CHAPTER 2 ENACTIVE COGNITION IN IMPROVISING MUSICAL ENSEMBLES: A SOUTH AFRICAN PERSPECTIVE

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1 Introduction

The activity of performing music or 'musicking'[1] seems a *prima facie* case for confirming theories of embodiment. The notion of musicking, according to Small, emphasises the idea of musical performance as an activity,[2] whereby the embodied activities of singers and instrumentalists create perturbations in a transmitting medium (that is, they move air in producing sounds which correspond with their bodily actions). For Small, these concerted musical activities also enact social relationships but the starting premise which animates his notion of musicking argues that the very possibility of music's coming into being as organised sound rests on embodied musical actions.

Taking the lived body as a starting point, I argue that musical performance (on a continuum from structured to improvised) has much to gain from theories of embodied cognition, not merely for understanding performance itself, but in accounting for the varieties of gestures, glances, and extra-musical cues that inform performance: in short, how musicians communicate in the moment. In addition, musicians' engagements with their chosen instruments can be addressed from the viewpoint of ecological psychology (especially Gibson's work on affordances)[3] as well as from its more contemporary framing in cognitive archaeology (Malafouris's

1 C Small *Musicking: The meanings of performing and listening* (1998).

2 For Small (n 1), 'if musicking is indeed an aspect of the language of biological communication, then it is part of the survival equipment of every human being. To music is not a mere enhancement of spare-time enjoyment but is an activity by means of which we learn what are our ideal social relationships, and that is as important for the growth of an individual to full social maturity as is talking and understanding speech' (210).

3 JJ Gibson *The ecological approach to visual perception: Classic edition* (2015).

material engagement theory for instance)[4] and anthropology.[5] These various approaches, I argue, provide rich methodologies and practical resources for drawing together strands from areas where phenomenology and the cognitive sciences intersect, such as how enactive cognition plays out in musical performance.

Scholars have further noted the cognitively demanding character of expert performance. The question arises as to which framework from cognitive science best captures the nuances of the musicking process, when considered from the viewpoints of musical activities which establish relationships. The chapter is divided into three main sections. The first section discusses the emergence of embodied cognition as a new paradigm within cognitive science in contrast to cognitivism, the middle section provides a brief overview of 4E cognition, while the third considers aspects of enactive cognition as relevant to musical performance.

2 The promise of embodied cognition

> To be human, indeed to be living, is always to be in a situation, a context, a world.[6]

In recent times a new paradigm has emerged within cognitive science to challenge the tenets of cognitivism, or what Sasha Bem and Huib Looren De Jong (Table 1) term 'classic computationalism'.[7] These authors establish three main stages in the advancement of knowledge in cognitive science, computationalism (in which the mind is broadly conceived of as an information-processing device), connectionism (in which changes to synaptic weightings account for developmental activities such as learning),

4 L Malafouris *How things shape the mind: A theory of material engagement* (2013).

5 T Ingold *Lines: A brief history* (2007); T Ingold *Making: Anthropology, archaeology, art and architecture* (2013).

6 FJ Varela, E Thompson & E Rosch *The embodied mind: Cognitive science and human experience* (1991) 59.

7 S Bem & HB de Jong 'Modern approaches to mind (2): The brain-based view: Neurophilosophy, connectionism and dynamicism' in S Bem & HB de Jong (eds) *Theoretical issues in psychology: An introduction* (2006) 181.

and finally dynamicism,[8] which draws from systems theory and notions of creature-environment couplings to propose a new understanding of cognitive processes. Also known as Cartesian cognitive science,[9] classical computationalism proposes a self-contained mind bounded by the skull and places the emphasis on symbol-processing and manipulation as key forms of mental activity. Buoyed by advances in early computer technology, its dominant analogy took the form of 'the mind as computer', with inputs and outputs and modules for processing data. Placing the emphasis on skull-bounded mental processes, computational cognitivism exalts mental processes to the exclusion of the body.[10]

