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Musical sense-making and the concept of affordance: an ecosemiotic and experiential approach

Mark Reybrouck
KU Leuven - University of Leuven, Belgium
Mark.Reybrouck@arts.kuleuven.be

Abstract
This article is interdisciplinary in its claims. Evolving around the ecological concept of affordance, it brings together pragmatics and ecological psychology. Starting from the theoretical writings of Peirce, Dewey and James, the biosemiotic claims of von Uexküll, Gibson's ecological approach to perception and some empirical evidence from recent neurobiological research, it elaborates on the concepts of experiential and enactive cognition as applied to music. In order to provide an operational description of this approach, it introduces some conceptual tools from the domain of cybernetics with a major focus on the concept of circularity, which links perception to action in a continuous process of sense-making and interaction with the environment. As such, it is closely related to some pragmatic, biosemiotic and ecosemiotic claims which can be subsumed under the general notion of functional significance. An attempt is made to apply this conceptual framework to the process of musical sense-making which involves the realisation of systemic cognition in the context of epistemic interactions that are grounded in our biology and possibilities for adaptive control. Central in this approach is the concept of coping with the environment, or, in musical terms, to perceive the sounding music in terms of what it affords for the consummation of musical behaviour.

Keywords: ecology, biosemiotics, embodied and experiential cognition, sense-making, functional tone, affordance, interpretant, circularity, pragmatism

Introduction

Is music something 'out there', a kind of structure or artefact, that can be dealt with in a static way? Or does it rely on processes which call forth interactions with the sounds? Should we conceive of music users besides the music, and think about music as something which is [392] perceived, conceptualised and enacted upon in order to be meaningful? Is music an ontological category, or a sounding phenomenon that calls forth epistemic interactions with the sounds? And can music be considered as a sonic environment and the music user as an organism that generates music knowledge as a tool for adaptation to the sonic world?
These questions revolve around the ecological concept of *coping* with the (sonic) world (Reybrouck, 2001a, 2005a, b). Musical sense-making, in this view, can be addressed in terms of interactions with the sounds, both at the level of perception, action and mental processing. It is a position that broadens the scope of music research, encompassing all kinds of music and sounds, and going beyond any kind of cultural and historical constraints. Music, in this broadened view, is to be defined as a collection of sound/time phenomena which have the potential of being structured, with the process of structuring being as important as the structure of the music. As such, it is possible to transcend a merely *structural description* of

the music in favour of a *process-like description* of the ongoing process of maintaining epistemic contact with the music as a sounding environment. A central focus, in this approach, is on the role of musical experience and the way how listeners make sense of music as it sounds (see Blacking, 1955; Määttänen, 1993; Reybrouck, 2004; Westerlund, 2002).

Dealing with music: embodied, enactive and experiential claims

The musical experience is multifaceted: it is crucial in the construction of musical knowledge and points in the direction of a processual approach to dealing with music with *embodied* and *experiential cognition* as its major epistemological paradigms. There are, in fact, current conceptual developments in cognitive science which argue for the inclusion of the body in our understanding of the mind (Anderson, 2003; Johnson, 1987; Lakoff, 1987; Lakoff & Johnson, 1980, 1999; Varela, Thompson & Rosch, 1991). As such, it is possible to articulate a plausible and grounded theory which is closely related to theories of cognitive organisation which treat cognition as an activity that is structured by the body which is immersed in an environment that shapes its experience. This *embodied approach* to cognition suggests an alternative basis for cognitive processes in general. It is closely related to *enactive cognition* in emphasising the way that organisms organise their knowledge by interacting with their environemnt and takes an epistemological position of *experiential realism* which grounds our cognitive activity in the embodiment of the actor and the specific context of activity. As such, it understands perception as perceptually guided action and conceives of sensory and motor processes as being fundamentally inseparable, mutually informative, and structured so as to ground our conceptual systems (Varela, Thompson & Rosch, 1991: 173). It also allows the cognisers to explore their environment with their bodies and their senses, correlating multisensory input with bodily experience through elaborate mechanisms of feedback among the sensory and motor apparatus, and with temporary information in the sensory input being matched to motor images of the body in the sensorimotor loop (Todd, 1999).

This experiential approach is very promising and can be translated easily to the realm of music. It fits in with some new emerging fields in music research such as *music as experience* (Määttänen, 1993; Reybrouck, 2004; Westerlund, 2002), *music and emotions* (Juslin & Sloboda, 2001), the *dispositional machinery* for dealing with music and the related question [393] of the *origins of music* and its evolutionary claims (Peretz & Zatorre, 2003; Wallin, 1991; Wallin, Merker & Brown, 2000; Zatorre & Peretz, 2001). Music, in this view, is not merely a set of structures, but something that has inductive power and that involves mechanisms of sense-making and reactive behaviour that are grounded in our biology and our cognitive abilities (Reybrouck, 2005a, 2006a). As such, it challenges traditional approaches and paradigms which run through musicology as a discipline, with a major emphasis on historical research, music analysis and performance studies. The latter, however, have received as yet a lot of empirical support from cognitive sciences with a vast body of literature on the effects of music performance as a skilled activity that requires the simultaneous integration of multimodal sensory and motor information with multimodal sensory feedback mechanisms to monitor performance (Gaser and Schlaug, 2003). Several behavioural, neurophysiological and neuroimaging studies have explored the highly specialised sensorimotor, auditory, visual-spatial, auditory-spatial and memory skills of musicians while performing motor, auditory and somatosensory tasks.

