Introduction

This Element is intended as a broad introductory overview of embodied cognition as applied to musical action. My aim is to provide a broad literature review which collates various strands of interdisciplinary thinking in one place, since these various theoretical approaches (and their applications) are generally somewhat scattered in the literature. This undertaking might serve emerging researchers in the field who are less than convinced that traditional computational approaches can account for musical performance as a complex phenomenon. I draw from five decades of experience engaging with various musical instruments to synthesise new ideas and insights about embodied approaches to performance and improvisation.

The last three decades of work in cognitive science have challenged the idea that thinking occurs entirely in the head, claiming instead that cognition is embodied, embedded, extended, and enactive. The claims of 4E cognition resist the dominance of computational approaches to cognition, and music scholars have explored Gibson's notion of affordances to propose a new understanding of musical performance as primarily grounded in action. I draw from paradigms such as enactive cognition, cybernetic and systems-theoretical approaches, phenomenological perspectives on practice, Gibson's theory of affordances, and aspects of my own practice as a multi-instrumentalist to consider cases of how the interface between musician and instrument influences performance.

Outline of Contents

The turn to embodiment provides a general overview of post-cognitive theories (such as 4E cognition) and how these might be fruitfully applied to musical action. *The systems-theoretical turn* explores the ways in which the framework of systems theory provides insights into musical performance in the moment and over time. *The phenomenological turn* considers musicians' lived experience and their learning development over time, emphasising the connections between cognitive science and phenomenology as first-person perspective, and how these connections might be harnessed to illuminate aspects of practice. *The turn to affordances* applies Gibsonian ideas of perception and action using ecological psychology as a broad framework for revisiting musicking as grounded in action. To conclude, *the turn to practice* examines my own practices as improvising multi-instrumentalist to foreground the idea of musical action, exploring concepts such as skilled performance to frame musical activities from a first-person perspective.

1 Theoretical Approach: Integrative Transdisciplinarity

Lineweaver et al. (2013), while acknowledging a lack of consensus on the exact nature of complexity – 'wrestling with complexity is not a new sport', as they claim (5) – argue that 'one cannot isolate the complexity of biological organisms from the complexity of their environment' (8). The future for such biological organisms, including humankind, is far from assured, given the irreversible changes wrought by our species' wholesale exploitation of precious and irreplaceable planetary resources. Solé and Levin (2022) portray a grim picture of the current status quo, which for them requires addressing from 'a complex systems perspective':

> Confronted with a planet decline where humans are part of a complex, endangered ecological network, novel approaches need to be taken. All these approaches include unsolved, multiscale problems and will need to be applied in a social context dominated by cities, political instability and rising inequality. A complex systems perspective including all key aspects of the problem is required, pointing to an agenda of well-defined alternatives. (3)

Complex problems, at the heart of humankind's 'complex unity', demand complex solutions, and Morin (1999, cited in Montuori 2022: 167) observes that humans are 'physical, biological, psychological, cultural, social historical beings' (2), so confirming that complexity is very much part of the human condition. Hence, I believe, his call for complexification of thinking, with his conception of the physical and biological aspects of this complex human unity surely also encompassing the fact of our embodiment. Morin is alert to the operations of what he terms 'the great Western paradigm', and its accompanying binaries of subject and object, soul and body, mind and matter, and sentiment and reason, among others (9), and its consequences: 'philosophy and reflective research here, science and objective research there' (9).

From elsewhere, some cognitive scientists and psychologists[1] also understand living creatures as coterminous with their particular environments, in which they maintain themselves through mutually transforming feedback loops, within species-specific ecological 'niches', defined as 'all of the interactions of a species with the other members of its community, including competition, predation, parasitism, and mutualism. A variety of abiotic factors, such as soil type and climate, also define a species' niche'.[2]

1 For instance, von Uexküll, Gibson, the enactivists, practitioners of 4E cognition, and others. What is frequently termed 'the body-brain-environment' (BBE) nexus (the *Umwelt*, in von Uexküll 2010) plays a central conceptual role in 4E cognition, ecological psychology, situated cognition, and systems theory, among other areas of research. This paradigm does not impose an artificial separation between these constituents but considers them as intertwined in mutually reinforcing feedback loops.

2 www.britannica.com/science/niche-ecology, accessed 29 June 2023.

Montuori (2022) proposes an approach in response to Morin's concerns regarding the need for complexification. Transdisciplinary scholarship (Cronin's term) is less a method than 'a form and practice of scholarship' (163), drawing from 'empirical and theoretical research, [which] contextualizes and connects, interprets, and integrates knowledge that is often buried in specialized journals in multiple disciplines to address a particular topic'. Montuori goes on to propose an approach he calls integrative transdisciplinarity (IT), incorporating five dimensions 'as heuristics and scholarly practices to orient researchers' (163).

