

Participatory sense-making in joint musical practice

Andrea Schiavio^{1,2} & Hanne De Jaegher^{3,4}

Abstract

Drawing from recent embodied and enactive frameworks in the cognitive sciences, in this chapter we explore musical interactivity as a form of ‘participatory sense-making’. In providing conceptual grounding, we adopt the notion of ‘mutual incorporation’ inspired by the phenomenological tradition, and argue that joint musical practice is best understood when considering performers as autonomous and interactive agents who negotiate in real-time their emotional, sensorimotor, and communicative skills. Finally, we put forward some hypotheses for future research through a dynamic systems approach.

1. Introduction

In this chapter we explore musical interactivity as a form of ‘participatory sense-making’ (De Jaegher & Di Paolo, 2007). This concept is associated with emerging embodied approaches to cognition, which pose a growing challenge to the information-processing or ‘cognitivist’ models that have traditionally (and often tacitly) directed research and theory in psychology and cognitive science (see Clark, 1997). According to the latter framework, cognition is understood as an input-output schema where strict separations are posed between an objective reality ‘out there’ and the ‘inner’ skull-bound mechanisms that process representations of that outer world. However, locating cognition ‘in the head’ may play down the active role of the *situated living body* in meaning- and world-making, and tends to portray the cognizer as a disembodied, decontextualized, and anonymous ‘spectator’ in both individual and collective tasks (Varela, Thompson, & Rosch, 1991).

In response to such concerns, the embodied approach understands mental processes not simply as ‘in the head’ – i.e. in terms of mechanisms, computations, representations – but rather as fundamentally integrated with the body of the cognizer in different ways (Thompson, 2007). Researchers have put forward a number of different interpretations to explain how this could be so (Gallagher, 2011). For example, advocates of a ‘sensorimotor’ approach maintain that what truly matters for cognitive processes is the mastery of certain concrete abilities that allow the animal to interact with the world (O’Regan & Nöe, 2001). Others have adopted a more ‘enactive’ interpretation, which considers the living body not only as the primary source of significance for our being-in-the-world, but also as a truly autonomous cognitive system in its own right (Varela, 1979). Here the origins of ‘mind’ are to be found in the embodied processes through which an organism maintains itself through constant adaptive interactivity with the environment - where the body’s biological structure determines the regulation and control of the homeostatic needs of the cognizer, who continually strives to maintain a stable relationship with its niche through affectively motivated forms of action-as-perception (Stewart, Gapenne, & Di Paolo, 2010). In other words, the body’s metabolic, homeostatic, neurologic, immune, and thermodynamic systems allow the living self-organising creature to interact with the world in a way that is meaningful in terms of its being-in-the-world: because the system’s

¹ Cognitive and Systematic Musicology Lab, School of Music, The Ohio State University, USA

² Music Mind Machine in Sheffield, Department of Music, The University of Sheffield, UK

³ IAS-Research Centre for Life, Mind, and Society, Department of Logic and Philosophy of Science, University of the Basque Country, Spain

⁴ Centre for Cognitive Science, Department of Informatics, University of Sussex, UK.

autonomous existence depends on maintaining metabolic stability under shifting worldly conditions, both bodily and environmental factors participate in driving cognitive processes in a recursive interplay (Di Paolo, 2009). This means that whilst being an autonomous system, the body is also deeply intermixed with its niche as central aspect of the cognitive system's being-in-the-world. The relational domain of cognition is thus not reducible to structures 'inside the head' but is rather constituted by the active interplay between living system and its environment, which are understood to be co-emergent (Chemero, 2009).

It should be noted here that this enactive view of embodied cognition, as originally put forward by Varela and colleagues (1991) and then developed by a number of other authors (e.g. Colombetti, 2014; Thompson, 2007; Hutto & Myin, 2013), contrasts with positions such as 'extended functionalism' for example, which sees the body as a tool that mental operations can be offloaded onto, without offering a truly phenomenological and autonomous account of it (see Wheeler, 2010). Indeed, from the enactive perspective, a living, phenomenological, body is not merely an objective piece of the world that helps us perform particular perceptual or cognitive tasks, nor can it simply be understood as a mediating category that separates *de facto* the realm of inner subjectivity from the world 'out there'. Rather, it is the fundamental source of experience open to the social and physical environment, a flexible entity that participates adaptively in the world (Kyselo, 2014).