Classical computationalism	**Connectionism**	**Dynamicism**
Formal, syntactical rules, symbols	Weights and activation patterns	Smooth mutual adaptation
Preprogrammed, no real development	Self-organisation, learning through adapting weights	Coupled co-evolving systems, developing over time
Brittle program rules	Graceful degradation under damage	Evolving through state space, circular causality, continuous adaptation
Structured, language-like architecture, concatenating discrete symbols	'Associationism', structure dependent on environmental regularities	Development in time

8 As Leman and Maes describe it: 'The recent results suggest that a new way of understanding music perception is based on our understanding of a dynamic action-perception system that is associated with sensing, movement, cognition and emotion. Basically this dynamic system determines complex meaning formation in relation to body and environment'; M Leman & P-J Maes 'Music perception and embodied music cognition' in L Shapiro (ed) *The Routledge handbook of embodied cognition* (2014) 86.

9 MA Rowlands *The new science of the mind: From extended mind to embodied phenomenology* (2013).

10 Clearly, this account does not make room for embodied musical (or other) activity.

Classical computationalism	**Connectionism**	**Dynamicism**
Productivity and systematicity through compositional architecture	Functional compositionality	Trajectory through state space
Functionalism, autonomy for psychology	Reductionist (more or less) brain-like cognition	Emergent properties of organism-environment system, and development
Folk psychology vindicated	Folk psychology eliminated	
Representations are symbolic structures	Representations are activation patterns	No representations needed – no satisfactory account of inner representational states
Solipsism, self-contained mind	Representations are products of interaction with environment	Body, mind and world part of a single system

Table 2.1: Three approaches to mind[11]

Louise Barrett characterises this approach to cognition as based on 'the processes by which sensory inputs are transformed, manipulated, augmented, and used to give rise to motor outputs, with the implicit assumption that these processes took place solely in the brain'.[12] The transformations and manipulations of the computationalist project largely

11 Bem & De Jong (n 7) 181.

12 L Barrett 'The evolution of cognition: A 4E perspective' in A Newen, L de Bruin & S Gallagher *The Oxford handbook of 4E cognition* (2018) 719. Barrett goes on to say that '[t]here is a distinctly anthropocentric tinge to this definition, grounded as it is in the cognitive revolution, which aimed to model (or even recreate) human intelligence via the use of computers'.

depend on combinations of representations[13] and rules.[14] The picture that emerges is the classic 'brain in a vat' conception, which privileges mental operations over all else including putative connections between the cognising organism and its environment.

For scholars working in the new embodied cognition paradigm, numerous problems arise with cognitivism's self-contained nature of mind and its emphasis on representations and formal syntactical rules, from which any considerations of bodily activity are expunged. While cognitivism remains the dominant paradigm in cognitive science to this day, challenges to its supremacy have come from several quarters, with the classic text '*The embodied mind: Cognitive science and human experience*'[15] presenting one of the earliest arguments for an enactive approach and explicitly paying homage to Merleau-Ponty's contribution to the embodiment discourse.[16]

In many ways, theirs is among the first concerted efforts to expose the fault lines of hidden Cartesianism underlying the cognitivist project.[17] As is well known, the famous *dictum* of Descartes, *Cogito, ergo sum* (1637) establishes a fundamental distinction between thought as *res cogitans* (a thinking thing, as in the human mind) and the material object as *res extensa*

13 Rowlands defines representations as follows: 'Mental representations are typically regarded either as brain states or higher-order functional properties realized by brain states. Since, on either interpretation, mental representations are things that are to be found in the brain, and only in the brain, their manipulation and transformation are also processes that occur in the brain'; Rowlands (n 9) 1082/5565. See also A Chemero 'An outline of a theory of affordances' (2003) 15 *Ecological Psychology* 181; A Chemero *Radical embodied cognitive science* (2011).

14 Rowlands (n 9).

15 Varela et al (n 6).

16 'For Merleau-Ponty, as for us, *embodiment* has this double sense: it encompasses both the body as a lived, experiential structure and the body as the context or milieu of cognitive mechanisms'; Varela et al (n 6) xiv (emphasis in original).

