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A BIOSEMIOTIC AND ECOLOGICAL APPROACH TO MUSIC COGNITION: EVENT PERCEPTION BETWEEN AUDITORY LISTENING AND COGNITIVE ECONOMY

ABSTRACT. This paper addresses the question whether we can conceive of music cognition in ecosemiotic terms. It claims that music knowledge must be generated as a tool for adaptation to the sonic world and calls forth a shift from a structural description of music as an artifact to a process-like approach to dealing with music. As listeners, we are observers who construct and organize our knowledge and bring with us our observational tools. What matters is not merely the sonic world in its objective qualities, but the world as perceived. In order to make these claims operational we can rely on the ecological concept of coping with the sonic world and the cybernetic concepts of artificial and adaptive devices. Listeners, on this view, are able to change their semantic relations with the sonic world through functional adaptations at the level of sensing, acting and coordinating between action and perception. This allows us to understand music in functional terms of what it affords to us and not merely in terms of its acoustic qualities. There are, however, degrees of freedom and constraints which shape the semiotization of the sonic world. As such we must consider the role of event perception and cognitive economy: listeners do not perceive the acoustical environment in terms of phenomenological descriptions but as ecological events.

KEY WORDS: adaptation and adaptive control, cognitive economy, coping behavior, ecosemiotics, enactive and experiential cognition, epistemic control system,
event perception, listener–environment interaction, musical epistemology

1. INTRODUCTION: FROM STRUCTURAL DESCRIPTION TO COPING WITH THE SONIC WORLD

[229] This paper is about musical epistemology. It addresses the question whether we can conceive of music cognition in biosemiotic and ecological terms. The question is tedious, as music processing is a skilled activity which is dependent on several higher functions of the brain. It embraces activities as different as listening, performing and even composing or improvising and offers an unrivaled opportunity to investigate the neural correlates of skill acquisition besides unique abilities as the recognition of absolute pitch or musical sight-reading. [230] There is a vast body of literature on the effects of music performance as a skilled activity which requires the simultaneous integration of multimodal sensory and motor information with multimodal sensory feedback mechanisms to monitor performance (Gaser and Schlaug 2003). Several behavioral, neurophysiological and neuroimaging studies have explored the highly specialized sensorimotor, auditory, visual-spatial, auditory-spatial and memory skills of musicians while performing motor, auditory and somatosensory tasks, and the search for ‘‘anatomical markers’’ of these extraordinary skills has resulted in findings which are at least fascinating: there are ‘‘functional’’ and ‘‘structural’’ differences between the brains of musicians and non-musicians which are illustrative of the neural plasticity and structural adaptation of brain tissue in response to intense environmental demands during critical periods of brain maturation (Gaser and Schlaug 2003). Music processing, further, is also related to language development, human communication, brain development and evolution (Besson and Schon 2001; Gray et al. 2001). It is legitimate, therefore, to consider the biological bases of dealing with music.

Music, as a ‘‘man-made construction’’ or ‘‘artifact’’, however, is biologically non-relevant: there is no causal relation between the music as a stimulus and any direct reaction to this stimulus. Music as a ‘‘physical stimulus’’ or ‘‘sound’’, on the contrary, is able to elicit reactions which can be explained in physiological and biological terms (Reybrouck 2001a; Martinelli 2002; see also the extensive literatureon music therapy and biosemiotics). The reactions can be either direct or cognitively mediated, with a gradual rather than a qualitative distinction between the processing of ‘‘sound’’ and ‘‘music’’. It allows us to conceive of music as part of the sonic environment and of listening as a way of coping with this environment. Listening, on this view, relies on music knowledge that must be generated as a tool for adaptation to the sonic world and that involves listening strategies which are the outcome of interactions between the listener as an organism and the music as environment. This ‘‘interactional’’ approach is a core assumption of the ecological approach to cognition, and is somewhat opposed to the scientific persuasion that the world can be described in a language that is incommensurable with our experiences. As such, it entails a transition from a structural description of the music to a process-like approach to coping with the sonic world.

[231] Arguing on these lines, we can conceive of the process of listening as establishing ‘‘semiotic relations’’ between an organism and its environment. This is an ecosemiotic position (for a critical definition, see Kull 1998b) with the listener – as an organismus semioticus (Nöth 1998) – showing adaptive behavior in his or her interactions with the music as environment (Reybrouck 2001c). The example of a musician who plays a violin is illustrative at his point: in order to produce a beautiful sound he relies on sensory–motor integration, ‘‘shaping’’ the sound through the perception of the sounding result which must match the internalized representation of this sound. Sound production, on this view, entails the reciprocity of ‘‘doing’’ and ‘‘undergoing’’,
as stressed already in the pragmatic philosophy of Dewey:

> In short, art, in its form, unites the very same relation of doing and undergoing, outgoing and incoming energy, that makes an experience to be an experience … The doing or making is artistic when the perceived result is of such a nature that its qualities as perceived have controlled the question of production. … The artist embodies in himself the attitude of the perceiver while he works. (1934, p. 48)

The reciprocity of doing and undergoing is typical of sensory–motor integration. This is obvious in ‘‘playing’’ music, but it applies also to the process of ‘‘listening’’, with the listener imagining or simulating mentally the manifest movements of the players (see Delalande 1984; Lidov 1987). There is, in fact, empirical evidence that motor imagery and motor execution involve activities of very similar cerebral motor structures at all stages of motor control (Crammond 1997). It allows us to stress the continuity between ‘‘sensory–motor integration’’ an ‘‘ideomotor simulation’’, the former dealing with movements that are actually executed in real-time, the latter with movements that are simulated at an ideational level of motor imagery (Paillard 1994b; Reybrouck 2001b).

2. FROM CYBERNETICS TO SEMIOTICS

To conceive of music cognition in terms of coping behavior is an epistemological position that deals with music in ‘‘behavioral’’ terms. Several options are possible here – playing, listening, composing, improvising – but the focus of this paper is on the process of listening as a kind of interaction with the sonic world. This calls forth a processlike approach to dealing with music which can be described in terms of ‘‘experiential’’ and ‘‘enactive’’ cognition – both terms will be explained throughout this paper – which, in turn, can be described [232] in operational terms that rely on the concept of control system (see Figure 1). It embraces the four major elements of adaptive control – input, output, central processing and feedback – and provides a common language for the description of adaptive behavior in general, leaning heavily on the conceptual work of cybernetics and artificial devices.

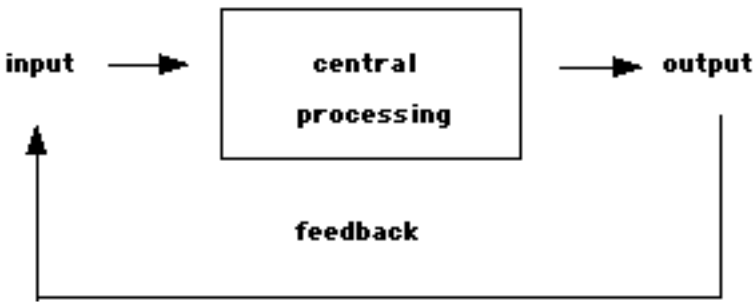

Figure 1. The basic schema of a control system with the four major moments of adaptive control.

2.1. The control system as a starting point

Cybernetics is a unifying discipline which brings together concepts as different as the flow of information, control by feedback, adaptation, learning and self-organization (see Bateson 1973; Brier 1999a, b; Cariani 2001a). It allows us to conceive of devices which behave as ‘‘autonomous agents’’ which, according to Emmeche [are not only] input-output devices, but [which] move around as cybernetic systems by their own motor modules guided by sensors, making decisions, having the capacity of acting more or less intelligently given only partial information, learning by their mistakes, adapting to heterogeneous and changing environments, and having a sort of life of their own. (2001, p. 659)
A central metaphor of cybernetics is the cyclic image of brain and environment,

with internal sets of feedback loops themselves having feedback connections to the environment and being completed through them (McCulloch 1989; Cariani 2001a, b). It is represented in the basic schema of the control system, which is an interesting conceptual tool that allows us to conceive of music users as ‘‘devices’’.