Skilled performance, however, is not the most common way of dealing with music. It is restricted to a minor part of music users in general and can be mastered only after years of special training. It is arguable, therefore, to broaden the experiential approach and to conceive of dealing with music at a more general level of coping with the sounds. 'Dealing with music', then, is to be considered as a generic term that encompasses traditional musical behaviours—such as listening, performing, improvising and composing—, as well as more general 'perceptual' and 'behavioural' categories as exploring, selecting and focussing of attention on the perceptual side, and actions, interactions and transactions with the (sonic) world on the behavioural side. In order to encompass all these behaviours, it is desirable,

further, not to speak of listeners, or performers—as these embrace only some of the possible ways of dealing with music—but of *music users* in general as a broad category of subjects that deal with music by means of one or more of these behaviours.

This broadened approach should address also some weaknesses and shortcomings of the traditional research which are reducible to three major claims: (i) the subject matter of much music research is too narrow in focussing mainly on the western canon of art music; (ii) music research deals basically with second order stimuli, relying on symbolic transcriptions of the music—score analysis is a typical example—rather than on the music as it sounds; and (iii) there is a lack of operational terminology for describing both the music as a temporal phenomenon and the process of dealing with the music (Reybrouck, 2005b).

Introducing the observer: the problem of subjectivity

Conceiving of music in experiential terms places emphasis on the *subjective* and highly *idiosyncratic* responses of individual music users. The latter, in fact can select at will and focus attention to what they consider to be meaningful, somewhat analogous to the claims of *second order cybernetics* which emphasises the role of the knower and observer besides the things or events to be known (Maturana 1978, 1988; Maturana & Varela, 1980, 1986: Pask, 1961, 1992; von Foerster, 1974, 1984). It typically conceives of the observer as a participant [394] and as part of the observed system. As Maturana puts it:

> *"... we are seldom aware that an observation is the realization of a series of operations that entail an observer as a system with properties that allow him or her to perform these operations, and, hence, that the properties of the observer, by specifying the operations that he or she can perform determine the observer's domain of possible observations..."* (Maturana, 1978: 28-29).

Music users, accordingly, are observers who construct and organise their knowledge and bring with them their observational tools. Musical sense-making, then, involves a process of 'semiotisation' of the sonic world and can be subsumed under the field of *ecosemiotics* (Kull, 1998), which studies the semiotic interrelations between an organism and its environment. As such, it calls forth an organism-environment ecosystem (Michaels & Carello, 1981) with semiotic relations which are not totally arbitrary but ecologically constrained: they addresses the world not merely at a physical level of description but in 'functional' terms, stressing the role of interaction between the organism and its environmental world. Organisms, in this view, pick up information which is already part of the (sonic) environment and which affords perceptual significance for the perceiver (Clarke, 2005; Martindale & Moore, 1989; McAdams, 1993; Neisser, 1987, and Reybrouck 2001a for a musical analogy). What matters, in this view, is not merely the world in its objective qualities, but the world as perceived by organisms. It is the hallmark of *ecological perception*, which studies the cognitive and perceptual system in the service of survival and orientation in the environment (Shepard, 1984). As such, it is related to *adaptive behaviour*, which fits in with the claims of biosemiotics as an area of knowledge which describes the biological bases of the interaction between an organism and its environment (Sebeok & Umiker-Sebeok, 1992; Hoffmeyer, 1997a, b).

The ecological approach, further, evolves around the central concept of *affordance* which was introduced by Gibson (1966, 1977, see also Chemero, 2003; Chemero & Turvey, 2007a, b), who stated that animals perceive their environment in terms of what it affords to the consummation of their behaviour. Being defined as the perceived functional significance of an object, event or place for an individual, it points to an important quality of the world, namely that its features are meaningful for an active perceiver. Affordances, however, are not merely subjective qualities. They rely on objective environmental features of the world as well as on perceiver-specific qualities, which are variable and subjective to a great extent. As such they provide a conceptual tool that goes beyond the objective/subjective dichotomy by

claiming that there is no outside standing over against an inside, but only ways to classify experiences (Heft, 2001).

The concept of *functional significance* is of major importance here. It brings together ecological, pragmatic and biosemiotic claims in stressing the importance of sense-making as an act of deliberate attention and epistemic autonomy. Pragmatics, e.g., investigates the relations between sign vehicles and their users and the processes involved in the interpretation of signs. As such, it defines meaning not in terms of ontological categories but in terms of dispositions to react to external stimuli. This sounds mildly behaviouristic, and has furthered the development of functional psychologies which have focussed mainly on the operations of [395] consciousness under actual life conditions rather than attempting to analyse and describe its elementary and complex contents (Angell, 1907).

The first generation of American pragmatists, therefore, were also the first cognitive scientists. They have been very influential in promoting a naturalist approach to experience in general which was based on explanation, justification and scientific methodology. They viewed organisms entirely naturalistically and have noticed how the brain grows and changes in youth and modifies its interconnections throughout the lifetime, explaining how learning consists of acquisition of workable habits for practical success in managing environmental conditions. They judged also that much of the brain's work occurs at nonconscious levels, and denied that cognition consists entirely of internal representations about static external matters (Shook, 2003). As such, they were forerunners of the new emerging field of *neuropragmatics* (Stemmer, 2000).