Embodied approaches to the study of human musicality, especially in relation to human ontogenesis, well-being, and how we make sense of the social and cultural environments we inhabit, emerged in recent years from a variety of perspectives (Leman, 2007; Reybrouck, 2005; Schiavio & Altenmüller, 2015). In particular, a growing number of empirical studies have provided evidence in support of an embodied interpretation of musical experience (Broughton & Stevens, 2009; Leman, Desmet, Styns, Van Noorden, & Moelants, 2009; Toiviainen, Luck, & Thompson, 2010). This work is exceptional in highlighting the role of the body for music performance, emotion, and perception (Keller, 2014; Maes, Leman, Palmer, & Wanderley, 2014a; Maes, Van Dyck, Lesaffre, & Leman, 2014b). However, it is from a more explicitly *enactive* perspective that we would like to discuss the concept of 'participatory sense-making' in the following sections (De Jaegher & Di Paolo 2007). This concept, situated within an enactive and phenomenological framework (Gallagher & Zahavi, 2008; Hanna & Maiese, 2009), may help us better comprehend the complex dynamics in play when musicians interact and cooperate to achieve a musical task (Schiavio, 2014, Moran, *this volume*; 2014a; 2014b). Indeed, operating from this perspective will allow us to highlight the concrete patterns of sensorimotor, emotional, and communicative interaction among musical subjects, and provide an alternative to what can be named the 'spectatorial stance'. The latter, it may be argued, reflects a common perspective in cognitive science based on the assumption that the individual 'unit' is sufficient to explain interaction (Reddy & Uithol, 2015). In musical research, for example, studies framed within so-called *simulation theory* may consider musical interactivity as a matter of the individual - as the single individual can simulate internally the actions performed by the other performer(s) and respond accordingly - rather than of the interaction itself (e.g. Keller, Knoblich, & Repp, 2007; Schiavio et al., 2014).

With this in mind, we also contrast this traditional view with the phenomenological approach of 'mutual incorporation' – which describes the way in which two or more (musical) subjects form a common *intercorporality* when acting together (see Fuchs & De Jaegher, 2009). The remainder of the chapter will be structured as follows: in the next section we introduce the notions of 'participatory sense-making' and 'mutual incorporation' in the context of the embodied and enactive frameworks considered above. We then explore these two concepts through the lenses of musical agency and interactivity. To conclude we discuss the main implications emerging within the broader context of musical research, and make predictions for further empirical corroborations.

2. Embodiment, Participation, Incorporation

Embodied and enactive approaches to cognition ask us to rethink the relationship between brain, body, and world (Wilson, 2002). They help us reconsider the meaning of body by emphasising its dynamical and

self-determining properties, and to re-define the ‘world’ not as a given category ‘out there’, but rather as an affordative structure, which has certain values and meanings depending on the adaptive complexity of the cognizer who interacts with it (Colombetti, 2014). In doing so, such frameworks do not identify ‘brain’ with ‘cognition’ or ‘experience’ because *extra-neural* (environmental and bodily) factors are co-constitutive in driving mental processes (Di Paolo & De Jaegher, 2012). This implies that there is a primacy of bodily-based skills over high-level mental faculties to understand how living beings participate in the changing dynamics of the world (Rizzolatti & Sinigaglia, 2008). Indeed, by adaptively developing its network of flexible self-generated properties and actions in relevant ways, the animal is able to maintain its own organization under precarious conditions (Varela et al., 1991). This idea is also known as ‘autonomy’, as the living system generates everything needed to stabilise its engagement with the world. But since these properties are self-regulated by the constant interaction of the system’s neural and extra-neural sub-networks, it is argued that the cognizer is also a ‘sense-maker’; that is, the creature must self-generate its own goals, significance, and meanings as it actively seeks out and develops the affordances of the environment (Thompson, 2007). In other words ‘sense-making’ defines cognition for enactivists because it accounts for the meaningful ways in which the living being interacts with the world. In the social domain, these enactive sense-making processes are explored in the study of interaction (e.g. van Alphen, 2014; Bourbousson, R’Kiouak, & Eccles, 2015), which represents a growing area of research across diverse fields such as development (e.g. Reddy, 2003; 2008), neuroscience (e.g. Favela, 2014; Kiverstein & Miller, 2015), pathology and therapy (Koch and Fischman, 2011; Behrends, Müller, & Dziobek 2012; Samaritter & Payne 2013; Øberg, Normann, & Gallagher, 2015), philosophy of mind (e.g. Gallagher, 2008; De Jaegher & Di Paolo, 2007), and music (e.g. Correia, Tahiroğlu, & Espada, 2013; Moran, 2014a; 2014b).