2.2. The listener as an adaptive device

Music users can be conceived of as adaptive devices that are able to change their semantic relations with the world (Reybrouck 2001c; and for a general discussion of adaptive devices, see Rosen 1978;

[233] Pattee 1982, 1985; Cariani 1991, 1998a). They can arbitrarily choose what kinds of ‘‘distinctions’’ are to be made (perceptual categories,features and primitives), what kinds of ‘‘actions’’ are done on the environment (primitive action categories), and what kinds of ‘‘coordinative mappings’’ are carried out between their actions and distinctions. As such, they behave as adaptive systems, which, according to Cariani (2001b), acquire a degree of ‘‘epistemic autonomy’’:

> … adaptive systems …continually modify their internal structure in response to experience. To the extent that an adaptive epistemic system constructs itself and determines the nature of its own informational transactions with its environs, that system achieves a degree of epistemic autonomy relative to its surrounds. (2001b, p. 60)

Adaptive devices can change the informational relationships with their environment through altering the basic functions of sensing, coordinating and acting. The ‘‘sensing function’’ can be changed through modifying or augmenting the sensors. It allows the device to choose its own perceptual categories and to control the types of empirical information it can access through the basic mechanisms of altering existing sensing functions or adding additional ones.

According to Cariani (1991, 1998b) there are basically four of them: (i) prosthesis or adaptive fabrication of new front-ends for existing sensors, (ii) active sensing or using motor actions to alter what is sensed through interaction (poking, pushing, bending), (iii) sensory evolution or adaptive construction of entirely new sensors and (iv) internalized sensing by creating internal, analog representations of the world out of which internal sensors extract newly relevant properties (perceptual learning) (1998b, p. 718). The ‘‘effector function’’, on the other hand, can be modified as well. The device can change its effectors or coordinate its actions with the sensing and coordinating function as in ‘‘active measurement’’. This is a process of acting on the world and sensing how it behaves as a result of the actions we perform (active sensing). It changes our sensing function without altering the sensor structures, requiring only additional coordinative and motor resources. The ‘‘coordinative function’’, finally, mediates between sensing and acting, realizing percept-action mappings which can be simple reflexes as well as highly elaborated internal schemes.

It is challenging to apply this to the realm of music and to conceive of the music user as an ‘‘adaptive device’’. Some analogies are obvious: the construction of musical instruments and the whole gamut of sound producing actions as an illustration of adaptation at the level of acting, and the role of technological tools for better listening

[234] at the level of sensing (see Reybrouck 2004). But the topic of this paper focusses mainly on the coordinating function of the control system and the construction of better cognitive tools for listening. As such, we should conceive of dealing with music in terms of making sense out of the perceptual flux. What matters, therefore, is the semiotization of the sonic world and the possibility to conceive of music in terms of musical semantics and the related concept of epistemic autonomy (Cariani 1989, 1991, 1998b, 2001a, b; Pattee 1995).
There are, however, constraints which shape the semiotization of the sonic world. Listeners do not perceive the acoustical environment in terms of ‘‘phenomenological descriptions’’ but as ‘‘ecological events’’ (Balzano 1986; Lombardo 1987). As such, we must consider the role of event perception and cognitive economy. Events – and also auditory events – are continuous in their unfolding but discrete in their labeling. They allow us to ‘‘recognize’’ an event rather than ‘‘experiencing’’ its unfolding through time: as soon as we recognize something as something, we stop acoustical processing in favor of conceptual processing. The latter is much faster and less demanding as to the effort of processing, as it is much easier to select and delimit an events and to pick it up in an act of episodic attention than to deal with it in an act of sustained attention. But which auditory events should be selected for conscious processing? There are literally tens of thousands of possible events in an average movement of classical symphonic music (Fink 2001). These are at least as many as there are notes in the score and probably there are many more of them. It is up to the listener, therefore, to define those events that are significant and eligible to function in the larger framework of a piece of music.
There is, of course, a lot of freedom here, but it is possible to reduce this virtual infinity to manageable proportions when we go beyond the merely perceptual aspects of dealing with the music. This means that we should consider an ‘‘interactive’’ approach to coping with the sonic world which brings together perception and action as exemplified in the cybernetic concept of circularity (Arbib 1981; Jeannerod 1994; Paillard 1994a; Annett 1996; Decety 1996; Deecke 1996; Berthoz 1997; Meystel 1998)

2.3. The claims of biosemiotics: functional cycles and the concept of circularity

To deal with music in terms of coping behavior is a position that broadens the scope of music. It allows us to encompass all kinds of
[235] music and sound, and to go beyond any kind of cultural and historical constraints: music is 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 favor of a ''process-like description'' of the ongoing process of maintaining epistemic contact with the sounding environment, allowing us to broaden the descriptive vocabulary that yields only ''static products'' which are not relevant to the music as it is heard (Smoliar 1995). More promising is an ''adaptive model'' of perceptual categorization which requires the negotiation of the ongoing activities of delimitation, discrimination and association of objects (Edelman 1989). It enables the music user to perform mental operations that go beyond mere identification and classification, and is helpful in coping with the world of our experience, rather than furnishing an objective representation of a world that might exist apart from our experiences (von Glasersfeld 1991, p. XV).

In order to elaborate these claims, we can rely on the epistemic control system (Figure 1). It is a rather old concept, which is appealing by its simplicity – it consists of the four major moments of input, output, central processing and feedback – and operational character. It transcends the limitations of the mere reactive machinery of an ''open loop'' construction by providing a cycle (closed loop) rather than a chain both through the mechanism of feedback (closed loop) and by the interposition of intermediate variables between the stimuli and the reactions to these stimuli. As such it fits in with the basic idea of a servomechanism, as pointed out by Wiener:

> The present age is truly the age of servomechanisms as the nineteenth century was the age of the steam engine or the eighteenth century was the age of the clock. – To sum up: the many automata of the present age are coupled to the outside world both for the reception of impressions and the performance of actions. They contain sense organs, effectors, and the equivalent of a nervous system to integrate the transfer of information from the one to the other. They lend themselves very well to description in physiological terms.'' (1961(1948), p. 43)

The role of the nervous system (central processing) must be considered here: being basically a system which transforms knowledge, the nervous system can be defined semiotically as a system which ''receives'' and ''transforms'' knowledge of the world so as to figure out a way to change this knowledge to benefit the carrier of the nervous system (Meystel 1998). Much depends on the level of pro-[236] cessing here: there is a difference between the processing of information at the level of the reflexes as against the higher-level cognitive processing of the brain. The latter call forth processes of cognitive mediation, which color the input/output mappings by referring to existing cognitive schemes which shape the listener–environment interaction and which lead to the construction of an internal model of the outer world (Klaus 1972).

A somewhat related idea has been advocated in the theoretical work of von Uexküll (1921, 1928, 1982(1940), see also Lagerspetz 2001) who introduced his key concept of functional cycle (Funktionskreis) (see Figure 2) as a conceptual tool that describes the basic structure of the interactions between a human/animal organism and the objects of its surrounding world:

> 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. (1957(1934), p. 10)

The concept of functional cycle is an interesting conceptual tool (Reybrouck 2001a). It can be considered as a simple, recursive loop that links action and perception, and that has its origins in the concept of the reflex arc, with this proviso that the linearity of the stimulus-reaction chain has been replaced by the concept of circularity (von Uexküll1986). Behaviors, in fact, are not merely movements or tropisms: they consist of ‘‘perception’’ (Merken) and ‘‘operation’’ (Wirken), which are organized in a meaningful way and not merely mechanically regulated.