These dimensions include the following:

(1) understanding the world as 'interconnected, interdependent, and creative', approached from standpoints of 'systems theory and complex thought'
(2) conceiving of research undertakings as inherently creative processes
(3) led by inquiry-based rather than discipline-based methods
(4) 'meta-paradigmatic', understanding that there may be many different ways of approaching a given topic while redeploying existing theoretical frameworks
(5) 'integrating the inquirer' (second-order cybernetics), acknowledging the inquirer's viewpoint and orientation (social and psychological aspects).

Integrative transdisciplinarity understands the world as 'complex, interconnected, interdependent, and in many ways unpredictable' (164), a conception which aims to supersede the Newtonian worldview where order and deterministic rules of scientific procedure held sway. Since humans are worldly beings facing unprecedented challenges, the Newtonian view must give way to a new way of comprehending the world (163–164).

According to Montuori (2022), this emerged in the last century, drawing from 'GST,[3] Cybernetics, Information Theory, and later Chaos and Complexity theories' (166). Montuori agrees with Morin's claim that 'complexity is perhaps the greatest challenge facing humanity' (166). In order to understand pressing complex social problems, further research on 'contexts, relationships, and the social dimensions of creativity' is called for, which conceives of the individual 'as an open system in constant interaction with its environment' (166): 'Part of the challenge of complexity is to dig deeper and find the traces of powerful influences that are due to historical and cultural factors not often considered in academia – particularly when a topic is studied in a very individual-centered way – but nevertheless exert their influence in the ecology of ideas' (167).

[3] General systems theory: see, for instance, von Bertalanffy (1968), Jantsch (1980), Prigogine and Stengers (2017), and Luhmann (2013).

One of these powerful influences is Descartes' sundering of mind from body and the metaphysical implications of the so-called Cartesian split. This influence – and its consequences – figures prominently in mainstream academic cognitive science, and in many respects the various challenges to this picture of humanity (see note 1) are united, despite their ideological and methodological differences, in rejecting the Cartesian picture of cognition. I will return to this point later in the Element.

Yet another powerful influence concerns funding issues and institutional (corporate, military, and so on) underpinnings of research. As Penny (2017) notes, 'It is not possible to understand the form "computing" took in the late twentieth century without understanding that the majority of fundamental computing research was pursued as (US) military research with military funding. From Colossus to the Manhattan Project to the SAGE system, computing systems were developed for and framed by military agendas' (65). This dispels the assumption that research takes place in some value-free discursive space,[4] to all intents and purposes neutral and objective, sealed off from the demands and exigencies of the world beyond the laboratory walls.

The consequences of treating aspects of complex phenomena in isolation (reductionism) are reflected in academia by the increasing specialisation and fragmentation of disciplines 'with little or no communication between them' (Montuori 2022: 167). Creative inquiry aims to call into question the drawing of strict boundaries between and within disciplines that increased specialisation brings in its wake. This tendency to specialise reflects a splintering of the field into sub-disciplines,[5] academic niches into which neophytes and seasoned academics alike strive to find 'their rightful place' as (future) experts in a particular field. The fragmentation of disciplines presents a major problem when these are reduced to their constituent elements and not treated as wholes unto themselves.

For instance, specialisations in music encompass audio engineering and production, musical aesthetics, musical composition, music education, psychology of music, improvisation, jazz studies, music history, music production, sound

[4] For instance, 'Much [sic] of Gibson's ideas about perception was developed during his time directing aviation training during World War II. In that context, it was critical that pilots orient themselves based on characteristics of the ground surface observed visually, rather than through data from their vestibular or kinesthetic senses' (www.newworldencyclopedia.org/entry/J._J._Gibson#Work, accessed 29 June 2023).

[5] See von Bertalanffy (1968:51): 'Conventional education in physics, biology, psychology or the social sciences treats them as separate domains, the general trend being that increasingly smaller subdomains become separate sciences, and this process is repeated to the point that each specialty becomes a triflingly small field, unconnected with the rest.'

editing, systematic musicology, and so on.[6] This bespeaks a splintered field in which specialists abound and the musical experience is reduced to its constituent elements (melody, harmony, rhythm, pitch, and so on). To counter this tendency, Montuori (2022) proposes that ‘A transdisciplinary approach may include – if pertinent to the question being researched – a range of “levels” all of which are significant in their own way. It is therefore multi-dimensional rather than reductionist’ (168).