There is, however, a distinction between *pragmatism* and *realism* (Sharov, 2001). Realists see the world as objective and conceive of ultimate and irreversable knowledge that exists unconditionally and independently from the knower. Pragmatists, on the contrary, conceive of a subjective universe with objects that are not separated from their interpreters. The degree of realism is not absolute but is adjusted to increase the usefulness for the knower, somewhat analogous to von Uexküll's theory of meaning, which considered 'usefulness' to be an essential part of meaning. In contrast, however, to Peircean pragmatics, which interprets signs mostly as mental concepts (interpretants), von Uexküll viewed usefulness as a biological concept which helps an organism to survive in its subjective universe. His influential theory—known as *Umwelt-research*—focusses on the phenomenal world of organisms, i.e., the world around animals as they themselves perceive it, and this is, in fact, an ethological approach. As such, the environment is not a neutral space, but a functional space that receives meaning through interactions that are interpreted differently by each participant depending on its inner model of the surrounding space.

Functional significance and the concept of circularity

The concept of functional significance brings together diverging disciplines such as pragmatics, ecology and biosemiotics and fits in with the general concept of sense-making and the semiotisation of the environmental (sounding) world. It revolves around the concept of *circularity* which links perception to action in a continuous process of sense-making and interaction with the environment. As such, it has a lot of operational power (Reybrouck, 2001a, 2005a) and has received a lot of theoretical grounding and empirical support in recent contributions (Annett, 1995; Arbib, 1981; Berthoz, 1997; Cutsuridis, Hussain & Taylor, 2011; Decety, 1996; Deecke, 1996; Fuster, 1990, 2004; Jeannerod, 1994; Lyons, 2010; Meystel, 1998; Noë, 2004; Paillard,1994a, b; Wagman & Miller, 2003), but the basic claims of circularity have been advocated already in the seminal contributions of von Uexküll and Piaget.

By introducing the concept of circularity, Piaget made a first contribution to supersede the traditional concept of the 'reflex arc' as a linear stimulus-reaction chain in favour of a basic principle of sensorimotor learning that goes beyond pure reactivity to sensory stimulation: a situation as it is perceived leads to an activity that is evaluated in terms of its beneficial or [396] expected results (Piaget, 1937, 1945, 1967). Reflexive action, as he conceived of it,

essentially consists of three parts: (i) a pattern of sensory signals (the stimulus), (ii) an activity which is triggered by the particular pattern of sensory signals (the response) and (iii) the experience of some change which is registered as the consequence of this activity and which turns out to be beneficial for the actor. The parts, taken together, build up an *action schema* which increases the internal organisation of the organism, allowing it to act in the face of perturbation.

Piaget probably had no contact with the work of Jakob von Uexküll. There is, however, a certain similarity between von Uexküll's concepts of *Merkwelt*—the world of sensing—and *Wirkwelt*—the world of acting—and Piaget's notion of the 'sensorimotor level'. Both authors were profoundly influenced by Kant's insights that whatever we call knowledge is necessarily determined to a large extent by the knower's way of perceiving and conceiving (von Glasersfeld, 1995: 55; Deely, 2004). The fundamental analogy, however, lies in the concept of circularity. von Uexküll, e.g., has elaborated on the concept of sensorimotor integration which he labeled as *functional cycle* or *functional circle* (Funktionskreis) and which describes the basic structure of the interactions between the human and animal organisms and the objects of their surrounding worlds. These interactions consist principally of two acts:

> *"Figuratively speaking, every animal grasps its object with two arms of a forceps, receptor and effector. With the one it invests the object with a receptor cue or perceptual meaning, with the other, an effector cue or operational meaning. But since all of the traits of an object are structurally interconnected, the traits given operational meaning must affect those bearing perceptual meaning through the object, and so change the object itself."* (von Uexküll, 1957 [1934]: 10)

This 'circularity' of stimulus and reaction is a central attribute of epistemic interactions with the world. It means that every stimulus presupposes a readiness to react, and that this readiness 'selects' as a stimulus a phenomenon of the environment which had been neutral up to that point. The stimulus, then, must realise the reaction, and the reflexive action can only be described as a circular event, in which a neutral phenomenon receives a property which it does not have independently from the reacting organ, and which it loses again after the completion of this action. Circularity of stimulus and reaction, therefore, has two meanings: (i), there can be no stimulus without the readiness to react and the stimulus ceases to be a stimulus with the cessation of the readiness to react,, and (ii) without a stimulus there can be no reaction (T. von Uexküll, 1986: 122-123).

The concept of circularity, further, is closely related to the conceptual framework of *cybernetics*, which brings together concepts as different as the flow of information, control by feedback, adaptation, learning and self-organisation (see Bateson, 1978[1973]; Brier, 1999; Cariani, 2003). As a unifying discipline, it provides a common language for the description of adaptive behaviour in general. Starting from the common concept of *(epistemic) control system*, it embraces the four major elements of adaptive control—perceptual input, effector output, central processing and feedback—, relying on perception, action and the mutual relations and coordinations between them as their functional counterparts. It is, in fact, a [397] central metaphor of cybernetics that there is a cyclic image of brain and environment, where internal sets of feedback loops themselves have feedback connections to the environment and are completed through it (Cariani, 2001; Cutsuridis, Hussain & Taylor, 2011; McCulloch, 1989). As such, the concept stresses such important things as input-output correlations, the mappings between sensory input and motor output, the computations at the representational level of the brain and the role of feedback. The latter, especially, is an interesting extension of the linear stimulus-reaction chain: it substitutes a *closed loop* for an *open loop* and challenges the mere reactive approach to sensory stimulation (open loop) in favour of a dynamic concept of *circularity* (closed loop) which brings together perception and action in a continuous process of sense-making and interaction with the environment. What matters, therefore, are not merely the actions proper but also their results.