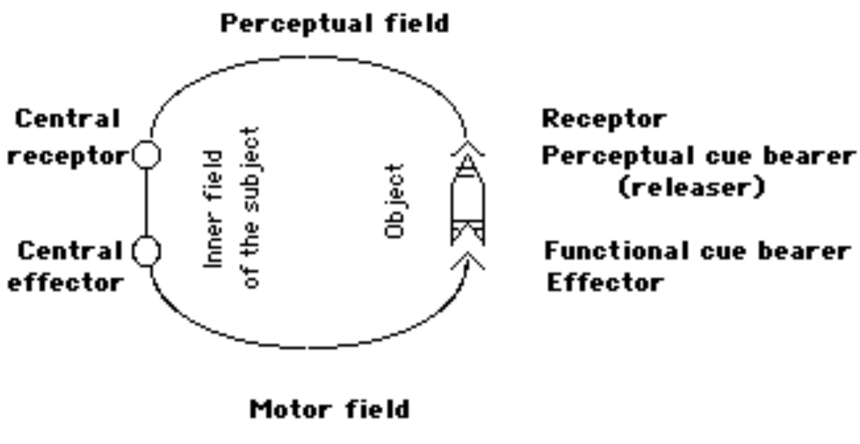

Figure 2. The functional cycle after von Uexküll (1957[1934]).

Rather than thinking in terms of reactivity to an ‘‘external’’ environment, we should stress the role of [237] the organism as the subject of these interactions, and place emphasis on the subjective, ‘‘internal’’ environment of the organism (Innenwelt). Every stimulus, on this view, presupposes a readiness to react, allowing the organism to select as a stimulus this phenomenon of the environment which has been neutral up to that point.

Functional cycles describe the formation of ‘‘sensory–motor interactions’’, somewhat analogous to the idea of a neural feedback loop (McCulloch 1946) in which coordinative circuits entail additional chains of interneurons interposed between receptors and effectors. This feedback loop, however, is completed through environmental linkages with the outer world, allowing us to conceive of functional cycles as elementary loops of functioning (Meystel 1998) which consist of sensors, sensory processing or perception, a world model, a commands generator, actuators and the world where changes happen (Meystel 1998, p. 351). This is an operational approach which has gained impetus from recent research that stresses the adaptive control of percept-action loops in artificial devices (Cariani 1989, 2001a, b; Ziemke & Sharkey 2001). It stresses the ‘‘ecological conception’’ of interaction with the environment, and presupposes an ‘‘epistemic cut’’ between an organism and its environment in drawing an operational distinction between the input (sensorium), output (motorium) and central processing as a kind of sensory–motor integration which does the mapping and the coordination between them (Cariani 2001a, b).

The idea of sensory–motor integration, however, has its shortcomings. It deals with ‘‘conservative behavior’’, which means that an organism reacts to the solicitations of the environment in order to achieve a state of equilibrium. This ‘‘functional’’ approach to interaction with the environment conceives of the brain as a controller, which proceeds in real-time, relying on the mechanism of ‘‘measuring’’ and ‘‘controlling’’ rather than merely ‘‘representing’’ the external outer world. It is possible, however, to transcend this perceptual bonding and to act as a simulator as well (Berthoz 1997, 1999). Simulation, however, is not conservative. It proceeds mostly out-of-time and leans heavily on imagery and internal dialogues, prompting us to consider the role of ‘‘internal modeling’’ and the carrying out of ‘‘symbolic operations’’ on mental replicas of the sonic world. The main emphasis, here, is on the internal model of the outer world. The concept of ‘‘internal model’’ is a central topic in von Uexküll’s work. It allows us to consider the external environment, which is objectively there, as a part of the subjectively perceived environment [238] or Umwelt of an organism. Such an ‘‘Umwelt’’ is the semiotic world of organisms: it is a collection of subjective meanings which are imprinted on external objects as a private subset of the world at large (Kull 1998a). It consists of the interrelation – actually a set of ‘‘mapping relations’’ – between the organism and its environment, allowing us to conceive of it in operational terms as being the sum total of the ‘‘functional cycles’’ which encompass all the meaningful aspects of the world for a particular organism. They bring together the world of ‘‘sensing’’ (Merkwelt) and ‘‘acting’’ (Wirkwelt) through processes of signification which invest the objects with perceptual and effector tones. To the extent that these are represented in the subject’s inner world, they call forth a gradual transition from cybernetic to semiotic analysis of the interaction with the outer world.

2.4. Introducing the observer: the role of subjectivity

The act of listening is a process of dealing with the music which can be described in terms of coping with the sounds – proceeding ‘‘in time’’ or ‘‘out-of-time’’. It allows us to conceive of listening in epistemological terms as a kind of knowledge acquisition: as listeners, we are observers who construct and organize our knowledge and bring with us our observational tools, somewhat similar to the epistemological claims of Maturana (1978):

> 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… (1978, pp. 28–29)

The central point in this approach is the role of subjectivity and the way it influences our reactions to the environment. Living organisms, in fact, behave as subjects that respond to ‘‘signs’’ and not to ‘‘causal stimuli’’. This is a 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 1998b, p. 243).

This subjectivity, fu on earth; (ii) the biological level of constraints includes only the living organisms; and (iii) the zoological level, finally, concerns those aspects which are shared among the animals. Each of them depends upon the others, with the proviso that we can conceive of lower levels functioning without the higher ones, but not conversely. Higher levels always involve the lower ones. As such we must distinguish between lower-level sensory processing and higher-level symbolic functioning. It really makes a difference whether we react to stimuli which are presented to the senses (presentational immediacy) or merely to their symbolic counterparts (representational mediation). The latter transcend perceptual bonding through a process of abstraction from the sensory material, allowing us to deal with the environment in the absence of sensory stimuli but at a reduced level of acuity. The organism–environment interaction, therefore, is not to be described in terms of mere reactive machinery, but as a hybrid process which combines both lower level sensory processing and higher-level cognitive functioning.

In order to give an operational description of this higher-level functioning, we can rely agai n on the already mentioned theoretical work of von Uexküll(1982(1940), 1957(1934); see Kull 2001 for an overview). Especially his key concept of functional tone is interesting in providing a workable conceptual tool for the description of different qualities or tones that can be attributed to the objects of perception. The example of a tree can be helpful here: dependent on the intentions that an animal or human being confers on it, it can have a number of different meanings – a shelter for a fox, a support for the owl, a thoroughfare for the squirrel, hunting grounds for the ant, egglaying facilities for the beetle, a source of valuable raw material for the forester – which give the object a particular and specific functional tone (von Uexküll1957(1934)). As such there is no one-to-one relationship between an object in the outer world and its actual meaning: each organism perceives the world through a network of functional relations which constitute its own ''phenomenal world'' or ''Umwelt''.

The organism's Umwelt is only a section carved out of the environment. It can be considered as the sum total of its perceptual cues among the stimuli in its environment. It consists of functional cycles, which operate by means of trigger mechanisms that select a number of objects with special relevance to act as either perceptual or func- [240] tional cue bearers. Both of them are related to each other in the sense that the functional qualities affect the perceptual ones: they transform the object of perception by giving it a ''functional tone''. Our relation to the world, therefore, is not merely representational, but is functional as well:

> We may say that the number of objects which an animal can distinguish in its own world equals the number of functions it can carry out. If, along with few functions, it possesses few functional images, its world, too, will consist of few objects. As a result its world is indeed poorer, but all the more secure. [...] As the number of an animal's performances grows, the number of objects that populate its Umwelt increases. It grows within the individual life span of every animal that is able to gather experiences. For each new experience entails a readjustment to new impressions. Thus new perceptual images with new functional tones are created. (von Uexküll1957(1934), p. 49)

The critical element in this approach is the sensitivity to functional characteristics of the environment. Animals and organisms, in general, perceive objects in their environment in terms of what they ''afford'' for the consummation of behavior, rather than in terms of their objective and perceptual qualities. This is a basic claim of Gibson's ecological psychology: affordances –

as he first coined the term – are environmental supports for an organism's intentional activities. They are subjective qualities that render them apt for specific activities such as supporting locomotion, concealment, manipulation, nutrition and social interaction for the animal (Gibson 1979). Translated to the realm of music this should mean that we try to understand music in terms of what it affords to us and not merely in terms of its acoustical qualities (Reybrouck 2001a). What is needed, therefore, is a description of the sonic environment in terms of functional signification. Every listener, in fact, builds up relations with the sonic world, selecting some of them to give them special meanings. In doing so, he or she constructs a kind of sonic Umwelt, which can be considered as a collection of subjective meanings that are assigned on some elements of a specific subset of the sounding environment.