2.1 Sharing musical worlds of meaning

In social contexts, ‘sense-making’ is ‘participatory’ because social dynamics such as coordination and interaction may affect individual sense-making (De Jaegher, 2009). This can be seen, for example, in interactions between infants and primary caregivers - where infants are not passive responders, but actively participate in the development of shared forms of communication and meaning-making through bodily and facial gestures and (proto-musical) utterances (Fantasia, De Jaegher, & Fasulo, 2014). In such primordial social coordinations, meanings and intentions are not pre-given but rather are “shaped and adjusted as the interaction unfolds” (Fantasia et al., 2014, p.6). With this in mind, we argue that because skilled coordination is a fundamental part of making music together, musicians (and audience), as a coupled system, participate *in, and thus can form and transform* each other’s sense-making, enacting unique shared worlds of meaning.

Think of two musicians playing together: how is it possible to study, model, and understand their ability to anticipate, complement, and participate in the other’s *musicizing*? The theory of participatory sense-making sees the musicians as interactors, who are first and foremost highly plastic systems (De Jaegher & Di Paolo, 2007; Gallagher, Hutto, Slaby, & Cole, 2013; Kelso, 1995) who negotiate the often-contingent patterns of goal-directed actions to be employed in a musical performance without inferential mediation. By this light, the phenomenological character of playing together cannot be studied through a stimulus-response perspective, nor through a ‘sender-receiver’ framework, because its very nature requires that the coupling among musicians becomes *self-sustaining* (Di Paolo & De Jaegher, 2012).

Put simply, the *relational* nature of musical experience is made explicit by the concrete adaptive activities of the living bodies embedded in the musical environments they co-create in the performance (Schiavio, 2014). Shared musical practices, in this sense, are not fully based in mental processes and behavioural outputs established before the interaction. No matter how many times a trio or a duo rehearses, no matter how much its members practice individually, a collective performance will always entail a different phenomenology - one based on shared agency, shared intentionality and contingently negotiated coupling in that unique context. This is not to say that prior rehearsals do not count in the developing of a musical performance. The set of skills acquired through individual practice and rehearsal constitute a repertoire of

acts, a set of possibilities that must be ‘enacted’ or ‘brought forth’ in light of the affordative demands of the music that is co-created - in and through our actions, emotions, thoughts, feelings, perceptions, we *participate* in the way other creatures make sense of the world, but also depend reciprocally on the others’ sense-making as well (for examples, see Laroche and Kaddouch, 2014). In this way, the dynamical nature of sense-making may reveal the ‘musical object’ not as a fixed, and wholly pre-given structure, but rather as an emergent phenomenon that develops through shared active involvement in the musical event - the musical object is, by this light, an ongoing ‘open’ structure that shapes and is shaped by the sense-makers in a ‘circular’ fashion. This is true not only when considering musicians playing jointly, but also when a musical performance involves an audience (Krueger, 2014a; Geeves, McIlwain, & Sutton, 2016). Indeed, because interactivity is not a property of a single individual who ‘reads the mind’ of the other and ‘responds’ accordingly, there can be musical interactions before explicit communicative processes are achieved (De Jaegher & Froese, 2009; Schiavio, 2012). In other words, musical experience cannot be reduced to a causal process that resembles the classic categorisation of the mind as a problem-solving device - one that perceives the musical event, elaborates a specific mental state (creating a musical mental representation), and produces an appropriate behavioural output. Although nowadays few researchers in music explicitly maintain such a view, it may be argued that leftovers of this position are still tacitly posited when describing collective music making through an input-output schema (see Schiavio & Høffding, 2015 for discussion). Instead, we argue that musical communication is realized in the cooperative generation and transformation of musical meaning; it depends on the embodied participation of everyone involved in realizing the collective musical event and is thus best described in non-linear, dynamical, and phenomenological terms.

2.2 Enacting intersubjective corporeality

From a phenomenological perspective, the way in which musicians play together may be best understood as ‘mutual incorporation’ (Fuchs & De Jaegher, 2009). The process of participatory sense-making is always a matter of gestures, expressions, speeches, and concrete actions, which allows for one individual to be integrated in the body schema of the other in a non-trivial way - as a dynamical source of significance that integrates and complements the subject’s original ‘point of view’ of the world.