Semiotic and pragmatic claims: the legacy of Peirce, Morris and James

The concept of circularity brings us to the pragmatic claims of Peirce who defined meaning in a rather retrospective way, from effect to causes. This is, in a sense, the core of his *pragmatism* or *pragmaticism* which defines the meaning and truth of any idea to be the result of its practical outcome or "conceivable sensible effects". In what has become known as one of his most famous definitions of pragmatics, he emphasises the role of the cogniser as an active participant in the process of semiosis:

> *"Consider what effect that might conceivably have practical bearings you conceive the objects of your conception to have. Then, your conception of those effects is the whole of your conception of the object."* (Peirce, 1905: 481)

Peirce's conceptions have shaped, to some extent, the functional and pragmatic philosophy of Dewey and James. Dewey (1958 [1934]), in particular, has stressed the role of having an experience and James (1976 [1912]) has elaborated on the distinction between percept and concept, stressing the role of knowledge-by-acquaintance—as the kind of knowledge we have of a thing by its presentation to the senses—and the richness of the full sensory experience. In an original epistemology which he has coined as *radical empiricism*, he states that the significance of concepts consists always in their relation to perceptual particulars. What matters is the fullness of reality which we become aware of only in the perceptual flux. Conceptual knowledge is needed only in order to manage information in a more 'economical' way. As such, it is related to principles of cognitive economy:

> *"It is possible ... to join the rationalists in allowing conceptual knowledge to be self-sufficing, while at the same time one joins the empiricists in maintaining that the full value of such knowledge is got only by combining it with perceptual reality again.*" (James, 1911b: 237)

Knowing, in this view, is as an ongoing process of continuously evaluating what is known against what is currently experienced, and as revising or updating the known with respect to inconsistencies relative to immediate experience. What is known, therefore, is only a [398] temporary and imperfect resolution to a question of fit between an adaptive agent and environmental structure (Heft, 2001: 381). As James puts it:

> *"We extend our view when we insert our percepts into our conceptual map. We learn about them, and of some of them we transfigure the value; but the map remains superficial through the abstractness, and false through the discreteness of its elements; and the whole operation, so far from making things appear more rational, becomes the source of quite gratuituous unintelligibilities. Conceptual knowledge is forever inadequate to the fulness of the reality to be known. Reality consists of existential particulars as well as of essences and universals and class-names, and of existential particulars we become aware only in the perceptual flux. The flux can never be superseded.*" (James, 1911a: 245)

Pragmatism, which can be considered as radical empiricism's companion theory of truth, attempts to deal with the problem of meaning. Prompted by Peirce's proposals, James argued that the meaning of a concept, resists in the practical and ideational consequences that result from utilising it. A simple application of his pragmatism is *operationalism*, which had a significant influence on behaviourism as it developed with the meaning of a concept devolving entirely on how it is measured or otherwise assessed (Heft, 2001: 21).

Pragmatics, however, did not start with Dewey and with James. It was Peirce who set the stage. Being considered as the founder of philosophical pragmatism, he argued that all cognition is irreducibly triadic, with signification occurring in a triadic relation of a sign or

sign vehicle that points to an object by invoking an interpretant which is merely another sign developed in the mind of an interpreter (Peirce, 1965: section 6.347). Cognition, in this view, is of the nature of a sign, it is fallible, and thoroughly immersed in a continuing process of interpretation.

Peirce considered his 'semeiotic'—as he spelled it—as an inclusive term for all the various studies of signs. Signs, however, can be studied at different levels of semiotic functioning with a major distinction between syntactics, semantics and pragmatics. It was Morris, who elaborated on this distinction in providing an operational description of the levels of semiotic functioning and of the semiotic process in particular:

> *"One may study the relations of signs to the objects to which the signs are applicable. This relation will be called the semantical dimension of semiosis [....]. Or the subject of study may be the relations of signs to interpretors. This relation will be called the pragmatical dimension of semiosis [...] and since all signs are potentially if not actually related to other signs, it is well to make a third dimension of semiosis co-ordinate with the other two which has been mentioned. This third dimension will be called the syntactical dimension of semiosis ..."* (Morris, 1975 [1938]: 6-7)

Up to now, musical semiotics has focussed mainly on syntactics and semantics. Music, however, has inductive power as well. Musical sense-making, therefore, should encompass also the *effects* music can have on music users. This is obviously the 'pragmatic' dimension of music, considered as a sign or a collection of signs as related to its interpreters.

Musical semiotics, in this view, should be the science of musical signs with music users being considered as subjects that respond to 'signs' rather than to 'causal stimuli'. This is a [399] major claim of semiotic functioning: it stresses the emancipation from mere causality and time-bound reactivity to ever wider realms of spatio-temporal freedom and epistemic autonomy (Cariani, 1998: 243). Signs, however, are rather general and abstract in representing sounding reality. Music, on the other hand, is a sounding art, with the sonorous articulation as its primary category. The problem, therefore, is a possible tension between a general description of music at an abstract-symbolic level and the idiosyncrasies and particularities of the music as it sounds.