Musical phenomena, as manifested in and through performance, can be understood on many levels, as involving the physics of sound (vibrations, timbral characteristics, duration, and so on), psychosocial aspects of individual and collective agency in composing and improvising performance, broadly sociocultural concerns as to the value and purposes assigned to music in various societal formations, and its widespread nature as a worldwide practice susceptible to distribution via such technological aspects of contemporary life as the internet, social networks, and so on. Understood holistically, these musical phenomena exhibit the kind of multidimensionality Montuori claims for complex phenomena in general.

For all these reasons, I am following Montuori’s lead in adopting the IT framework, in which he characterises synthesis as ‘weaving together empirical research and/or ideas and theories to create new ways of understanding phenomena’ (168). The various – and sometimes divergent – approaches surveyed in what follows all share to some degree the concerns of non-reductionism, the acknowledgement of embodiment as a vital factor for all manner of creatures, the dynamic changes unfolding over time through mutually reinforcing action-perception loops between environments and their inhabitants, the influence and place of the observer, and notions of ambiguity and uncertainty in a complex world. In adopting a transdisciplinary approach to questions of musical performance, I engage with these concerns ‘as an embodied and embedded participant rather than spectator to life and knowledge’, as Montuori (2022) characterises creative inquiry (171).

Music as experienced, traditionally conceived of as the most abstract of the performing arts,[7] regarded as a multidimensional and multisensory holistic phenomenon, encompasses aspects of affect, cognition and perception, gesture, and emotion regulation, with different purposes and ethical contexts in different cultural settings. As laboratories and repositories of knowledge, some academic

6 academia.edu, accessed 19 August 2022.

7 ‘Music, the most abstract and uncanny art, is an eternal river of sound moving through time. We can free ourselves from whatever may be holding us back, and join that flowing river’ (Westney 2006: 222).

approaches tend to preclude such a holistic view because their aim is analysis of the elements that constitute music, not necessarily the observer's – or the participant's, for that matter – viewpoint in performance. The distance between music as *objective knowledge* and *the experience of musical performance* is maintained, as is that between theory and practice.[8]

In regard to the differences between music understood objectively and subjectively, I find instructive parallels in Hayles' (2017) definitions of the differences between thinking and cognition. She writes: 'Thinking, as I use the term, refers to high-level mental operations such as reasoning abstractly, creating and using verbal languages, constructing mathematical theorems, composing music,[9] and the like, operations associated with higher consciousness' (14). Drawing from Maturana and Varela (1980), Hayles understands cognition, on the other hand, as 'a much broader faculty present to some degree in all biological life-forms and many technical systems'. Here she finds alignment with 'the emerging science of cognitive biology, which views all organisms as engaging in systematic acts of cognition as they interact with their environments' (14).

2 The Turn to Embodiment

Humberto Maturana (1928–2021) was a Chilean biologist among whose contributions to the field together with his colleague Francisco Varela (1946–2001) and others was the so-called Santiago theory of cognition. Maturana[10] independently developed this new concept of mind as process,[11] with Maturana and his colleague Francisco Varela developing Maturana's earlier work into an enactive approach to cognition. As Capra and Luisi (2014) maintain, this approach to cognition understands that 'mind and consciousness are not things

8 Despite official recognition of creative outputs in South African academia (Duby 2022a), the dominance of the 'objectivist' research agenda imposes the requirement of formally stating the aims and objectives of creative work. This raises a significant problem for practitioners in articulating in verbal form the 'unthought' (Hayles 2017) actions that bring the work to fruition.

9 Notice her conception of composition as a higher-level process, one which inadvertently conjures up an old-fashioned portrait of the composer's desk, chaotically strewn with messy ink- and coffee-stained manuscripts with a battered piano close by. I am curious as to what she might make of collective improvisation in this regard.

10 Maturana, as one of the co-authors of Lettvin et al. (1959), collaborated with McCulloch in researching and drafting this important paper. For Hallowell (2009), 'despite the fact that some in mainstream science may view their ideas as marginal or wrong, both Maturana and Varela distinguished themselves as important, legitimate biologists through well-known laboratory work that served as the foundation for their theoretical ideas' (143).

11 In the 1960s, the British biologist Gregory Bateson similarly argued for the notion of mind as process. 'In biology, this novel concept of mind was developed during the 1960s by Gregory Bateson, who used the term "mental process", and independently by Humberto Maturana, who focused on cognition, the process of knowing' (Capra and Luisi 2014: 252).

but processes' (252). These authors further propose that an approach to understanding real-world events as processes rather than interactions between static objects accords with developments in contemporary physics:

> Modern physics thus pictures matter not at all as passive and inert but as being in a continuous dancing and vibrating motion whose rhythmic patterns are determined by the molecular, atomic, and nuclear configurations. There is stability, but this stability is one of dynamic balance, and the further we advance into matter, the more we need to understand its dynamic nature to understand its patterns. (75)

On this post-Newtonian view, it is similarly possible to understand musical sound as an emergent *process* (Carvalho 2019), rather than some finished product. As Carvalho states it, 'We say we make music when, better put, we enact it by patterning sounds that achieve or contribute to the emergence of music in an otherwise undifferentiated field of sound' (77). For now, allow me to declare that this dynamic and emergent understanding of music making as process rings true with respect to my experience of in-the-moment performance.