To simplify things, we might first consider the notion of ‘incorporation’ where a musical instrument - rather than an embodied agent - is involved. For example, Nijs, Lesaffre, & Leman (2013; see also, Nijs, *this volume*) describe musician-instrument interactions in terms of transparency and incorporation. That is, when playing a musical instrument, an agent incorporates it into her cognitive system rather than simply ‘using’ it as an occurrent object. Consider Merleau-Ponty’s famous example of the blind man using a cane. As the cane becomes a transparent tool, incorporated into the agent’s body image like an “extension of the bodily synthesis” (1945 [1962], p. 153), the blind man becomes able to ‘see’ through his cane by interpreting the data of the world without any inferential mediation (i.e. without measuring the cane in order to understand the distance of an object or feeling the pressure on his hand when the stick hits an object). Similarly, musical instruments may become transparent tools during performances (see also Heidegger, 1927). Here, Merleau-Ponty’s analysis of the organist is illuminating. Like the blind man, the organist explores a new instrument without analysing the instrument in a disembodied way. He does not prepare a plan, or develop abstract cognitive representations of the registers and the pedals (ibid.). Indeed, during the rehearsal or during a concert, the keys, the registers and the pedals are not simply located in an objective space. Rather, they become a horizon of musically-directed motor possibilities, and are therefore intermixed with the musician’s physiology and the musical environment in constitution.

These insights resonate with the idea of ‘transparency constraint’ proposed by Thompson and Stapleton: “for anything external to the body’s boundary to count as part of the cognitive system it must function transparently in the body’s sense-making interactions with the environment” (2009, p. 29). In joint musical practices, sense-making is always participatory in a strong sense, because both the ‘object’ (the musical piece) and the dynamical process shaping it (playing together) are possible *only* through the systematic and

recursive influence of each individual on another. Thus, like the relationship between musicians and their instruments (i.e. as ready-to-hand equipment), the relationship between musical participants can be seen as enmeshed, where the horizon of possibility is constituted by their embodied interactivity - the common intercorporeality 'lives' in the music and in the embodied interactivity that constitutes it. It is a dynamical process that shapes and is shaped by the music, the musicians (with all their sense-making activities), and the audience (with all their sense-making activities) (Geeves & Sutton, 2014; Krueger, 2014b; 2014c). To repeat, music in intersubjective contexts is never 'fully constituted' - it is not 'given'. Rather, it is always shaping and being shaped, through time, space, and interactive dynamics - all these elements are coupled together in musical perceptual experience. Interestingly, from a neuroscientific point of view, the dynamics of actions present in the musical feedback have been shown to occur pre-attentively, further highlighting the active role played by the body - over reflective awareness - in constituting musical experience (Lahav, Saltzman, & Schlaug, 2007; Overy & Molnar-Szacaks, 2009; Schiavio, Menin, & Matyja 2014).

Taken together, 'participatory sense-making' and 'mutual incorporation' point to a theoretical framework in which the coupling of interactors through participatory sense-making constitutes new intersubjective biocognitive organizations. By this view, the creative, transforming, and shared forms of embodied world-making that characterize *living* musical interactions display a bidirectional relationship with the 'musical object'. They are irreducible to mindreading, simulation, and sender-receiver modelling; as well as purely 'in-the-head' cognitivist approaches. As such, we argue that further empirical and theoretical frameworks aimed at investigating musical interactions should investigate the domain of mutual codetermination unfolding among music users and music makers (see D'Ausilio, Novembre, Fadiga, & Keller, 2015; Demos, Chaffin, & Kant, 2014; Glowinski, Mancini, Cowie, Camurri, Chiorri, & Doherty, 2013).

3. Conclusion: dynamically open co-creation of music

In this chapter we examined how a phenomenological and enactive perspective on embodied musical interactivity enriched by the notion of 'participatory sense-making' may inspire a more nuanced understanding of the complex dynamics involved in joint musical practices. In doing so we are heeding the call of Moran (2014b), who shares with us some of the same worries concerning the legacy of individualism in music psychology research - we agree with her that we need to highlight social interactions as the heart of joint musical behaviours and develop our research agenda accordingly. With this in mind, we find that enactive-friendly approaches to cognition provide a fertile ground for such an enterprise - one that may open fascinating new perspectives for the study of human musicality and cognition (van der Schyff, 2015). To anticipate a likely objection, however, we want to clarify that we do not endorse an implicit version of behaviourism, or interactionism. Enactivism differs from both. First, as acknowledged by Moran (2014b), enactivists do not tend to reduce 'meaning' to behaviour only. Meaning is rather 'enacted' through the history of structural coupling between organisms and environment; it depends on neural and extra-neural (bodily, wordly, interactive) factors and as such is not simply dependent on or causal to behavior. Rather, behavior and meaning, perception and action, low level and high level, are always mutually and dynamically interacting in non-linear terms. This makes enactive approaches to music cognition highly attractive, not only with regard to studying the relationship between music and movement, but also for the processes of interaction and meaning-generation itself. In fact, while we recognise the outstanding work made by recent studies on movements analysis for communication, sensorimotor synchronization, and interactions among performers (e.g. Badino, D'ausilio, Glowinski, Camurri, & Fadiga, 2014; Repp, 2005) we also notice the risk of being committed to an individualist or Cartesian framework when movements are not coherently integrated with the constitutive dynamics of meaning-making and interaction. We say 'Cartesian' because some may interpret the focus on movement analysis as representing movement as a *distinct* category from cognitive processes, giving rise to the dichotomy we previously discussed between inner subjective