Semiosis and the concept of interpretant: an operational approach

Music is a sound-time phenomenon. It has the potential of being structured by music users, with levels of processing that range from direct reactivity to more elaborate reactions to the sounds. It is possible, therefore, to conceive of musical sense-making in terms of epistemic interactions with the sounds.

Starting from the music as it sounds, music users can delimit configurations and assign to them the status of signs. The result is a semantical system with signs as basic elements that build relations between signifying 'means' —i.e. the material sign vehicles—and their signified 'objects'. In building such a system one can proceed in a way analogous to the building of 'syntactic systems': defining elements with elementary meaning, putting them together in a basic set and formulating rule systems for defining signs and combining them to supersigns. Such a way of proceeding is classical in stating that meanings are static, discrete and objective. It is lacking, however, in not providing communicative interaction between the parties of a referential exchange. A transclassical model, therefore, defines the elements as subjective, process-like and non-discrete (Maser, 1977). As such, it is related to Morris' process of semiosis, which can be defined in operational terms:

> *"Semiosis (or sign process) is regarded as a five-term relation - v,w,x,y,z, - in which v sets up in w the disposition to react in a certain kind of way, x, to a certain kind of object, y (not then acting as a stimulus), under certain conditions,*

> *z. The v's, in the cases where this relation obtains, are signs, the w's are interpreters, the x's are interpretants, the y's are significations, and the z's are the contexts in which the sign occurs."* (Morris, 1964: 2)

This 'pragmatic' approach to sense-making brings us to Peirce's notion of *interpretant* as an important operational tool in the actual description of the process of semiosis that goes beyond the dyadic Saussurian distinction between *signifier* and *signified.* Semiosis, in Peirce's view, entails a 'triadic' relation between a sign (sign vehicle or representamen), an object and an interpretant, each of them being relationally interconnected:

> "*A Sign, or Representamen, is a First which stands in such a genuine triadic relation to a Second, called its Object, as to be capable of determining a Third, called its Interpretant*." (Peirce, 1960 [1902]: 156**)**

And further:

> "*A sign, or representamen, is something which stands to somebody for something in some respect or capacity. It addresses somebody, that is, creates in the mind of that person an equivalent sign, or perhaps a more developed sign. That sign which it creates I call the interpretant of the first sign."* (Peirce, 1960 [1897]: 135)

[400] Smoke is an example. It is a sign (or sign vehicle) that refers to fire as an object and the idea of fire is an interpretant. Another example is depicted in figure 1 which provides a rather loose interpretation of Peirce's ontological categories of firstness, secondness and thirdness (Peirce, 1958 [1904]): 220). The footprints of the girl can be considered as signs of the feet which are the object. The young man who is looking at the footprints can have a mental image of the connection between the object (feet) and the signs (footprint) and this is an interpretant. The process of semiosis is clearly exemplified in showing levels of representation that can be labeled as firstness or actual things as things (the feet of the girl, the footprints), secondness (physical causation between object and sign) and thirdness (signification process that interprets both firstness and secondness).

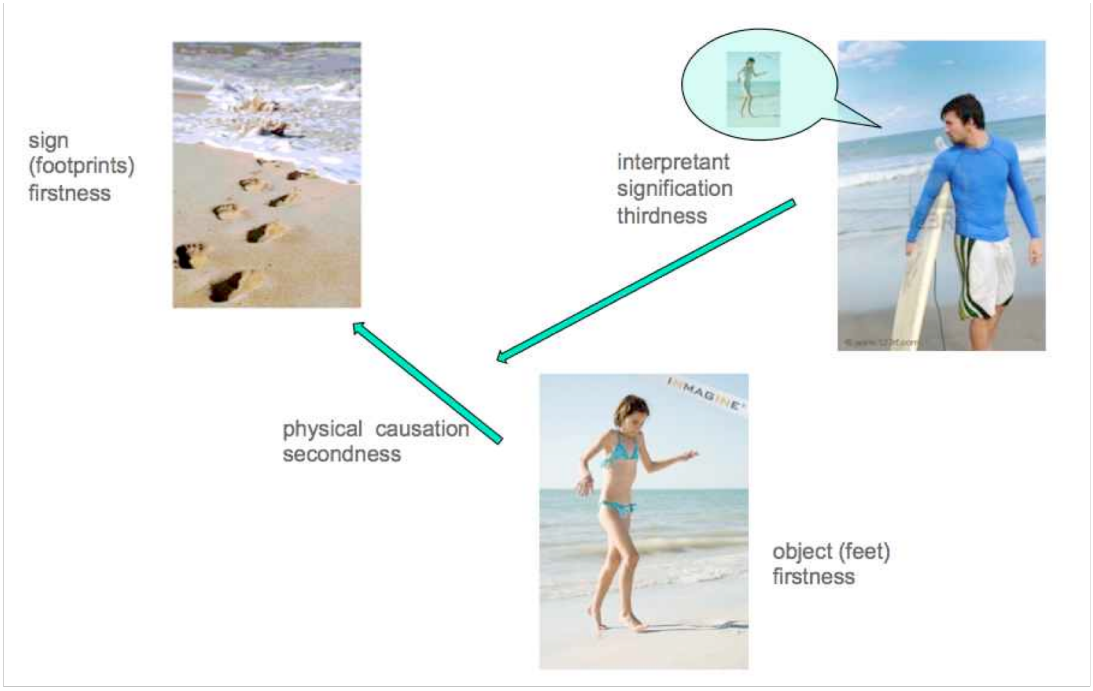

Figure 1. The triadic sign function of Peirce.

