Enactive Music Cognition: Background and Research Themes

Jakub Ryszard Matyja • University of Huddersfield, UK • jrmatyja/at/gmail.com
Andrea Schiavio • University of Sheffield, UK • a.schiavio/at/sheffield.ac.uk

> Context • The past few years have presented us with a growing amount of theoretical research (yet that is often based on neuroscientific developments) in the field of enactive music cognition. **> Problem** • Current cognitivist and embodied approaches to music cognition suffer, in our opinion, from a too firm commitment to the explanatory role of mental representations in musical experience. This particular problem can be solved by adopting an enactive approach to music cognition. **> Method** • We present and compare cognitivist, embodied and enactive approaches to music cognition and review the current research in enactive music cognition. **> Results** • We find that, in general, the enactive approaches to human musicality are capable of explaining the basic relationship between a musical subject and a musical object according to a pre-conceptual and pre-linguistic form of understanding related to bodily motor expertise. This explanation does not rely on on sophisticated forms of representation. **> Implications** • Proponents of enactive music cognition should, in our opinion, focus on providing a consistent explanation of the most basic level of musical understanding. **> Constructivist content** • We hope to invite the constructivist community to engage with the discussions on the intersection between music and enactivism. **> Key words** • **Music, cognition, embodiment, enactivism, musical understanding.**

Introduction

In this survey, we summarize the current state of research in enactive music cognition (EMC). We begin with a brief description and criticism of the classic cognitivist account. Then, we discuss what sort of alternatives embodied and enactive approaches claim to offer, and finally review recent publications and their main themes and implications.

Cognitivist accounts

A common account in investigating musical experience is shaped upon the classic cognitivist perspective of perception, where the mind's processes are understood in terms of representations and high-level information computations (Neisser 1967, 1976). In league with the traditional Cartesian stance, this standpoint holds that representations can be defined as symbols, images or neural configurations, used to generate in our minds a *virtual copy* of the world (see Hutto 2009 for discussion). These brain's information-bearing structures allow us to make sense of the objects of our perception as the real world provides us with a stream of information that we interpret within our mind, creating a *representation* of it. What we are aware of, therefore, is not the actual world but, rather, its inner replica. Jerry Fodor (1980), for example, defended the thesis of "methodological solipsism," in which the agent's mental properties can be defined only on the basis of these particular mental states or in their relationship with other inner states, without considering the world where the agent is embedded as having any sort of reference.

In a musical context, this paradigm has been variously interpreted and defended, both explicitly (e.g., Lerdahl & Jackendoff 1983) and implicitly (e.g., Nussbaum 2007 – see below for discussion), giving rise to different interpretations and applications (see Huron 2006 for a focus on musical expectations). To understand the basis of this perspective, where the musical stimulus is conceived in terms of an abstract and unidirectional stream of information encoded and processed by the brain, we can go back as far as the seminal work by Hermann von Helmholtz (1863). He provided one of the first accounts aimed at investigating music perception in terms of mere physiological processing. His work gave a neurophysiological explanation of some of the key aspects of Western musicality, such as perception of consonance and dissonance, harmony and tonality and provided "the physiological grounding for gestalt psychology in the first half of the twentieth century, and for the cognitive sciences approach for the second half of the twentieth century" (Leman 2008: 29). In a well-known paper, Marc Leman and Albrecht Schneider (1997) described the origins of modern cognitive and systematic musicology (see also Parncutt 2007) by analysing the revival of gestalt perspectives as well as cognitive accounts. Considering the cognitive perspective, they referred to the study by Allen Newell (1982) as representative of the *symbol system approach*, where "propositional representations of music were believed to be a proper starting point for the study of musical cognition" (Leman & Schneider 1997: 18–19). The rise of cognitivist musicology was also characterized by a strong link with the research in linguistics by Noam Chomsky (1965) and the computational approach in the field of artificial intelligence (Laske 1977). For instance, Leman and Schneider examined musical semiotics – the study of the musical signs and their meaning (see Monelle 1992) – from a purely linguistic point of view (Ruwet 1975) as well as from Charles Sanders

Peirce's theory of signs. These approaches, in league with the classic *modular* account of the mind provided by Fodor (1983), could be summarized in the massive trend in current music psychology that ultimately aims to draw an accurate map of specialized brain areas involved in music processing in order to provide a universal description of musical abilities. The following quote clarifies the idea behind this area of research:

> "As with language, specific areas of the brain seem to be devoted to the processing of music information. If we could grasp universal principles of musical intelligence, we would get an idea of how our music understanding gets refined and adapted to a particular musical style as a result of a developmental process triggered by stimuli of that musical culture." (Purwins et al. 2008: 152)

In other words, the localisation of musical brain modules (which represent "universal principles of musical intelligence") might lead to a satisfactory explanatory model of musical understanding despite developmental and cultural differences. According to Isabelle Peretz and Max Coltheart (2003), several unique brain modules underlie different musical sub-functions, such as pitch and temporal perception, and serve as a genuine hierarchical structure for encoding musical stimuli. However, the modular account has been heavily criticized (for example by Karmiloff-Smith 1992 and Uttal 2003), not only from a theoretical perspective (Prinz 2006) but also from the view that the history of *homo sapiens* "is simply not sufficient, under any plausible scenario, for genetic variation and natural selection to have created many different and independent human cognitive modules" (Tomasello 1999: 55).

The representationalist account is still widespread, even if sometimes it manifests itself in disguise. In a more recent work, for instance, Charles Nussbaum (2007) claimed to have developed an *embodied* approach to musical meaning. This approach assumes that a listener would develop a *mental map* of the bodily actions elicited by the music. In particular, the author explicitly refers to music as a supplier of extra-musical content, such as physical movements or mental states with religious characters. The role of the body is therefore merely *passive* because, for Nussbaum, what allows the understanding of music is the listener's ability to infer non-musical contents and build a representation of them in her/his brain. Music learning, too, is understood as "a process by which mental representations (genuine musical conceptions) are developed and gradually altered, differentiated, extended, and refined" (Gruhn 2006: 17). This shows that the cognitivist paradigm is still used as an important tool for musical understanding and education.

In contrast to the cognitivists, many authors maintain that "the human mind is embodied in our entire organism and embedded in the world, and hence is not reducible to structures inside the head" (Thompson 2005: 409). Francisco Varela, Evan Thompson & Eleanor Rosch (1991) argued that traditional cognitive science of music suffers from the so-called *Cartesian anxiety* (as it assumed that "to know" means to have internal representations of information we are passively encoding from the so-called "external world.") So "a different way of conceiving brain function, specifically in non-representational, integrative and dynamical terms" (Gallagher et al. in press) has been posited. We will show in the remainder of this article that EMC provides such an alternative to cognitivist accounts as it focuses on the pre-conceptual levels of music cognition, advocating for a definition of music as an object of the world in which the agent is embedded, rather than assuming the concept of mental representations as playing an explanatory role on every (even the basic) level of humans' interactions with music.

Embodied and enactive cognitive sciences of music

Inspired by the contemporary sciences of mind shaped upon the broad notion of *embodiment* (e.g., Johnson 1987; Gibbs 2005 for an overview), music researchers have started to lay the foundations of an embodied music cognition paradigm, putting together arguments from embodied phenomenology (Pelinski 2005; Schiavio 2012) and evidence from cognitive neuroscience (e.g., Lahav, Salzman & Schlaug 2007; Overy & Molnar-Szacaks 2009). Although there are various definitions of and approaches in *embodied cognition* (Gallagher 2011), its central claim can be roughly summarized in the idea that cognition relies on processes widely distributed through the bodily structures (cf. Wheeler 2005; Thompson 2007; Clark 2008; Shapiro 2010, 2011). There is a common agreement that this theoretical framework has roots in Immanuel Kant's (see Carpenter 2008) and Maurice Merleau-Ponty's (1945) respective philosophies, and radically challenges cognitivist accounts. As pointed out above, cognitivism advocates the existence of mental representations specified by functionally related brain mechanisms. Susan Hurley (1998) referred to this standard view on cognition as a "sandwich," where the meat (cognition) is segregated between two slices of bread (perception and action). By contrast, the *embodied approach* posits a representational equivalence between perception and action (Rizzolatti & Sinigaglia 2008) and considers cognition as emerging from the dynamic interaction between bodily experience and neural processes. In this line of thought, Marc Leman argues in his book *Embodied Music Cognition and Mediation Technology* (2008: xiii; see also Matyja 2010) for the understanding of the human body as the biologically designed mediator between musical subjects and their musical environment. In his view, the body enables the transfer of physical musical energy to a "mental level," allowing the agent to make sense of the musical material in light of her motor expertise. What is more, the human body is also able to transform ideas (or mental representations) into the form of sound. Despite the promising recognition of the *active* role of the bodily power of action in musical processing, Leman's writings on embodied music cognition are firmly committed to a form of *mediation* between mind and body, thus far from a truly embodied kind of sense-making. This emerges when considering Leman's notion of "cerebral intentionality," which in music "explores the speculative pursuit of potential interpretations. The essence of cerebral intentionality is interpreting the source of intentions attributed to music" (Leman 2008: 84). This kind of speculative intentionality presents, in our understanding, a miscomprehension of the general embodied claim in which the *intentions attributed to music*, too, could be coded by an agent without any inferential mediation (see Overy & Molnar-Szakacs