experience and objective external world. This may emerge, for example, when the notion of mental representation is adopted to describe the way in which performers elaborate a stimulus ‘in the head’ before generating a relevant behavioral outcome (e.g. Davidson, 2005). Also, our framework is different from *interactionism* (see De Jaegher & Di Paolo, 2013). Indeed, while we consider interactivity to be necessary for understanding (music) cognition, we do not endorse a view that sees embodied interactions as *sufficient* for cognitive processes to take place. Rather, interactions are understood as fundamental to sense-making, which shapes how living systems engage with the world and as autonomous entities; they entail the study of how individual and participatory forms of sense-making relate and affect each other in non-reductionist terms (Di Paolo & De Jaegher 2016).

Lastly, while we argue that methodological individualism may fall short of capturing the concrete dynamics of musical interactions, we do not attempt to make interactivity the only factor in play. This is best understood when considering how dynamical systems may elegantly model interactive situations (Kelso, 1995). Good examples of the application of dynamic system to musical performance and entrainment come from Clayton (2013), while other studies have focused on musical tonality, (Large, 2010), and interactive performance and artificial systems (Zhang & Miranda, 2007) among others. Dynamic systems are indeed useful in characterizing living systems as truly open, context-dependent, but at the same time “patterned and recurrent” (Colombetti, 2014, p. 58) creatures. As De Jaegher and Di Paolo (2007) put it, considering interactions as autonomous processes allows dynamic systems models to study the histories of *coordination*, *breakdowns*, and *recoveries* that characterise self-sustaining interactions at different levels and time scales. Along these lines, exploring the degrees of interactions occurring in real time among sense-makers may reveal interesting features of what musical interactions entail. This could shed light, for example, on whether a system comprised of performers with similar degrees of expertise will suffer fewer perturbations and be thus more stable in terms of performance accuracy when compared to music-makers with different years of musical training (see Schiavio & Cummins, 2015). Moreover, modelling how the loss and regain of coordinated behavior impacts individual musical choices and the perceived expressivity of the musical material could shed new light on how sense-makers gain new contextual significance through interactions - how they negotiate emotional, expressive, sensorimotor, and communicative musical skills to ‘bring forth’ the music in real time. While many more possibilities remain to be considered, we hope to have provided here a useful introduction to how the idea of participatory sense-making can help better understand the complex dynamics governing both the flexibility and openness of musical creations, as well as the dialogical, active, and participatory nature of musicians in interaction.

Acknowledgments

We are grateful to Dylan van der Schyff and Nikki Moran, whose comments on our first drafts improved the quality of this chapter. We also thank the editors and the anonymous reviewers for their insightful suggestions and remarks.

Bibliography

- Badino, L., D’ausilio, A., Glowinski, D., Camurri, A., & Fadiga, L. (2014). Sensorimotor communication in professional quartets. *Neuropsychologia*, *55*, 98–104.
- Behrends, A., Müller, S., & Dziobek, I. (2012). Moving in and out of synchrony: A concept for a new intervention fostering empathy through interactional movement and dance. *The Arts in Psychotherapy*, *39*, 107-116.