3. ENACTIVE COGNITION AND THE INTERACTIONAL APPROACH

The concept of Umwelt is appealing: every organism is able to build up its own subjective environment by changing its semantic relations [241] to the world. It is related to the modern concept of adaptive device – as an artificial device which can choose or tune its sensors, effectors and the coordinative mappings between them (Cariani 1989, 1991):

> When adaptive systems construct their own sensors and effectors, they then determine, within limits, the categories through which they interact with the world. This confers upon such systems a limited degree of epistemic autonomy—in effect they choose their own observables and modes of action. (Cariani 2001a, p. 261)

Adaptive epistemic systems interact with their surrounds through action and perception. They build up semiotic linkages over time, which evolve as the result of experiences and interactions with the world at large. These linkages determine the categories of action and perception that are available to the system, but to the extent that they can be modified – through the adjustment of sensors or sensory– motor coordinations – the system can learn to make new distinctions and create new observables. As such, it is possible to conceive of epistemic adaptive systems – and even listeners – as measuring devices that determine the external semantics through processes of selection and delimitation of observables and through measuring of their semantical weight.

3.1. Measuring devices, observables and symbolic play

The notion of measuring device was introduced by Hertz (1956(1894)). He pointed out the possibility of linking particular ''symbol-states'' to particular ‘‘external states-of-affair’’: a measurement is produced by measuring devices that interact with their environs and provide a pointer-reading of an observable that functions as the initial condition of a formal model for predicting the value of a second one – often the same observable at a later time or different position in space. These ‘‘pointer-signs’’ reflect the particular interactions between the measuring apparatus and the outer world.

Given these initial conditions, it is possible to carry out predictivearithmetic and/or logical calculations on the pointer-signs, providing the formal part of modeling which is completely rule-governed and syntactic in character (see Cariani 2001a). The role of symbolic play must be considered here: formal computation is carried out on the symbolic counterparts of the observables, and not on the observables themselves. This is a major claim of symbolic functioning that has its theoretical elaboration in the concepts of model (internal model of the outer world) and strategic play (Klaus 1972). It reminds us of the [242] older concept of the epistemic rule system (see Figure 3) with its epistemic generalizations of homo sapiens, homo faber and homo ludens. Each of these can be considered in terms of automata, conceiving of homo sapiens as a ‘‘perception machine’’ (selection and classification), of homo faber as an ‘‘effector machine’’ and of homo ludens as a ‘‘playing automaton’’ (see Klaus 1972).

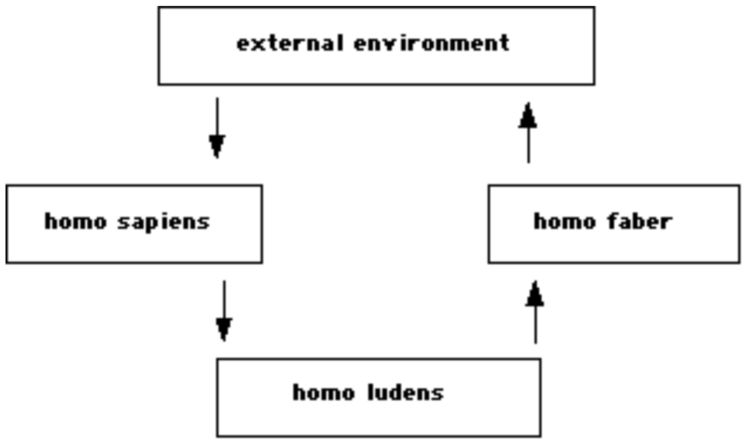

Figure 3. The epistemic generalizations of the rule system (after Klaus 1972).

The latter, especially, is of paramount importance for the symbolic functioning. It calls forth the introduction of intermediate variablesbetween input and output (Paillard 1994b; Reybrouck 2001b), andraises the functioning of the rule system to a level that transcends thereactive machinery of causal stimulus-reaction chains. Reactiveactivity involves a direct input-output coupling – sensory input andresulting effect–based on a transfer function of a particular automatism that is not influenced by its previous history (Meystel 1998). Assuch it is not fitted for goal-directed behavior which involves deliberateplanning and mental simulation at the level of imagery. The latter is thehallmark of the homo ludens as a playing automaton: it stresses thepossibility of internal dialogues and of carrying out symbolic computationson the mental replicas of the observables. In order to do so, the''player'' must have a symbolic repertoire at his disposal for doing themental arithmetic that is typical of symbolic behavior in general.

Applied to music, this should mean that we conceive of listening in computational terms (Mazzola 2002), allowing us to lean upon the conceptual framework and tools of mathematics, not in terms of tunings and temperaments – with mathematical models of musical scales – or working with note values (adding, ratios, fractions), but in terms of mathematical activities such as counting, measuring, classifying, comparing, matching, ordering, grouping, patterning, sorting [243] and labeling, inferring, modeling and symbolic representation. What is meant is an approach to mathematics which stresses the mathematical experience (Davis & Hersh 1990(1981)) and the cognitive approach to mathematics (Lakoff & Nuñez 2000), rather than conceiving of it in terms of ciphering and arithmetic. Translated to the domain of music, this should mean that we can conceive of musical ''objects'' and ''processes'' in terms of formal and syntactic operations which take place at the level of imagery. Music, however, is also a sounding art, which means that the symbolic operations can be helpful in coping with the sonic world without exhausting the possibilities of the process of listening as a sensory experience.

3.2. Experiential cognition and the concept of adaptation

Imagery and symbolic play transcend time-bound reactivity. They call forth the introduction of an internal model of the outer world. But which kind of model must we conceive? The question addresses the topic of epistemic autonomy: are we constrained by the external environment or can we change the relations with the external world at will? The answer is not obvious since the music user can be considered as an ''adaptive device'' which is capable of changing its semiotic linkages to the sonic world.

The concept of adaptation is of primary importance here. It is originally a biological concept, which describes the possibility of an organism to change itself in order to survive in its environment (Fleagle 1999). The claim, however, can be translated also to the realms of cognition, as did Piaget (1977). Especially his concepts of assimilation and accommodation are workable conceptual tools for providing an operational approach to the mechanism of adaptation. The latter is depicted schematically in Figure 4, with the left side symbolizing the elements of the music, and the right side symbolizing their representations (labels) in the listener's mind. Several options are possible here. At first there is a matching (1–1 relationship) between the sounding music and the representations in the listener's mind (Figure 4a): this is assimilation, with the mental schemata being there, already installed, and ready to be matched by the elements of the music. If, however, there are more elements in the music than there are representations in the listener's mind (Figure 4b), the listener must accommodate by creating new representations. Once installed, however, the elements and the labels match again (Figure 4c) and the listener has adapted him/herself to achieve a new state of equilibrium.

[244] The concepts have proven to be fruitful. They have furthered a lot of discussion and have influenced profoundly the constructivist approach to knowledge acquisition in general (see von Glasersfeld 1995a, b), but above all, they provide a descriptive and explanatory vocabulary for conceiving of an organism in terms of a learning device, which is capable of modifying its semantic relations with the world. According to Cariani (1989, 1991, 2001a, b) there are three possibilities for doing this: (i) to amplify the possibilities of participatory observation by expanding its perceptual and behavioral repertoire, (ii) to adaptively construct sensory and effector tools, and (iii) to change the cognitive tools as well.