As Maturana (1980: 13) suggests, the Santiago theory understands simple and complex life forms alike as cognitive systems and proposes that life and mind are themselves manifestations of cognitive processes. Capra and Luisi point out how Bateson and the Santiago theorists understood living creatures' interactions with – and within – their environments as 'cognitive', whether such organisms happen to be plants, animals, or human beings.

Von Uexküll's (2010) work on the *Umwelt* also proposes a deep connection between earthly creatures and the environments in which they live. As Capra and Luisi (2014) state it, 'Mind – or, more accurately, mental activity – is immanent in matter at all levels of life' (254). It is on this basis that Maturana can assert the apparently counter-intuitive claim that even organisms without nervous systems[12] can be understood as exhibiting forms of cognitive activity.

This approach and the later work of Maturana and Varela (also see Varela, Thompson, and Rosch 2016) examine apparently simple cases of biological cognition beginning at cellular level and find basic commonalities in all living systems, on the basis that '[a]ll known multicellular living beings are elaborate variations of the same theme: cellular organization and the constitution of a phylogeny' (1987:81). They conclude (Maturana & Varela 1998) that '[the]

[12] See Lagomarsino (2019, emphasis added) on tree communication, whereby 'experiments confirmed that trees are indeed communicating with each other and sharing nutrients through their roots, forming a *complex system* sometimes referred to as the "wood wide web"'. The danger of a cephalocentric model of communication is that it limits thinking to humans. It should not escape us those other modes of cognising need considering, even if they appear in 'alien' (non-human) species.

rich diversity of living beings on earth, including us, is due to the appearance of this multicellular variant within cellular lineages'.

They propose *autopoiesis* (self-making) as a principle that unites all living creatures ('autonomous, self-referring and self-constructing closed systems' (Cohen and Wartofsky 1980: v)). Jantsch (1980) acknowledges this principle as a 'core notion' in a new understanding of how living systems operate and offers the following definition: 'Autopoeisis refers to the characteristic of living systems to continuously renew themselves and to regulate this process in such a way that the integrity of their structure is maintained.[13] Whereas a machine is geared to the output of a specific product, a biological cell is primarily concerned with renewing itself' (7).

In stark contrast to this unifying framework stands the work of the French philosopher René Descartes[14] (1596–1650), who famously drew a distinction between mind and matter.

> From that I knew that I was a substance, the whole essence or nature of which is to think, and that for its existence there is no need of any place, nor does it depend on any material thing; so that this 'me', that is to say, the soul by which I am what I am, is entirely distinct from body, and is even more easy to know than is the latter; and even if body were not, the soul would not cease to be what it is.[15]

With these famous words, Descartes draws a fundamental distinction between soul as an insubstantial, eternal, and persistent entity floating free ('no need of any place') and the body as finite, transient substance, the 'material thing' par excellence. This conception of mind and matter as distinct entities (Cartesian 'substance dualism' and its later variants)[16] has permeated Western philosophy for centuries.

Proponents of embodied cognition challenge this separation between mind and its biological grounding as perpetuating an artificial distinction, one that is unproductive in attempts to understand cognition outside the confines of the laboratory. To establish the computational theory of mind (computationalism)[17]

[13] Complex adaptive systems (immune systems, the brain, cities, and so on) share autopoeitic principles.

[14] For a discussion of the provenance and origins of the Cartesian spilt (by way of Plato) and its implications for understanding and teaching music, see Westerlund and Juntunen (2010).

[15] Cited in Damasio (1994: 176). Also see Penny (2017: 6), who argues that 'There are historical reasons for this contorted idea – not least, Descartes's desire to reconcile his religious faith with his endorsement of emerging empirical and rationalist thought. Also he presumably wanted to avoid the fate of Giordano Bruno or Galileo.'

[16] https://plato.stanford.edu/entries/descartes/#MinRel (accessed 6 September 2022).

[17] '[Classic] CTM holds that the mind *literally is* a computing system. Of course, the most familiar artificial computing systems are made from silicon chips or similar materials, whereas the human body is made from flesh and blood. But CCTM holds that this difference disguises a more