- Bourbousson, J., R'Kiouak, M., & Eccles, D. W. (2015). The dynamics of team coordination: A social network analysis as a window to shared awareness. *European Journal of Work and Organizational Psychology, 24*(5), 1-19.
- Broughton M., & Stevens C. (2009). Music, movement and marimba: an investigation of the role of movement and gesture in communicating musical expression to an audience. *Psychology of Music, 37*(2), 137–153.
- Chemero, A. (2009). *Radical embodied cognitive science*. Cambridge, MA: MIT Press.
- Clayton, M. (2013). Entrainment, ethnography and musical interaction. In M. Clayton, B. Dueck, & L. Leante, (Eds.), *Experience and Meaning in Music Performance* (pp. 17 - 47), Oxford: Oxford University Press.
- Clark, A. (1997). *Being there: Putting brain, body and world together again*. Cambridge, MA: MIT Press.
- Colombetti, G. (2014). *The Feeling Body: Affective Science Meets the Enactive Mind*. Cambridge, MA: MIT Press.
- Correia, N. N., Tahiroğlu, K., & Espada, M. (2013). “PESI: extending mobile music instruments with social interaction”. *Seventh International Conference on Tangible, Embedded and Embodied Interaction (TEI)*, Barcelona, SPA.
- Davidson, J. W. (2005). *Bodily communication in musical performance in musical communication*. Oxford, UK: Oxford University Press.
- D'Ausilio, A., Novembre, G., Fadiga, L. & Keller, P.E. (2015). What can music tell us about social interaction? *Trends in Cognitive Sciences, 19*(3), 111-114.
- De Jaegher, H. (2009). Social understanding through direct perception? Yes, by interacting. *Consciousness and Cognition, 18*(2), 535-542.
- De Jaegher, H., Di Paolo, E. & Gallagher, S. (2010). Can social interaction constitute social cognition? *Trends in Cognitive Sciences, 14*(10), 441-447.
- De Jaegher, H., & Di Paolo, E. (2007). Participatory sense-making: An enactive approach to social cognition. *Phenomenology and the Cognitive Sciences, 6*(4), 485-507.
- De Jaegher, H., & Froese, T. (2009). On the role of social interaction in individual agency. *Adaptive Behavior, 17*(5), 444-460.
- Demos, A.P., Chaffin, R. & Kant, V. (2014) Toward a dynamical theory of body movement in musical performance. *Frontiers in Psychology, 5*(477). doi: 10.3389/fpsyg.2014.00477
- Di Paolo, E. (2009). Extended life. *Topoi, 28*, 9-21.
- Di Paolo, E., & De Jaegher, H. (2012). The interactive brain hypothesis. *Frontiers in Human Neuroscience, 6*(163) doi:10.3389/fnhum.2012.00163

- Di Paolo, E., & De Jaegher, H. (2016). Neither individualistic, nor interactionist. In C. Durt, T. Fuchs & C. Tewes (Eds.), *Embodiment, Enaction, and Culture—Investigating the Constitution of the Shared World*. Cambridge, MA: MIT Press.
- Fantasia, V., De Jaegher, H., & Fasulo, A. (2014). We can work it out: an enactive look at cooperation. *Frontiers in Psychology*, 5(874). doi:10.3389/fpsyg.2014.00874
- Favela, L. H. (2014). Radical embodied cognitive neuroscience: addressing “grand challenges” of the mind sciences. *Frontiers in Human Neuroscience*, 8(796). doi:10.3389/fnhum.2014.00796
- Fuchs, T., & De Jaegher, H. (2009). Enactive Intersubjectivity: Participatory sense-making and mutual incorporation. *Phenomenology and the Cognitive Sciences*, 8(4), 465-486
- Gallagher, S. (2011). Interpretations of embodied cognition. In W. Tschacher, & C. Bergomi, (Eds.), *The implications of embodiment: Cognition and communication* (pp. 59-71). Exeter: Imprint Academic.
- Gallagher, S. & Hutto, D. (2008). Understanding others through primary interaction and narrative practice. In T. Zlatev, T. Racine, C. Sinha, & E. Itkonen (Eds), *The Shared Mind: Perspectives on Intersubjectivity* (pp. 17–38). Amsterdam: John Benjamins.
- Gallagher, S., Hutto, D., Slaby, J. & Cole, J. (2013). The brain as part of an enactive system. *Behavioral Brain Science*, 36(4), 421–422.
- Geeves, A. M., McIlwain, D. J., & Sutton, J. (2016). Seeing yellow: 'Connection' and routine in professional musicians' experience of music performance. *Psychology of Music*, 44(2), 183-201.
- Geeves, A. & Sutton, J. (2014). Embodied cognition, perception, and performance in music. *Empirical Musicology Review*, 9(3-4), 247-253.
- Glowinski D., Mancini M., Cowie R., Camurri A., Chiorri C., Doherty C. (2013). The movements made by performers in a skilled quartet: a distinctive pattern, and the function that it serves. *Frontiers in Psychology*, 4(841). doi: 0.3389/fpsyg.2013.00841
- Hanna, R. & Maiese, M. (2009). *Embodied minds in action*. Oxford, UK, and New York, NY: Oxford University Press.
- Heidegger, M. (1927). *Sein und Zeit*. Halle: Max Niemeyer.
- Hutto, D., & Myin, E. (2013). *Radicalizing enactivism*. Cambridge, MA: MIT Press.
- Keller P. E. (2014). Ensemble performance: interpersonal alignment of musical expression. In D. Fabian, R. Timmers, & E. Schubert (Eds.), *Expressiveness in Music Performance: Empirical Approaches Across Styles and Cultures* (pp. 260–282), Oxford, UK: Oxford University Press.
- Keller, P. E., Knoblich, G., & Repp, B. H. (2007). Pianists duet better when they play with themselves: On the possible role of action simulation in synchronization. *Consciousness and Cognition*, 16, 102–111.
- Kelso, S. (1995). *Dynamic Patterns*. Cambridge, MA: MIT Press.