This triadic sign function can be easily applied to music. Sounds, in this view, are not considered as objects (firstness) but as signs (secondness) that refer to something that has caused them and that can be interpreted by music users (thirdness). It is an important conceptual transition that fits in with Peirce's pragmatic claims which state that the whole problem of meaning is not reducible to the study of the sign or sign vehicle but to the study of the sign user or interpreter and his/her disposition to react:

> *" ...the problem of what the meaning of an intellectual concept is can only be solved by the study of the interpretants, or proper significate effects of signs."* (Peirce, 1965 [1907]: 326).

The concept of interpretant, further, has a lot of operational power and has been elaborated in depth by Peirce and Morris. Peirce, especially provided a wealth of subdivisions that entail e.g. a kind of feeling (emotional interpretant), a muscular or mental effort (energetic [401] interpretant) or a mental effect that acts as a habit-change or modification of a person's tendencies toward action (logical interpretant) (Peirce, 1965 [1907]: 326-328). There are even further subdivisions, such as the direct effect actually produced by a sign upon its interpreter (dynamical interpretant), the effect that is produced at a virtual level only (final interpretant) and the total unanalysed effect that the sign is calculated to produce upon a mind without any reflection upon it (immediate interpretant). All these distinctions show unmistakably the very complex character of the interpretant, which has been defined by Morris as *"a disposition to react in a certain kind of way because of the sign*" (Morris, 1964: 6).

The ecological and biosemiotic approach: affordance and functional tone

Dispositions to react to sounding stimuli as signs are highly idiosyncratic and complex. They shape the human-environment interaction and are crucial in the semiotisation of the sonic world. As such, they entail a process of sense-making that can be described in *ecological* terms. Ecology, in fact, was coined by Haeckel as "*the science of the relations between the organisms and the environmental outer world"* (Haeckel, 1988 [1866]: 286). The related term of *ecosemiotics* can be defined accordingly as the study of the semiotic interrelations between organisms and their environment (Kull, 1998).

This brings us to the role of interactions with the environmental, outer world, which is, in a way, the hallmark of ecological perception. A basic claim is that a full description of perceiving cannot be given by analysing either the organism or its environment (organism-environment dualism) but only by considering the mutualism of organism and environment (reciprocity). What is needed, therefore, is an approach which is not animal-neutral but which treats the environment as perceived.

This program was mapped out by Gibson (1966, 1979) who provided a wealth of conceptual tools to describe the perceptual process in ecological terms. He claimed that perceivers rely on mechanisms of information *pickup* and information *extraction* by searching actively for useful information. They 'search out' information which is already part of the environment and which affords perceptual significance for them. As such it is possible to conceive of 'perceptual systems' which are 'tuned' to the information that is considered to be useful. Hence the role of key concepts as *attunement*, *reciprocity* and *resonance* and the corresponding perceptual processes of *detection*, *discrimination*, *recognition* and *identification*. They remind us of Mead's conceptions about cognition as:

> *"... a development of the selective attitude of an organism toward its environment and the readjustment that follows upon such a selection. This*

> *selection we ordinarily call 'discrimination', the pointing-out of things and the analysis in this pointing*." (Mead, 1936: 350)

This selective pickup of information is done mostly without the mind intervening in this process, involving a bottom-up approach to music cognition, and stressing the role of knowledge-by-acquaintance and the extraction of information from the sounding flux. The same information, however, can be processed also in a top-down approach, by applying conceptual knowledge that has been assimilated in the cognitive structure of the music user as [402] the outcome of previous interactions with the sounds. Ecological perception, therefore, holds a somewhat hybrid position with respect to the nature of the processing in relying both on a bottom-up and top-down approach.

Music perception, accordingly, can be conceived in terms of organism-environment interaction and the related notion of *coping* with the sounding world. Music, then, can be considered as a challenging environment and the music user as an organism that must adapt itself to cope with this environment. There is, however, not yet a major tradition of thinking of music in ecological terms (see Clarke, 2005; Gaver 1993a, b; Reybrouck, 2005a, b). Most studies in ecological perception have been concerned with visual rather than with auditory stimuli. Yet, some basic claims are likely to be relevant for auditory perception as well. This holds true for the concept of direct perception and the related concept of affordance: The former holds that perception is a form of noninferential awareness without the mind intervening in the process. The latter is one of the central concepts of Gibson's ecological psychology. It refers to environmental supports for an organism's intentional activities by claiming that animals—and by extension also human beings—are sensitive to the functional characteristics of their environment:

> "*The affordances of an environment are what if offers the animal, what it provides or furnishes, either for good or ill*." (Gibson, 1979: 127)