17 Phenomenology as espoused by Heidegger and Merleau-Ponty antedates this by half a century or so. 'Several phenomenological philosophers, most notably, Merleau-Ponty and Heidegger, took exception to the subjectivistic slant of Husserl's initial program of phenomenology. Merleau-Ponty specifically saw that phenomenological philosophies were in a position to reject the objective–subjective dichotomy that plagues traditional philosophical thought.' H Heft *Ecological psychology in context: James Gibson, Roger Barker, and the legacy of William James's radical empiricism* (2001) 116.

(an extended thing or material substance).[18] Alert to the consequences of this distinction, Varela and others depict 'the Cartesian anxiety' as playing out in a state of persistent instability: 'By treating mind and world as opposed subjective and objective poles, the Cartesian anxiety oscillates endlessly between the two in search of a ground.'[19]

Adopting a non-reductionist approach, their critique of Cartesian dualism considers cognition as grounded to a large degree in species-specific biological capabilities:[20]

> Cognitivist architectures had moved too far from biological inspirations; one does not wish to reduce the cognitive to the biological, but the most ordinary tasks are done faster when performed even by tiny insects than is possible when they are attempted with a computational strategy of the type proposed in the cognitivist orthodoxy.[21]

This conception, as espoused by Varela et al,[22] is as far from Cartesian dualism as can be imagined. It is not a pre-given static environment, but subject to change to which creatures must respond from moment to moment (as environmental features transform over various time-scales)[23] and replete with information, with which various species interact in accordance with their sensory capacities. What underpins these various responses is the idea of action-perception cycles,[24] mechanisms which enable creatures to act upon and in turn be acted on by environmental

18 'Cartesian metaphysics is the fountainhead of rationalism in modern philosophy, for it suggests that the mathematical criteria of clarity, distinctness, and logical consistency are the ultimate test of meaningfulness and truth. This stance is profoundly antiempirical.' https://www.britannica.com/topic/Western-philosophy/The-rationalism-of-Descartes (accessed 24 June 2021).

19 Varela et al (n 6) 141.

20 Barrett (n 12) 77 refers to such interactive capabilities as drawing on 'reliably recurring developmental resources', emphasising the mutuality of the relationships between organisms and their environments.

21 Varela et al (n 6) 86.

22 As above.

23 These transformations might take place in a specific creature's life span or more broadly as a species evolves.

24 JM Fuster *The neuroscience of freedom and creativity: Our predictive brain* (2013).

factors. Fuster defines these cyclic processes as follows:[25]

> A flow of environmental signals gathered by sensory systems shapes the actions of the organism upon the environment; these actions produce environmental changes, which in turn generate new sensory input, which informs new action, and so on. This circular flow of information operates in the interactions of all animal organisms with their environment.

In these various senses, the world is not objectively 'out there' and human minds 'in here'. For these authors, enactive cognition (discussed more fully below) takes into account the mutual influence between organisms and their environments, in a changing world that is always under construction and revision. This move away from computationalism is essential 'to determine the common principles or lawful linkages between sensory and motor systems that explain how action can be perceptually guided in a perceiver-dependent world'.[26]

In a somewhat different context, referring to the metaphorical dimension of human language, the cognitive linguists Lakoff and Johnson[27] argue that Descartes reaches three conclusions that extend beyond the confines of the cogito, as follows: The ability to reason is crucial to defining what being human means, the mind exists independently from the body (that is, it is disembodied), and finally that our humanity has nothing to do with our bodily existence. As an alternative to Descartes's dualism,[28]

25 Fuster (n 24) 90.

26 Varela et al (n 6) 173.

27 G Lakoff & M Johnson *Philosophy in the flesh: The embodied mind and its challenge to Western thought* (1999) 401. It is worth noting that they reach these conclusions from a linguistic perspective and that their conception of 'embodied realism' does not explicitly invoke theories of perception-action cycles or enactivist conceptions.