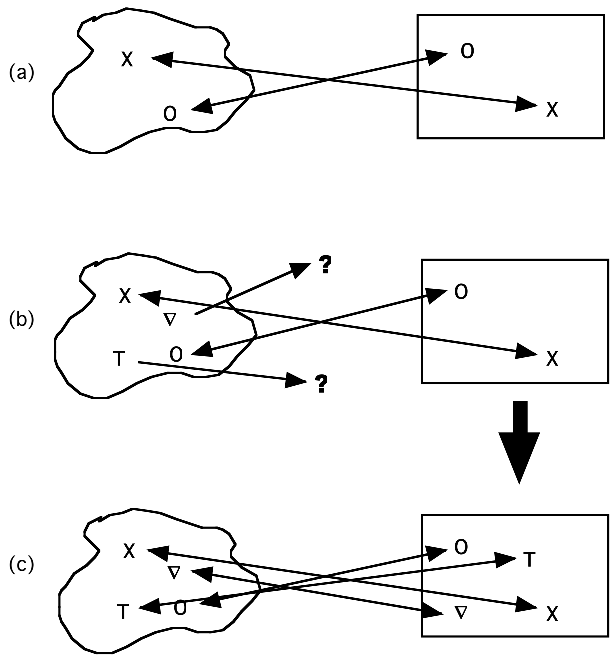

Figure 4. The Piagetian notions of assimilation and accommodation.

It is tempting to apply this to the process of dealing with music – and to the process of listening in particular – which we have already defined in biosemiotic terms as ''coping with the sonic world''. Listening, on this view, can be

considered as a process of knowledge acquisition which is helpful in the semiotization of the sonic world. But which kind of knowledge do we mean? Can we rely on the objectivist paradigm of knowledge – which states that there is something ‘‘out there’’ which can be known in an objective way – or must we take into account also the claims of non-objectivist cognition (Johnson 1987; Lakoff 1988) which defines meaning in terms of human understanding? The latter highlights the dynamic, interactive
[245] character of understanding (and meaning) in terms of ‘‘being in’’ or ‘‘having’’ a world, and stresses the experience of a common world that we can understand.

In order to acquire knowledge, the listener must interact with his or her environment. Our cognition is not reducible to ‘‘naive realism’’ but has the mark of our cognizing with our minds (‘‘cognitive realism’’): it is the result of an ongoing interpretation that emerges from our capacities of understanding, that are rooted in the structures of our biological embodiment but which are lived and experienced within a domain of consensual action and cultural history (Varela et al. 1991, p. 150). This is a cognitive semantics that accounts for what meaning is to human beings, rather than trying to replace humanly meaningful thought by reference to a metaphysical account of a reality external to human experience (Lakoff 1987, p.120). As such it is related to the epistemological claims of experiential and enactive cognition (Johnson 1987; Lakoff 1987; Varela et al. 1991) which are, in turn, related to the embodied approach to cognition (see below) as a typical example of non-objectivist semantics. All of them hold an epistemological position which has not yet received much attention in academic circles, but which has been elaborated already in evolutionary epistemology – as initiated by Konrad Lorenz – in secondorder cybernetics (Maturana, Varela, von Foerster), autopoiesis theory (Maturana, Varela) and Lakoff’s and Johnson’s experientialism (see also Brier 2000a, b).

3.3. Embodied cognition and the concept of enactment

The enactive approach to cognition is an epistemological position which focusses on the realization of systemic cognition in the context of the living system‘s interactions with the environment (Varela et al. 1991). Cognition, on this view, must not be considered as a recovery or projection but as ‘‘enactment’’ on the world:

> Cognition is not the the representation of a pregiven world by a pregiven mind but israther the enactment of a world and a mind on the basis of a history of the variety ofactions that a being in the world performs. (Varela et al. 1991, p. 9)

Crucial in this approach is the grounding of cognitive activity in the embodiment of the actor and the specific context of activity. It defines cognition as:

[246]

> Embodied action that depends upon the kinds of experience that come from having a body with various sensorimotor capacities which are embedded in a more encompassing biological, psychological, and cultural context. (Varela et al. 1991, p. 173)

The role of contextualization and ‘‘having an experience’’ should be considered here. It reminds us of the pragmatic philosophy of Dewey and James who have dealt extensively with this topic. Dewey (1958 (1934)) in particular has stressed the role of action and perception and the reciprocity of doing and undergoing in the ‘‘experience proper’’. James (1976, 1912), in turn, has introduced his doctrine of radical empiricism, which is an original epistemology that deals with the tension between ‘‘concept’’ and ‘‘percept’’. It stresses the role of knowledge-by-acquaintance – as the kind of knowledge which we have of a thing by its presentation to the senses – rather than conceptual knowledge. What matters in this ‘‘empiricist’’ approach, is the fulness of reality which we become aware of only in the perceptual flux (Mc Dermott 1968 (1911)). Conceptual knowledge is needed as well, but only in order to manage information in a more economical way. As such, it is related to the principle of cognitive economy.

The claims are challenging. They allow us to broaden our cognitive structures from a ‘‘classical’’ to a ‘‘transclassical model’’ model of categorization, with a corresponding transition from a conception of meaning in terms of ‘‘static, discrete and objective’’ categories to a conception of meaning as ‘‘subjective, process-like and non-discrete’’ (Maser 1977). It emphasizes those categories of cognition that are the outcome of perceptual–motor interactions with the environment (Mazet 1991) and takes a position that restates the hypothesis that there is a correspondence between the structure of our categories and the degree of functional interaction of an organism with its environment (Dougherty 1978). As such, it increases the range of categorization from mere perceptual to functional categories, integrating both perceptual attributes as classes of action (Mazet 1991).

The whole approach fits in with the categorization theory of Rosch (Rosch et al. 1976; Rosch 1978; see also Dubois 1991). Especially her basic-level categories are workable examples here: they constitute very inclusive categories – a category as ‘‘chair’’, for example, is less inclusive than ‘‘furniture’’, but more inclusive than ‘‘kitchen chair’’ or ‘‘living room chair’’ – which allow us to pick up discontinuities, correlations, similitudes and perceptual and functional resemblances. They allow us to interact with our environment at a normal level

of functioning. Properties, on this view, are not
[247]‘‘objective’’ qualities of the outer world, but qualities which are shaped by our ‘‘interactions’’ with the world. At this basic level they “seem’’ to be objective to the extent that our bodies can interact optimally with them (Lakoff 1987; see also Edelman 1989).

4. MUSIC COGNITION AND THE ECOLOGICAL APPROACH

To conceive of music cognition in interactional terms is a position which is related to the ecological approach to cognition. It stresses the role of the interaction of an organism with its environment, which, applied to music, should mean that we must conceive of the listener as an organism and of the music as a sounding environment. But how can the listener make sense out of this environment? This is the basic problem of maintaining ongoing epistemic contact with the perceptual flux, which involves real-time processing and decoding of the sonorous unfolding through time. Dependent upon the role the mind is playing in this process, we can distinguish ‘‘direct’’ from ‘‘mediated perception’’.

4.1. Direct perception, cognitive mediation and the principle of cognitive economy

The concept of direct perception is an ill-defined category which is responsible for a lot of ambiguity. It is grounded in ecological theory (Gibson 1966, 1979, 1982; Michaels & Carello 1981) which claims that perception occurs immediately, without the mind intervening in this process: ‘‘direct’’ perception involves direct contact with the sensory stimuli, and the reaction to these stimuli proceeds in a lock-and-key approach. As such, it combines continuous perception – the sensory stimuli are continuous in their presentational immediacy – with a symbolic representation that reduces the fulness of the sensory experience to a single cue, which has the advantage of speed of processing.