Animals thus perceive environmental objects in terms of what they 'afford' for the consummation of behaviour rather than in terms of their objective perceptual qualities (Gibson, 1966, 1979). Numerous examples can be given: the surface of water as support to run across for water striders, storks that nest on top of chimneys or street lighting columns, and swallows using nails extending from an outer wall to function as support for nesting. As such, these 'affordances' are subjective qualities that render the environment apt for specific activities, such as supporting locomotion, concealment, manipulation, nutrition and social interaction for the animal. They are, however, 'real' and 'objective' qualities as well. As Gibson put it:

> "*An important fact about the affordances of the environment is that they are in a sense objective, real, and physical, unlike values and meanings, which are often supposed to be subjective, phenomenal, and mental. But, actually, an affordance is neither an objective property nor a subjective property: or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer."* (Gibson, 1979: 129)

von Uexküll argued in similar lines when he considered the particular qualities or *functional tones* of objects. A tree, for example, has different qualities with respect to the respective 'Umwelten' or subjective universes of animal and human beings that confer qualities on it: the tree can be a shelter for the fox, a support for the owl, a thoroughfare for the squirrel, it can provide hunting grounds for the ant, or egg-laying facilities for the beetle, and can be a source of valuable raw material for the forester (von Uexküll, 1957 [1934]: 73-79).

Each animal thus moves within its habitat and confronts a number of objects, with which it has a narrower or wider relationship. The objects mostly are not neutral objects, since they are [403] tranformed into meaning-carriers as soon as they enter into a relationship with a subject. This is illustrated most clearly by von Uexküll's example of an angry dog that barks at somebody on a country road. In order to drive the dog away, the person can pick up a stone to throw it at the dog. The stone which first lays on the ground is the same object when thrown. None of its physical or chemical features have been altered and yet, a fundamental transformation has taken place: it has changed its meaning. As long as the stone was incorporated in the country road, it served as a support for the walker's feet and its meaning layed in playing a part in the performance of the path. Hence it had acquired a 'path-quality'. This changed fundamentally, however, when the stone was picked up to throw it at the dog. The stone became a missile and a new meaning became imprinted on it: it had acquired a 'throw-quality' (von Uexküll, 1982 [1940]: 27).

The example shows the importance and primacy of *functional relations*. It is a major claim of Gibson's ecological psychology which has been stressed also by Michotte who stated that objects are experienced ultimately in terms of their functional significance for possible activities. As such, it is not fruitful to study perception in itself. Perception, on the contrary, must be treated as a phase of action in relation to the motor and intellectual activity of individuals. An object only affects behaviour in so far as it has meaning, and this only arises from its functional relations to the other objects, be they spatial or temporal relations, or relations of causality or purposiveness (Costall, 1991: 54).

This functional approach can be found also in research on *categorisation* that stresses the importance of goal-directed activities (Dubois, 1991; Mazet, 1991). Typical in this approach is the duality of perceptual pregnancy and functional signification as organisational principles of categorisation. The functional properties, then, can be expressed on the basis of the linguistic expression 'for + verb' (e.g. a chair is 'for sitting down') and on the basis of what language theorists have called their *activity signature*. It is possible, for example, to study the muscular habits associated with the word 'chair' (what the body normally goes through to sit down and to get up) and to find these motor habits to be helpful to define the concept of chair, to distinguish it from other objects that can be sat on (Beck, 1987).

The concept of 'activity signature' is related to Gibson's notion of affordance, which was basically concerned with the question how organisms have evolved to respond directly to opportunities for action. Gibson stated that the energy that reaches an organism's sensory systems is richly structured by the objects and events encountered in the environment and that the sensory systems should be able to directly detect the invariants of that structure. These invariants, further, specify unambiguously what is to be found in the environment and what the organism needs to know in order to act adaptively. Affordances, therefore, are important types of *invariants* that indicate where actions with important outcomes should be possible (Pickering, 2007). As such, they are signs to organisms that actions are possible, or stated in another way, they are behavioural meanings of the environment for particular organisms.

Musical affordances

It is tempting to apply these insights to the realm of music and to conceive of music not merely in terms of its acoustic qualities but in terms of what it affords to music users. The question, then, is what these 'musical affordances' are? There seem to be three major [404] possibilities, which are all related to the activity signature of musical sounds: (i) the production of musical instruments out of sounding material, (ii) the development of playing techniques in order to produce musical sounds, and (iii) the shaping of the sound by using modulatory techniques.

Examples of the first possibility are rather common. The whole history of *musical instrument building*, e.g., is one prolonged search for applying craftmanship to raw materials in order to obtain musical sounds. About all kinds of materials have been scrutinised for what they afford to human ears from a musical point of view. This holds true for traditional

instruments as well as for the many attempts at finding new sounds out of new materials (Reybrouck, 2006b.)

The development of *playing techniques* is also related to the search for sounding materials, with a special focus on the sound-producing actions that can be applied to them. These can be singular actions like hitting, stroking, kicking and blowing as well as more complex or compound ones, such as drumming a rhythmic pattern or sliding up and down a melodic contour. But even the metaphors used in talking about music refer to sound-producing actions (slow, fast, up and down, ...) and the same applies to many musical terms like martellato, leggiero, tenuto and legato (Godøy, 2001).

The *shaping of the sound*, finally, is a further extension of sound production. Strings, e.g., can be plucked or bowed, but within the action category of bowing, there is a whole spectrum of techniques for modulation of the sound. The same holds true for a singer who uses his/her technique to shape the sounds that result from the air supply provided by the lungs. Singing involves not merely the production of vowels and consonants: it involves aspects of intonation and common ways of emotional expression such as timing, articulation, dynamics, tone onsets and vibrato. It embraces, for short, the whole gamut of sentic modulation (Clynes, 1977) with the three graded spectra of tempo modulation, amplitude modulation and selection of register.