2009). In fact, in light of the mirror mechanism theory of action understanding (Rizzolatti &Craighero 2004; Rizzolatti & Sinigaglia 2008; Gallese et al. 1996; Rizzolatti et al. 1997; Kohler et al. 2002; Gallese, Keysers & Rizzolatti 2004), the comprehension of goal-directed actions, emotions and others' intentions (Gallese 2009) depends on the ability of the agent's motor system to simulate them internally without dealing with sophisticated cognitive analysis (Sinigaglia 2008a, 2008b). The role of the *body as mediator* between the brain and the auditory signal, in fact, assumes aprioristically a starting dichotomy between the agent and the musical object. This assumption reflects a position à la Mark Rowlands (2006) where a representation is conceived as an *explanans* used to shed light on – in principle – non-representational modalities (actions), making redundant the concept of representation itself (Gallagher 2007).

First emerging within the dynamicist approaches to embodiment (see Froese 2009), the *enactive paradigm* (Varela, Thompson & Rosch 1991) offers a remedy here, as it provides a stronger anti-representationalist framework, still sharing with the embodied paradigm the same focus on the agents' situatedness and corporeality. Broadly speaking, enaction posits that cognition is essentially sense-making (De Jaegher & Di Paolo 2007, 2008), as experiences are seen as being constituted by the agent's meaningful engagement with the environment (Stewart, Gapenne & Di Paolo 2010) and thus not to be considered as soplipsistic inner events (see also Dreyfus 2002). Within to this paradigm, the role of mental representations is dramatically reconsidered. In fact, as Hanne De Jaegher (2010) clearly states, *enaction* denies that the only way to explain thinking or inferential skills is by means of employment of representational mechanisms, where the agents' brain is "playing around" with extremely controversial concepts such as "belief" or "pretend."

With regards to music cognition, the general distinction between embodied and enactive approaches lies in the scope of their research and their commitment to the explanatory role of mental representations. The enactive standpoint (EMC) tackles the most primal, basic and intimate levels of our musical involvement (which, in the approach of *radical enactivists* such as Hutto & Myin 2013, do not necessary involve inherently contentful mental representations), and is to be seen as providing the necessary theoretical basis for any further research on music. In the approach of his seminal works on EMC, Mark Reybrouck (2005b, 2012) draws heavily on classical works in constructivism. In opposition to cognitivist accounts of music, he provides arguments for the understanding of music as a "tool for adaptation to the sonic world" (Reybrouck 2001). Reybrouck (2005a) sees music as something that is "heard and "enacted" upon, rather than being merely imagined or represented." He also reflects on the issues of musical epistemology not only using the biological concept of adaptation to realms of cognition but also relying on the works of Jean Piaget (1976) and the constructivist epistemology of Ernst von Glasersfeld (1995) and Jacob von Uexküll's concept of "umwelt" (roughly defined as an organism's environmental niche possessing a meaning for that organism, thus representing its model of the world):

> "…[r]ather than stating that music, as an artifact, is 'out there,' ready to be discovered, I claim that music knowledge must be generated, as a product of development, and that music cognition is not a path towards a true understanding of the music as an ontological category, but a tool for adaptation to the sonic world." (Reybrouck 2001: 599)

Music and consciousness

Recent works on consciousness and music (e.g., the collection in Clarke & Clarke 2011) also provide interesting perspectives on EMC. Referring to Varela, Thompson and Rosch's (1991) views, which consider consciousness as enactive cognition and knowledge depending on our bodily being in the world, Bennett Hogg (2011) discusses the ideas of sonic *intertextuality* and free musical improvisation. Hogg, who is also a practicing improviser and composer, describes music as intertextual because sounds do not carry meanings in and of them, but rather are the sites of:

> "complex and mediated sets of relationships between physical sounds, perceptual systems, personal associations, culturally significant gestures, bodily and emotional responses, observed actions and reactions, and culturally learned expectations." (Hogg 2011: 89)

Hogg claims that from this perspective, it is easy to see that if being conscious of music is something we *do* rather than something that is *happening* to us, it takes place within both the cultural and the physiological constraints (of our bodies): music consciousness is an *embodied* and *encultured* activity. The same applies to musical improvisation. According to Hogg, it needs to be defined in terms of the *play* across our memory, embodiment and situated consciousness, and includes multisensory experiences and actions that lead to our perceptions of sounds. In line with Reybrouck's writings and in opposition to Nussbaum (2007), Hogg's claims resemble the position of Vijay Iyer (2004), an established jazz pianist, who maintains that music perception (and music cognition itself) is *actively* constructed by the listener, rather than passively transferred from performer to listener within the given culture and context. Interestingly, this claim parallels von Glasersfeld's (1988) principles, according to which knowledge is actively built up by the cognizing subject instead of being passively received by senses or ways of communication. In his papers, Iyer argues that discernment of pulse and meter from a piece of music depends on a person's culturally contingent listening strategies. Iyer thus argues that certain varieties of *microrhythmic* variations (within the rhythmic expressions of our embodied involvement with music) are shown to display and carry encoded sonic traces of the culturally situated music-making bodies (Iyer 2004). Importantly for the proponents of sensorimotor enactivism, Iyer (2004) also draws on Alva Noë's work, in particular on his understanding of perceptual experience as a "temporally extended process of exploration of the environment on the part of an embodied animal" (Noë 2000: 128).

The interrelation between enactivism and musical consciousness is also visible in the recent work of Alicia Peñalba Acitores (2011). She considers her work as an application of Kevin O'Regan and Alva Noë's *sensorimotor contingency theory*, in which "the knowledge of the ways movements affect sensory stimulation is necessary for ex-

perience" (O'Regan & Noë 2001: 1055), and defines primary musical consciousness as *awareness of musical material*. Bodily movements (such as the rotation of the head or movements of the whole body closer to the sound source in order to increase the amplitude) and the knowledge of sensorimotor contingencies guiding them are claimed to be crucial for auditory perception. Acitores goes further and points out that sensorimotor contingency theory and James J. Gibson's theory of *affordances* (Gibson 1966, 1977, 1979; E. J. Gibson 2000) are deeply interrelated when explaining perceptual experience. *Affordances,* quite vaguely defined by Gibson himself (see Heft 2005 for further discussions), are perceived as environmental opportunities for goal-directed actions. Unfortunately, Actiores does not go into the often-discussed issue of what *musical affordances* could be (for propositions on musical affordances see DeNora 2000; Clarke 2005; López Cano 2006; Krueger 2011; Reybrouck 2012). Rather, she hypothesizes a strong interrelation between the concepts of so-called *bodiliness* (the fact that when you move your body the incoming sensory information changes immediately, see O'Regan, Myin & Noë 2004) and *grabbiness* (the fact that sensory stimulation can grab and turn your attention away from what you were previously doing), and the explanatory importance of these concepts for some unclear issues in Gibson's theory of affordances. By her so doing, her work suggests that theorists should account for musical *bodiliness* and *grabbiness* in further theories of conscious, enactive musical experience.

Musical actions and intentions

In one of his papers, Joel Krueger (2009) applied an enactive model of perceptual consciousness to the experience of listening deeply (that is: sensitively and understandingly) to an instrumental piece. The very idea of musical experience (understood as an enactive, skilful, exploratory activity) challenges classical ways of thinking about musical experience found in contemporary aesthetics of music (Kivy 2002). The latter (leading to over-intellectualized accounts) relies on the idea that the very acquisition of knowledge (in the sense of formal musical training) is both necessary and sufficient for musical understanding. Krueger, by contrast, suggests that sensitive music listening is a kind of *doing*: "[W]e enact music perception via the sensorimotor manipulation of sonic structures" (Krueger 2009: 104). Krueger (2011) goes further by defining the role of *musical affordances* in terms of processes pertaining to emotional regulation and to social coordination that affordances enable. As such, Krueger comes to another important issue – the understanding of the actions and the intentions of others. In the context of musical research, this extremely important issue is connected with the role of the body for the listener (which responds and resonates to music) and the performer (who acts on a musical instrument to produce sounds). According to a disembodied interpretation, the status and identity of a given action rely on the ability to "mind-read," namely, to attribute specific mental states to others. As we previously saw in Nussbaum, indeed, the ability of a listener to understand a musical piece is strictly related to her ability to build cognitive high-level representations. Enactivists such as Reybrouck take a different position here:

> "Sounds […] are the outcomes of human actions. Even if they are not self-produced, they can induce a kind of (ideo)motor resonance that prompts the listener to experience the sounds as if they have been involved in their production." (Reybrouck 2005a: 3)

This view is consistent with the SAME model (which stands for "Shared Affective Motion Experience") provided by Katie Overy and Istvan Molnar-Szakacs, which holds that "musical sound is perceived not only in terms of the auditory signal, but also in terms of the intentional, hierarchically organized sequences of expressive motor acts behind the signal" (Overy & Molnar-Szakacs 2009: 492; see also Molnar-Szakacs & Overy 2006). From this perspective, the listener (according to his or her motor expertise) is able to extract different levels of motor information:

1 | the *intention* level, which defines the long-term goal of a given action;
2 | the *goal* level, which describes the basic goals that lead to the achievement of long-term intentions;
3 | the *kinematic* level, which deals with the space movements of the body;
4 | the *muscle* level, which comprehends the pattern of muscular activity required for the actual execution.

In the general line of sensorimotor contingency theory, it can be argued that it is our *vocabulary of acts* (Rizzolatti & Sinigaglia 2008), i.e., our motor knowledge, that determines our level of (musical) understanding. The sensory stratifications evoked by the musical object are considered to be inherent in the motor repertoire, rather than underpinned by high-level modular-based internal representations. What we intend for the motor repertoire, or motor knowledge, is an actual "vocabulary of acts" constituted by the set of neurons that code specific goal-directed actions (Rizzolatti & Luppino 2001: 891). The form of cognitive understanding based on high-level abilities is not totally excluded: the point here is that the agents' immediate relationship with music is shaped by a specific kind of intentionality (see Schiavio 2012), based on the agent's motor expertise, which *enactively* allows the listener to make sense of a musical object *before and below* any metacognitive, inferential subordination (Gallese 2007). This assumption disregards the high-level forms of musical understanding that are not shaped by motor knowledge such as music theory, musical analysis, etc. Those forms are moulded by a more theoretical kind of sense-making and thus cannot be accounted for by EMC.

Conclusion

In our survey, we aimed to provide an overview of current themes in research on EMC. We have firstly focused on a cognitivist and embodied account of music cognition, underlying the tendency to deal with an implicit dualistic stance. In particular, we have discussed the ways in which embodied approaches to music cognition are still committed to such residue of cognitivist views. Accordingly, we have distinguished between embodied and enactive approaches to music cognition on the basis of their commitment to the role of mental representations. We have then suggested that the problems of cognitivist and embodied approaches to music cognition are to be overcome by adopting an *enactivist* point of view. Next, we reviewed works in enactive music cognition (considering also

JAKUB RYSZARD MATYJA
is a PhD student of philosophy at the Polish Academy of Sciences, Warsaw and of music at the University of Huddersfield, UK. He graduated from the University of Edinburgh (MSc in Mind, Language and Embodied Cognition) and is currently working on embodied and enactive (music) cognition.

ANDREA SCHIAVIO
is currently a PhD student in Music Psychology at the University of Sheffield, having graduated in philosophy of science and in musicology from the University of Milan. His research is on the phenomenological and developmental implications of the embodied and enactive approaches to human musicality, in light of the mirror mechanism's theory of action understanding.

their relation to constructivist literature), noticing their focus on the basic, pre-conceptual and pre-linguistic level of music cognition: the level related to the bodily power of action and motor expertise. In our opinion, this attention towards these basic aspects of musicality enables EMC to explain the basic relationship between a musical subject and a musical object. Although much further work remains to be done in this field, we see such a motivated approach to music cognition as a firm chance to provide a new and refreshing view on the nature of musical understanding.

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