The ambiguity is related to the distinction between the stimuli which are continuous, and the symbolic representation in the perceiver’s mind, which is characterized by processes of abstraction, keeping distance and polarization between the organism and its environment. As such we should consider the possibility of a mixed discrete-symbolic
and continuous-anolog processing of the outer world.

The symbolic processing, however, has adaptive value as well. It

transcends the frame of the present and provides means for anticipatory behavior in general. To quote Edelman:
[248]

> The development of short-term memory that was related to the succession of events and signals … consolidated the evolutionary advantage provided by an integrated ‘‘mental image’’, allowing the assignment of salience to events in terms of adaptive values. But an animal possessing these means is still tied to a frame of the present: although its behavior is undoubtedly altered by long-term changes in learning, it has no means of reviewing explicitly its present perceptions in terms of analogues in the past or in terms of anticipated analogues projected to the future. It has no direct awareness … and is not ‘‘conscious of being conscious’’. (1989, p. 186)

Symbolic processing calls forth processes of cognitive economy. It relinquishes the particularities and idiosyncrasies of the sensory experience in favor of forms of conceptualization by which we can process the incoming information in a more economical way. As such it is an important cognitive tool that transcends perceptual bonding and that allows us to do autonomous processing – without ‘‘peripheral connection’’ to the senses (Langacker 1987) – and to go beyond temporal and spatial constraints. It is closely related to the difference which was drawn by James (1976, 1912) in his distinction between ‘‘percept’’ and ‘‘concept’’. It is possible, in fact, to conceive of either ‘‘sensory realia’’ or their ‘‘symbolic counterparts’’. It is reasonable, however, to take a ‘‘realist’’ position as a starting point – this is the empiricist claim of perception – which means that there really is something ‘‘out there’’, which is already structured in the environment. This is the ecological claim of direct perception which calls forth the veridicality of perception and which allows us to speak of perception in objectivist terms as well.

The same holds true for dealing with music. Music is a sounding art which is actualized in its sonorous articulation through time and which we can try to objectify by providing means for portraying the continuous acoustic signal. Music cognition, however, is not reducible to this kind of ‘‘naive realism’’ with ‘‘acoustical’’ or ‘‘auditory’’ listening as the only processing mechanism (Handel 1989). Making sense out of the perceptual flux must go beyond a mere acoustical description of the sound: what matters is not merely the continuous flow of matter in the physical world, but the perceptual and cognitive processes of the perceiver, which means that we must consider the role of the way how human listeners structure the acoustic flow. This is the basic tension between the ‘‘bottom-up’’ and ‘‘top-down’’ approach which draws a distinction between the sensory information which is presented to the senses (bottom-up) and the cognitive mediation of the mind, which applies discrete labels to the continuous unfolding through time (top-down). Music, on this view, is both an

[249] ‘‘experiential’’ and a ‘‘conceptual’’ affair. We should consider, however, the economy of thinking which allows us to reduce the complexity of the sounding world to major categories, which are not totally arbitrary but which are ecologically constrained.

4.2. Musical semantics between ecological constraints and epistemic autonomy

Perception is ‘‘ecologically constrained’’. It addresses the world not at a physical level of description but in functional terms, stressing the role of interaction between the organism and its environment. What matters is not merely the physical world in its objective qualities, but the world as it is perceived by the organism. This is the hallmark of ecological perception, which studies the human cognitive and perceptual apparatus in the service of survival and orientation in the environment (Shepard 1984). As such, it is related to adaptive behavior, 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, 1998; Sebeok 1998). The role of interaction is of primary importance here: a full description of perceiving cannot be given by either analyzing only the organism or only its environment (organism-environment dualism). What is needed is an ecological approach which is not ‘‘animal-neutral’’ but which treats the environment ‘‘as perceived’’.

The same holds true for listening to music (Neisser 1987; Martindale & Moore 1989; McAdams 1993; God.y 1999; Reybrouck 2001c) which can be defined in terms of organism-environment interaction – with the listener as the organism and the music as the environment. Listening, on this view, is a process of picking up of information which is considered to be useful. It can be subsumed under the field of ecosemiotics which studies the semiotic interrelations between an organism and its environment (Kull 1998b), encompassing the whole domain from lower sensory functioning to higher levels of cognitive processing and allowing us to conceive of the listener as part of an organism–environment ecosystem (Michaels & Carello 1981). We must draw a distinction, however, between levels of processing which are ‘‘wired-in’’ and which are ‘‘acquired’’. This is the well-known ‘‘nature/nurture distinction’’, or the distinction between ‘‘nativism’’ and ‘‘empiricism’’ with its corresponding epistemological positions, which claim that knowledge is dependent [250] upon innate faculties (the Chomskyan position) as against the construction of knowledge as the result of interaction with the environment (the Piagetian position). Rather than joining this debate (see Hargreaves 1986; Reybrouck 1989, 1997) I argue for a continuum between lower and higher levels of processing, starting from a basically reactive machinery which functions as lock-and-key – with wired-in and closed programs of behavior – to levels of processing which are the result of perceptual learning and cognitive mediation. The distinction is somewhat related to the difference between primary, secondary and tertiary codes in communication systems (Bystřina 1983): primary codes are of an innate nature (genetic code, perception code and intraorganismic code), secondary codes are the result of a learning process (language code) and tertiary codes operate at the level beyond the secondary code (cultural codes) (see Jiranek 1998).

From a developmental point of view, it makes sense to build our listening strategies on the grounding of primary codes, which are, in a sense, our perceptual primitives. Most animals and men, according to Cariani (1998b), have neural coding strategies that are used in the representation and processing of sensory information:

> While the particular experiential textures of things, their qualia, undoubtedly vary among different vertebrates, the basic body-plans, sensory organs, and neural representations are roughly similar. We see in different colors, hear in different frequency registers, and smell different odors, but the basic relational organizations of our percept-spaces in the end may not be so radically different. (Cariani 1998b, p. 252)

Arguing on these lines we can question the ecological claim of direct perception (Gibson 1966, 1979, 1982) which states that perception is possible without the mind intervening in the process of making sense of the perceptual flux. Direct perception involves ‘‘presentational immediacy’’ and launches immediate reactions to the solicitations of the environment. As such, it calls forth ‘‘conservative’’ behavior which proceeds in real-time. It is possible, however, to go beyond the constraints of time-bound reactivity and to interpose ‘‘intermediate variables’’ between the sensory stimuli and the reactions to these stimuli. This is a basic claim of cognitive mediation, which seems to be opposed to the ecological approach. It is possible, however, to conceive of both of them, when we hold an ecosemiotic position which combines the ‘‘bottom-up’’ and the ‘‘top-down’’ approach to music cognition.

This holds true for music cognition in particular. Listening embraces perceptual immediacy as well as conceptual abstraction. It brings together continuous and discrete processing, stressing both the [251] idiosyncrasies of the sonorous unfolding – which is continuous – and the process of sense-making which can be intermittent in applying discrete labels to slices of the temporal unfolding. Both approaches hold different but complementary positions that depend on the listener’s perceptual strategies which are shaped by his or her interactions with the ‘‘sonic’’ environment: what we are listening to are not sounding things, but things as signs which shape our world. There is, in fact, a whole machinery of ‘‘semanticity’’ and ‘‘semiotization’’ which involves acts of selection and intentionality in the delimitation of the elements we can mentally point at. As such we should conceive of the sonic environment in terms of the listener doing the cognizing. It is the listener, who can select at will and focus attention to things and events which he or she considers to be interesting. This means that perception is not totally constrained and that there is a lot of epistemic autonomy in the way the listener builds up semantic relations with the sonic world.

