philosophy (Bernstein, 2010; Cram, 2009; Egginton & Sanbothe, 2004; Parret, 2011; Ralston, 2011; Rorty, 1982). Central in this approach is the insight that most of the important themes in the philosophy of the past 150 years are variations and developments of ideas that were developed already in the work of pragmatic philosophers such as Peirce, James, Dewey and Mead. Pragmatic thinkers reject strongly the sharp dichotomy between subject and object—the body-mind dualism advocated so strongly in Cartesian philosophy—, in favor of an approach that goes beyond a representationalist epistemology or spectator theory of knowledge. As such there has been a rapprochement between the continental tradition of semiotics, with a principal orientation to the schools of de Saussure and Hjelmslev and the Anglo-Saxon tradition which was oriented primarily to the theoretical framework of the American pragmatic philosophers. Applied to music, this means, that meaning cannot merely be defined in terms of ontological categories, but rather in terms of dispositions to react to the stimulias well as ongoing epistemic and physical interactions with the sounds. This is exactly what a dynamic and experiential approach to musical sense-making should stand for. Much is to be expected here from the empirical findings from neuropragmatics (Bambini, 2010; Bara & Tirassan, 2000; Stemmer & Schönle, 2000) and neurophenomenology (Varela, 1996; Lutz et al., 2003), which seem to provide the operational tools to describe the conflation between the subjective and the objective approach to knowledge construction. This is the "hard problem" in the study of consciousness (Chalmers 1995), which addresses the relationship between our subjective experience and the objective bio-physical embodiment—also known as the "explanatory gap" (Levine 1983)—and which states that the relationships between an individual's physical system and his/her subjective properties remain obscure to some extent (Rudrauf et al. 2003).

The field of neuropragmatics is a recent and emergent field that brings together empirical data and overarching principles regarding the brain mechanism that underlie a vast range of pragmatic phenomena. There have been already some studies with regard tolanguage and communication, with a focus on those aspects of meaning and language use that are dependent on the speaker and the addressee as well as other features of the communicative situation, such as inference, the speaker's meaning and intention, the use of common ground, the ways how context contributes to meaning context and the specific language use (Bambini, 2010; Bertuccelli Papi, 2010). As such, it touches issues as subject-specific variables and emotional and embodiment processes, which all point in the direction of a broader view that does not study the processing of object or events in isolation, but in and through the environment in which they emerge.

The neurophenomenological approach, on the other hand, tries to solve the hardproblem in the European tradition of phenomenology by rejecting the fundamental opposition between the objective and the subjective.Varela's neurophenomenology, in particular, has stressed the need to bridge the gap between the biological and the experiential mind (Varela, 1996). By insisting on the concept of experience from the point of view of the subject himself, he has associated the lived experience with cognitive and mental events, thus taking a pragmatic approach to reduce systematically the distance between the subjective and the objective, drawing heavily on the work of philosophers like Husserl, Heidegger and Merleau-Ponty. As such, he has stressed the central role of first-person accounts to cognition and experience rather than relying on a third-person account.

The cognitive sciences, more in general, have seen a recent evolution in favor of a concept of the mind as an emerging property of the functioning of the brain as a sequence of mental states rather than as a mere computational device. The mind, in this view, is to be considered as an evolved control system that governs interactions with the world and with others, and areas like neuropsychology and pragmatics may play a major role in this evolution with methodological groundings in the areas of evolution theory, dynamic systems theory and neurosciences (Bara & Tirassa, 2000). There are, moreover, many converging points between cognitive pragmatics and complex systems theory. Conceiving of the participants of a communicative interchange (e.g. the listener and the music) as complex adaptive systems, it is possible to see their behaviour as a dynamic form of interaction between the participants, and to conceive of it in terms of stable states of organization that result from the dynamics of interactions with external stimuli. The translation to the realm of music, however, still mostly has to be done (Reybrouck, 2016a).

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