All these examples refer to the *productive aspects* of musical affordances. They take as a starting point the raw material and what it affords for musical sound production. It is possible, however, to go beyond this productive level and to conceive of affordances also at the *receptive level* of experience. Affordances, in this extended view, embrace perceptual qualities, mood induction qualities and socio-communicative qualities, invoking aspects of sense-making, emotional experience, aeshetic experience, entrainment and judgments of value (Krueger, 2009, 2011; Windsor, 2004).

It is possible, finally, to bring together productive and experiential aspects of musical affordances as exemplified in the huge body of *action and perception* studies (see Gabrielsson, 1987; Repp & Miller, 2003). Music, in this view, is something that induces a kind of (ideo)motor resonance that prompts the listener to experience the sounds as if he/she is involved in their production (Reybrouck, 2001b). This is a claim which is somewhat analogous to the central version of the *motor theory of perception*, which means that motor 'intention' rather than manifest motor behaviour, is thought to be a largely endogenous phenomenon which is localised in the 'central' nervous system. As such, it has been shown that there is a motor aspect in perception and that the same areas in the brain are activated during imagined and executed actions. Perception, in fact, involves the same neural substrates as action (the supplementary motor area) and the same holds true for imagined action (Annett, 1996; Berthoz, 1996, 1997; Decety, 1996; Di Pellegrino, Fadiga, Fogassi, Gallese, & [405] Rizzolatti,1992; Jeannerod, 1994). Perception, therefore, can be considered as simulated action, as imagining the actions that are implied in manipulating the perceived objects.

Not all perception, however, is reducible to motor components, but motor components are involved in perception and are an integral part of it (Mahon, 2008; Noë, 2004). Even if they are not manifest, they operate at virtual levels of imagery and simulation—also called *ideomotor simulation*—with motor behaviour being manifest only at an ideational level of mental representation. As such, it is possible to conceive of music also in terms of its 'activity signature' with at least five major possibilities: (i) the sound producing actions proper, (ii) the effects of these actions, (iii) the possibility of imagining the sonorous unfolding as a kind of movement through time, (iv) the mental simulation of this movement in terms of preconceptual bodily experiences or bodily based image schemata and (v) the movements which can be possibly induced by the sounds.

There is, however, a distinction between the action aspects of sound production that can be described in an objective way and what they afford to the listener. To conceive of music in terms of experience involves at least an aspect of egocentricity, in describing subjective experiences in terms of bodily resonance or motor imagery that projects our bodily movements to the music. This bodily projection, further, is rather complex, as the music can be conceived as the mover with the listener as a still spectator (Kramer, 1988), but the listener

can move as well, keeping step with the music as it proceeds in real time or navigating through the music in a kind of mental map that is constructed on the basis of memory and mental representation. The music user, then, is moving in a kind of virtual space, sowewhat analogous to the audio tools in a sound editing program which allow the listener to move fast forward, to rewind or stop at will (see Reybrouck, 2004, 2009, 2010).

What is argued for, therefore, is a kind of phenomenal experience which involves the experience of movement but without the action being actual or manifest. It corresponds to the so called *internal imagery*—or first person perspective—which enables the transition from overt action to internalised forms of action. The whole process calls forth a kind of *motor empathy* and *ideomotor simulation*, allowing the listener to experience the music as something that moves over time, while simultaneously experiencing this movement as a movement of the own body (Reybrouck, 2001b).

A last interpretation of music in terms of affordances, finally, is more manifest and involves musical *entrainment* and the possibility to move in reaction to the sounding music. Music, then, is a stimulus for movement and is perceived in terms of its *motor induction capacities*. The movements can be specific and articulate, but they can relate also to more general levels of motor induction, as 'forces' and 'energies' that are inherent in musical structures which, in turn, account for our perception and imagination of tension, resolution and movement.

Conclusions and perspectives

Conceiving of musical sense-making in ecological terms has a lot of operational power. Especially the concept of affordance is promising as a topic for future empirical research as it sees perception as related with action (Prinz & Bridgeman, 1995; Warren, 2006). There is, in fact, a growing body of neurophysiological research that stresses the importance of this coupling (Berthoz, 1997, 1999, and for the domain of music: Gromko & Poorman, 1998; Mikumo, 1994; Repp & Knoblich, 2007; Todd, 1999). But also the ecological approach to perception and action is very promising (Shaw & Turvey, 1999; Michaels & Carello, 1981). It sees psychology as continuous with the natural sciences and has been elaborated in depth by the Connecticut Tradition (Center for the Ecological Study of Perception & Action at the University of Connecticut) which aimed at identifying general principles at the ecological scale of action and perception which pose new and exciting challenges to be met by the development of novel tactics within an inter-disciplinary framework.

As such, there is up to now a considerable body of research that has addressed the ecological concept of affordances. Most of this research, however, has focussed on visual perception and motor behaviour. The question remains, therefore, whether this research can be translated also to the realm of music in an attempt to bring together action and perception. Music, in fact, has an activity signature and music cognition seems to be also the outcome of interactions with the sounds, both at an actual and virtual level.

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