4.3. Listening as a process of sense-making: principles of perceptual learning and development

Listening to music involves a process of semiotization of the sonic world. It is related to the ecological idea of ‘‘organism–environment interaction’’: what the listener selects in focussing attention is not arbitrary but is ecologically constrained. This is the ecological approach to perception which was advocated by Gibson (1966, 1979, 1982) who claimed that perceivers ‘‘search out’’ information which becomes ‘‘obtained’’ information. They pick up information which is already part of the environment and which affords perceptual significance for the organism. In order to do so they must not lean on ‘‘senses’’ which simply function to arouse sensations, but on 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. (1936, p. 350)

[252] There is, of course, a lot of freedom here, which provides strong arguments against the classical ‘‘information processing paradigm’’ which holds a functionalist and computational position that does not encompass the role of the observer. To quote Brier:

> It is the human perceptive and cognitive ability to gain knowledge and communicate this in dialogue with other in a common language that is the foundation on which science is built. To be aware of this will…lead one to start in the middle instead of in the extreme, not to start either with the subject nor the object, but to start with the process of knowing in the living systems which is basically what second order cybernetics do. (Brier 1999a, p. 86)

The reference to ‘‘second order cybernetics’’ is important. It typically conceives of the observer as a participant and as part of the observed system, with a shift in focus from mere communication and control to the role of interaction (see Pask

1961a, b, 1992; von Foerster 1974, 1984; Maturana & Varela 1980; Luhmann 1990, 1995). Translated to the realm of music, this means that we should consider the role of the listener/observer. Depending on his or her listening skills he or she can focus at will, but there are perceptual-auditory triggers which are more salient and which impinge upon our perceptual and cognitive dispositions with more pregnancy. We can conceive of them as perceptual primitives which, in turn, can be considered as universals in music cognition (see Brunner 1998; Kon 1998; Marconi 1998; Miereanu & Hascher 1998; Normet 1998; Padilla 1998). A ‘‘musical experience’’, on this view, is not basically different from an auditory experience at large. It is continuous with the ‘‘natural experience’’ or ‘‘experience proper’’ (see Dewey 1958 (1934)) with a difference in degree rather than in quality. This means that we must build our listening strategies on natural strategies ofperception and listening with the transition from a naive listener to an expert listener being a matter of learning rather than to rely on innate faculties (Bamberger 1991). Listening, on this view, is not passive registration: it involves processes such as exploring, selecting, modifying andfocussing of attention. As such it is related to the principlesof perceptual learning and development (for an exhaustive overview, see Werner & Kaplan 1963; Gibson 1969).

The claims are not really innovative. They have been furthered by developmental psychologists – such as Piaget (1967), Werner & Kaplan (1963) and Gibson (1969) – but up to now they did not yet receive the needed attention in music education. There is a vast body
[253] of research which has been concerned with the interaction between ‘‘perceiver’’ and ‘‘environment’’, but which has focused almost exclusively on the domain of visual perception. It is tempting, therefore, to generalize from the visual to the auditory domain, if, at least, we are dealing with general principles of perceptual development. As such, we may conceive of listening as an active process of sense-making, in which we try to replace isolated and meaningless elements with coherent structural patterns which are characterized by articulation, differentiation and integration. These claims, which were articulated by Werner & Kaplan (1963), remind us of the principles of Gestalt psychology – as advocated by KoÅN hler and Koffka – and can be summarized by five transitions which are typical of perceptual learning at large: (i) the transition from syncretic to discrete, (ii) from diffuse to articulate, (iii) from indeterminate to determinate, (iv) from rigid to flexible and (v) from unstable to stable (Werner 1961; Werner & Kaplan 1963).

5. EVENT PERCEPTION AND THE RECOVERY OF INVARIANCE

The search for information is a major claim of ‘‘ecological listening’’. Purely

auditory listening is quite improbable. as observers do not perceive the environment in terms of phenomenological descriptions but in terms of ecological events (Balzano 1986; Lombardo 1987). Translated to the domain of music, this should mean that listeners do not perceive the acoustic environment in terms of acoustical descriptions but as ''auditory events''. The claim is somewhat related to the description of an auditory image (McAdams 1984) as a psychological representation of a sound entity which exhibits a coherence in its acoustic behavior. Auditory cognition, in fact, mostly involves source-knowledge (McAdams 1984, 1993) which is processed in a cross-modal way – involving motor, kinaesthetic, haptic and visual, besides the purely auditory components. It refers to the auditory source, the sound-producing actions – such as hitting, stroking, kicking, blowing (see God.y 1997, 2001b) – and the associated kinematic images and allows the listener to recover invariant patterns over time rather than mere acoustic properties (Handel
1989).

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5.1. Structural and transformational invariants

The extraction of invariants pertains to either static or dynamic features of stimulus information. As such we can draw a distinction between structural or transformational invariants (Michaels & Carello 1981; Bartlett 1984; Shaw et al., 1996): structural invariants refer to features that are not or only slowly changing, transformational invariants refer to styles of change (Shaw & Pittenger 1978). Both of them underlie the perception of events which can be defined in operational terms as ''something happening to something'', with the ''something happening'' being specified by transformational and the ''something'' to which something is happening by structural invariants (Michaels & Carello 1981, p. 26). Transformational invariants specify the change that is occurring in or to the object, structural invariants describe the object by itself. Recognition of the sound of a clarinet, for example, is a structural invariant, the specific articulation of the sound is transformational.

The concept of invariant is an interesting conceptual tool. It allows us to conceive of events as sequences of stimuli which are extended in time and which can be described in terms of their ''invariants''. They behave as basic building blocks which function as units in perception and memory. As such they call forth an ''ecological approach'' to memory phenomena, which is related to the core ideas of event perception: (i) the units of perception and memory are temporally extended ''events''; (ii) the basis of perception and memory is the pick-up of invariants over time; and (iii) perception and memory are essentially veridical. These core ideas, in turn, are very similar to what is commonly known as the event perception hypothesis (Gibson 1966, 1979; Bransford & McCarrell 1977), which claims that there is no clear dividing line between the traditional domains of perception and memory, and that the units of memory or perception can be greatly extended in time. ‘‘Events’’, on this view, are the appropriate units of analysis, whether they are fast – as in perception – or slow – as in memory (Bartlett 1984).

Events, further, can be defined in an intuitive way as ‘‘things that happen’’, involving ‘‘changes in objects or collections of objects’’ (Michaels & Carello 1981). It is obvious that the concepts of invariants– structural and transformational – and of events are tightly intertwined: the former act as a kind of ‘‘glue’’ that ‘‘unitizes’’ sequences of stimulus information into coherent events (Bartlett 1984). They allow us to describe events either at a glance or in their temporal [255] unfolding, providing both a discrete and a continuous description of invariant patterns over time.

5.2. Categorical and auditory perception

Event perception calls forth principles of cognitive economy. It induces categorical rather than auditory perception to the extent that it relies on ‘‘discrete’’ processing in which the ‘‘event’’ is heard directly with the ‘‘acoustic properties’’ of the sound being recovered only from memory. In the case of auditory perception, on the contrary, the ‘‘acoustic properties’’ are heard directly, with the perceptual events being deduced (Handel 1989, p. 274). There is, in fact, a difference between the ‘‘recognition’’ of a sounding object or an event as a discrete entity and the ‘‘experience proper’’ of its sonorous articulation through time. The experience of time is critical in this distinction: auditory perception involves real-time processing, categorical perception relies on memory and proceeds partially out-of-time. Event perception calls forth both of them. It can be described in a propositional way by specifying an event (E) perceptually when both the transformational (TI) and the structural invariant (SI) are available to be detected. An event, then, can be specified when the two-variable function E(TI, SI) can be evaluated (Shaw et al. 1996). To give an example: an event involving a bouncing ball might be denoted as E(TI 1/4 bouncing, SI 1/4 ball) 1/4 bouncing ball.