- Kiverstein, J., & Miller, M. (2015). The Embodied Brain: Towards a Radical Embodied Cognitive Neuroscience. *Frontiers in Human Neuroscience*, 9(237). doi:10.3389/fnhum.2015.00237.
- Koch, S. C., & Fischman, D. (2011). Embodied enactive dance/movement therapy. *American Journal of Dance Therapy*, 33(1), 57-72.
- Krueger, J. (2014a). Affordances and the musically extended mind. *Frontiers in Psychology*, 4(1003). doi: 10.3389/fpsyg.2013.01003
- Krueger, J. (2014b). Emotions and the social niche. In C. von Scheve & M. Salmela (Eds), *Collective Emotions*, (pp. 156-171). New York: Oxford University Press.
- Krueger, J. (2014c). Varieties of extended emotions. *Phenomenology and the Cognitive Sciences*, 13(4), 533-555.
- Kyselo, M. (2014). The body social. An enactive approach to the self. *Frontiers in Psychology*, 12: <http://dx.doi.org/10.3389/fpsyg.2014.00986>.
- Lahav, A., Saltzman, E., & Schlaug, G. (2007). Action representation of sound: Audiomotor recognition network while listening to newly acquired actions. *Journal of Neuroscience*, 27, 308-314.
- Large E. W. (2010). Dynamics of musical tonality. In R. Huys & V. Jirsa (Eds), *Nonlinear Dynamics in Human Behavior* (pp. 193–211). New York: Springer.
- Laroche, J., & Kaddouch, I. (2014). Enacting teaching and learning in the interaction process: "Keys" for developing skills in piano lessons through four-hand improvisations. *Journal of Pedagogy*, 5(1), 24-47.
- Leman, M. (2007). *Embodied music cognition and mediation technology*. Cambridge, MA: MIT Press.
- Leman M., Desmet F., Styns F., Van Noorden L., Moelants D. (2009). Sharing musical expression through embodied listening: a case study based on Chinese Guqin music. *Music Perception*, 26, 263–278
- Maes, P-J., Leman, M., Palmer, C., & Wanderley, M. M. (2014a). Action-based effects on music perception. *Frontiers in Psychology*, 4(1008): doi: 10.3389/fpsyg.2013.01008
- Maes, P-J., Van Dyck, E., Lesaffre, M., & Leman, M. (2014b). The coupling of action and perception in musical meaning formation. *Music Perception*, 32(1): 67–84.
- Merleau-Ponty, M. (1945/1962). *Phénoménologie de la perception*. Paris: Gallimard.
- Moran, N. (2014a). Music, bodies and relationships: An ethnographic contribution to embodied cognition studies. *Psychology of Music*, 41(1), 5-17.
- Moran, N. (2014b) Social implications arise in embodied music cognition research which can counter musicological “individualism”. *Frontiers in Psychology* 5(676). doi: 10.3389/fpsyg.2014.00676