It is easy to translate this to the process of listening to music and to consider ‘‘event perception’’ as a kind of top-down processing of the music with schemata or labels which are assigned to segments of the sonorous unfolding through time (God.y 2001b). It allows us to conceive of ‘‘musical events’’ as higher-order variables which can be described as having time-varying complex acoustic properties with temporal constraints. As such we should consider the possible transition from ‘‘high-frequency’’ or ‘‘high-resolution’’ processing – in the range of about 10 msec – to perceptual units – in the range of 2–3 sec – which allow event identification over time (Wittmann 1999; Wittmann & Pöppel 1999–2000). Most musical events, for example, have a clearly defined time of beginning and of ending and have a grosst emporal patterning as well (Handel 1989). As such they hold a position between ‘‘invariance’’ and ‘‘change’’, allowing processes of discrete labeling and categorization. Event perception, on this view, is related to the problem of resolution. To quote Meystel:

> [256] A nervous system cannot deal with the whole network of a particular level of resolution; it selects a ‘scope of attention’. At each moment of time, the nervous system processes knowledge arriving externally and internally. In the meantime, the amount of knowledge the nervous system processes is limited. No more knowledge is processed than that which goes into our scope of attention. Within our scope of attention, we cannot distinguish knowledge ‘finer’ than the input resolution (smallest distinguishable unit) our nervous system is capable of handling’’. (1998, pp. 348–349)

5.3. Categorization and the principle of cognitive economy

Event perception is a core issue in musical epistemology. It stresses the role of the listener who is doing the cognizing. What he or she is hearing are not acoustic properties, but acoustic ‘‘events’’ which receive significance as the result of a process of semiotization of the sonic world. The events are evaluated as to their their semantical weight, which depends on the listener’s previous and actual interactions with the sound. This is basically the constructivist approach to cognition (von Glasersfeld 1995a, b) which claims that knowledge is the result of a learner’s activity rather than the passive reception of information or instruction. It goes back to the revolutionary attitude pioneered by Piaget, who redefined the concept of knowledge as an adaptive function, with the results of our cognitive efforts having the purpose of helping us to ‘‘cope’’ with the world of our experience, rather than furnishing an objective ‘‘representation’’ of a world as it might exist apart from us and our experience (von Glasersfeld 1991, p. XIV).

The perception of events has adaptive value as well: event schemes are cognitive schemes wich are helpful in making sense of the environmental world. What listeners consider to be an ‘‘acoustic’’ or ‘‘auditory event’’, however, is dependent on the way they schematize the physical structures in the sonic environment and on the way these structures are considered to be relevant to their adaptive efforts to succeed in their interaction. As such, we can conceive of music cognition as a schematizing process that ecologizes the stuff of the world (events) either to render it more assailable by the organisms or to accommodate the organism to its environment (Shaw & Hazelett 1986). Music cognition, on this view, is related to the principles of categorization with its basic characteristics of cognitive economy and the principle of reality. Categorization is a cognitive activity of paramount importance: it stresses the importance of providing the maximum of information with the least cognitive effort – this is [257] cognitive economy – and allows us ‘‘to render discriminably different things equivalent, to group objects and events and people around us into classes, and to respond to them in terms of their class membership rather than their uniqueness’’ (Bruner et al., 1956, p. 1). This means that genuinely diverse inputs lead to a single output, without preserving the shape, size, position and other formal characteristics of the stimulus (Neisser 1967, 1987). As such we use categorization as a tool to manage a complex environment: it is fundamental to any sort of discrimination task and is indispensable in using previous experiences to guide the interpretation of new ones. Categorization, further, mostly starts from the assumption of an implicit ontological realism – as advocated in the early work of Rosch on categorization (Rosch et al., 1976; Rosch 1977; Rosch & Lloyd 1978, see also Dubois 1991) – claiming that the perceived world is not unstructured, but consists of real and natural discontinuities and co-occurrent properties. It takes the categories in the external outer world for granted, as advocated in ‘‘objectivist cognition’’ or ‘‘objectivist semantics’’. But categorization does not deal with ‘‘ontological categories’’: it revolves around ‘conceptual structures’’ which contain constituents differentiated by major ontological category features such as thing, place, direction, action, event, manner and amount, smell and time (Jackendoff 1988). As such, it brings together the claims of ‘‘objectivist‘‘ and ‘‘conceptual’’ or ‘‘cognitive semantics’’.

6. CONCLUSIONS

In this article I have argued against the positivist position which has been taken for granted in traditional musicological research. Music is not merely something ‘‘out there’’ which can be described in an ‘‘objectivist’’ way. Music is a sound/time phenomenon which has the ability to be structured as it is heard. Hence the role of music cognition as knowledge construction and the role of listening strategies for making sense out of the sonorous flux. As such, we must consider an epistemological shift from music cognition as a structural description of an artifact in favor of music cognition as a process of maintaining epistemic contact with the sounding world. This is a position which prompts us to consider the transition from mere labeling of static objects to categorizations which are the outcome of an interaction with the sound. Hence the role of ‘‘enactive’’ and ‘‘experiential cognition’’.

[257] Cognition, however, relies on principles of cognitive economy and the same holds true for music cognition, which relies both on experience and

conceptualiza ion. As such we must consider the role of categorization which allows the listener to cope with music in a way that is less demanding as to his or her cognitive efforts. Listening, on this view, is a process of sense-making that reduces the virtual infinity of information of the perceptual flux to a manageable and limited set of perceptual categories which can be either discrete or continuous. It is a challenging idea to conceive of them as hybrid constructions which allow both a continuous and discrete labeling, and the whole domain of event perception seems to be very suited for this task.

Besides, we must consider the role of functional categorization as well. There is strong evidence that the ‘‘function’’ of objects is a primary basis for the construction of concepts and for doing the categorizations. This is an idea which matches Piaget’s sensory–motor basis of early cognition, since the actions that we can perform on objects are primitive definitions in terms of function (Nelson 1977). What is meant, here, is a broadening of our cognitive structures from the rather limited linguistic categories to those categories that are the outcome of perceptual–motor interactions with the environment (Mazet 1991). It restates the hypothesis that there is a correspondence between the structure of our categories and the degree of functional interaction of individuals with their environment (Dougherty 1978). As such, it broadens the field of categorization from mere perceptual to functional categories, integrating both perceptual attributes and classes of action (Mazet 1991).

Translated to the domain of music this means that we should try to understand music in terms of perceptual–motor interactions with the sonic environment and describe the music not only in terms of ‘‘nouns’’ and ‘‘adjectives’’ – which refer to perceptions of the environment – but in terms of ‘‘action verbs’’ as well: the word ‘‘chair’’, for example, means something to sit down or get up. As such, we can describe things in terms of their activity signature (Beck 1987). This motor element in categorization was already advocated in earlier theories of categorization (Rosch & Lloyd 1978) but the translation to the realm of music is still to be done (see Delalande 1984; Lidov 1987; Reybrouck 2001b). What is needed, in particular, is a description of music in terms of its ‘‘action aspect’’ and to consider its ‘‘activity signature’’ in different descriptions: the sound producing actions proper, the effects of these actions, the possibility of imaging the sonorous articulation as movement through time, the mental [259] simulation of this movement in terms of bodily based image schemata and the movements which can be possibly induced by the sounds (Godøy 1997, 2001a, b; Reybrouck 2001b). Sound producing actions, further, can be simple in their phenomenological appearance but complex in their sounding results (God.y 2001b), but, as a rule, they allow a kind of motor categorization of sounding events, which refers to singular (hitting, stroking, kicking, blowing) or complex or compound ‘‘sound-producing actions’’ (drumming a rhythmic pattern, sliding up and down a melodic contour). The same holds true for many ‘‘metaphors’’ which are used in talking about music (Godøy 1999, 1997). The whole approach is pointing towards a new area of research. Music cognition is not a special ability which is accessible only for gifted individuals. It is grounded in our cognitive abilities which, in turn, are part of our biological equipment. As such, it is possible to conceive of the biological roots of musical epistemology.

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