- Moran, N. (this volume). Agency in Embodied Music Interaction. In M. Lesaffre, M. Leman & P. J. Maes (Eds.), *Routledge Companion to Embodied Musical Interaction*. London: Routledge.
- Nijs, L. (this volume). The merging of musician and musical instrument: an internal model-based approach. In M. Lesaffre, M. Leman & P. J. Maes (Eds.), *Routledge Companion to Embodied Musical Interaction*. London: Routledge.
- Nijs, L., M. Lesaffre & Leman, M. (2013). The Musical Instrument as a Natural Extension of the Musician. In M. Castellengo, & H. Genevois, (Eds,) *Music and its instruments*. Delatour, France: Sampzon Editions.
- Øberg, G. K., Normann, B., & Gallagher, S. (2015). Embodied-enactive clinical reasoning in physical therapy. *Physiotherapy Theory and Practice*, 31(4), 244-252.
- O'Regan, J.K. & Noë, A. (2001). A sensorimotor approach to vision and visual consciousness. *Behavioral and Brain Science*, 24(5), 939-973.
- Overy, K. & Molnar-Szacaks, I. (2009). Being Together in Time: Musical Experience and the Mirror Neuron System. *Music Perception*, 26(5), 489–504.
- Reddy, V. (2008). *How Infants Know Minds*. Cambridge, MA: Harvard University Press.
- Reddy, V. (2003). On being the object of attention: implications for self-other consciousness. *Trends in Cognitive Science*, 7, 397–402.
- Reddy, V. & Uithol, S. (2015), Engagement: Looking beyond the mirror to understand action understanding. *British Journal of Developmental Psychology*. doi: 10.1111/bjdp.12106.
- Repp, B. H. (2005). Sensorimotor synchronization: a review of the tapping literature. *Psychonomic Bulletin and Review*, 12, 969–992. doi: 10.3758/BF03206433
- Reybrouck, M. (2005). Body, mind and music: Musical semantics between experiential cognition and cognitive economy. *Trans: Transcultural Music Review*, 9.
- Rizzolatti, G., & Sinigaglia, C. (2008). *Mirrors in the brain. How our minds share actions and emotions*. Oxford: Oxford University Press.
- Samaritter, R., & Payne, H. (2013). Kinaesthetic intersubjectivity: A dance informed contribution to self-other relatedness and shared experience in non-verbal psychotherapy with an example from autism. *The Arts in Psychotherapy*, 40(1), 143-150.
- Schiavio, A. (2014). Action, Enaction, Inter(en)action. *Empirical Musicology Review*, 9(3-4), 254-262.
- Schiavio, A. (2012). Constituting the musical object. A neurophenomenological perspective on musical research. *Teorema* 13(3), 63–80.
- Schiavio, A. & Altenmüller, E. (2015). Exploring Music-Based Rehabilitation for Parkinsonism through Embodied Cognitive Science. *Frontiers in Neurology* 6(217). doi: 10.3389/fneur.2015.00217

- Schiavio, A., & Cummins, F. (2015). An inter(en)active approach to musical agency and learning, in R. Timmers, N. Dibben, Z. Eitan, R. Granot, T. Metcalfe, A. Schiavio, & V. Williamson, (Eds). *Proceedings of the International Conference on the Multimodal Experience of Music 2015*.
- Schiavio, A. & Høffding S. (2015). Playing together without communicating? A pre-reflective and enactive account of joint musical performance. *Musicae Scientiae*, 19(4), 366-388.
- Schiavio, A., Menin, D., & Matyja, J. (2014). Music in the Flesh: Embodied Simulation in Musical Understanding. *Psychomusicology. Music, Mind & Brain*, 24(4), 340-343.
- Stewart, J., Gapenne, O., & Di Paolo, E.A. (2010). *Enaction: Toward a New Paradigm for Cognitive Science*. Cambridge, MA: MIT Press.
- Thompson, E. (2007). *Mind in Life: Biology, Phenomenology, and the Sciences of Mind*. Cambridge and London: Harvard University Press.
- Thompson, E., & Stapleton, M. (2009). Making Sense of Sense-Making: Reflections on Enactive and Extended Mind Theories. *Topoi*, 28(1), 23-30.
- Toiviainen P., Luck G., Thompson M. R. (2010). Embodied meter: hierarchical eigenmodes in music-induced movement. *Music Perception*, 28, 59–70.
- van Alphen, F. (2014). Tango and enactivism: first steps in exploring the dynamics and experience of interaction. *Integrative Psychological and Behavioral Science*, 48(3), 322-331.
- van der Schyff D (2015) Music as a manifestation of life: exploring enactivism and the ‘eastern perspective’ for music education. *Frontiers in Psychology*, 6(345). doi: 10.3389/fpsyg.2015.00345.
- Varela, F. (1979). *Principles of Biological Autonomy*. Boston, MA: Kluwer Academic.
- Varela, F., Thompson, E., & Rosch, E. (1991). *The embodied mind*. Cambridge, MA: MIT Press.
- Wheeler, M. (2010) In Defense of Extended Functionalism, in R. Menary, R. (Eds.), *The Extended Mind* (pp. 246-270). Cambridge: The MIT Press.
- Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, 9, 625-636.
- Zhang, Q. & Miranda, E. R. (2007). Evolving Expressive Music Performance through Interaction of Artificial Agent Performers, in *Proceedings of ECAL 2007 Workshop on Music and Artificial Life* (MusicAL 2007), Lisbon (Portugal).