28 For Rowlands (n 9) 300/5665, 'dualism is still almost certainly one of the most reviled philosophical views ever invented'. Evidence suggests that this judgment may be premature, since for Lakoff and Johnson the Cartesian anxiety is alive and well. As Lakoff and Johnson (n 27 463) state it: 'Our brains and minds do not operate using abstract formal symbols that are given meaning by correlations to an allegedly mind-independent world that comes with categories and essences built in.' For these writers, the metaphysical residue of Cartesian rationalism remains a

Lakoff and Johnson propose 'embodied realism',[29] an approach which 'relies on the fact that we are coupled to the world through our embodied interactions'. They maintain that embodied realism (and its associated concepts) does away with the mistaken subject-object distinction of Descartes's argument and restores value to the idea of intersubjectivity as connected to *the world we experience as human subjects*.

Perspectives from phenomenology,[30] ecological psychology[31] and neuroscience[32] underpin the new paradigm, by definition an interdisciplinary undertaking. The following section provides a brief overview.

3 4E cognition: A brief overview

Commonly known as 4E cognition, incorporating as it does aspects of embodied, extended, enactive, and embedded mind, this new paradigm seeks to explore alternatives to classic computationalism. It aims to take into account our situated condition in the world and proposes thereby to examine what takes place outside controlled laboratory conditions, so respecting tenets of ecological validity. For Michael Anderson:[33]

> [T]his new approach focuses attention on the fact that most real-world thinking occurs in very particular (and often very complex)

dominant, if submerged, driver of the classic cognitive project.

29 Lakoff & Johnson (n 27) 93.

30 M Merleau-Ponty *Phenomenology of perception* 2002; M Heidegger *Being and time* trans J Macquarrie & ES Robinson (2008).

31 JJ Gibson *The senses considered as perceptual systems* (1968); Gibson (n 3); JJ Gibson 'Observations on active touch' (1962) 69 *Psychological Review* 477.

32 M Ratcliffe 'Phenomenology, neuroscience, and intersubjectivity' in HL Dreyfus & MA Wrathall (eds) *A companion to phenomenology and existentialism* (2006); MS Gazzaniga, RB Ivry & GR Mangun *Cognitive neuroscience: The biology of the mind* (2002); PJ Marshall 'Relating psychology and neuroscience: Taking up the challenges' (2009) 4 *Perspectives on Psychological Science* 113; Fuster (n 24); A Graziano & JK Johnson 'Music, neurology, and psychology in the nineteenth century' in E Altenmüller et al (eds) *Music, neurology, and neuroscience: Historical connections and perspectives* (2015) 216; Chemero (2011) (n 13).

33 ML Anderson 'Embodied cognition: A field guide' (2003) 149 *Artificial Intelligence* 91.

> environments, is employed for very practical ends, and exploits the possibility of interaction with and manipulation of external props. It thereby foregrounds the fact that cognition is a highly embodied or situated activity – emphasis intentionally on all three – and suggests that thinking beings ought therefore be considered first and foremost as acting beings.

Researchers working in post-computationalist paradigms have identified four central pillars of cognition respectively as embodied, embedded, extended, and enactive (commonly known as 4E cognition).[34] Proponents of embodied cognition (such as Shapiro and others)[35] claim that *cognition requires embodiment*, because of its grounding in unfolding relationships between bodies and worlds. Laura Malinin understands the embedded thesis as claiming that 'people exploit features of the physical and social environment to increase cognitive capabilities.'[36] Extended cognition, in turn, suggests that cognition extends outward from the embodied mind to incorporate devices that enhance creaturely capabilities[37], such as tools and prostheses to facilitate and enhance environmental interactions. Finally, enactive cognition places the emphasis on creaturely actions in the world, how 'people implicitly understand how settings provide resources for thinking-in-action'.[38]

Embedded cognition proposes some form of relationship or dynamic coupling between organism and *Umwelt*, so sharing some concerns with situated cognition.[39] Extended cognition also takes account of organism-

34 This is not to say that 4E cognition presents a united front in responding to the challenges of computationalism.

35 Shapiro (n 8). See also CP Sobel & P Li *The cognitive sciences: An interdisciplinary approach* (2013).

36 LA Malinin 'Creative practices embodied, embedded, and enacted in architectural settings: Toward an ecological model of creativity' (2016) 6 *Frontiers in Psychology* 5.

37 For Aizawa, '[r]ather than causal dependency relations between cognitive processes and environmental processes, extended cognition postulates a constitutive dependence between cognitive processes and processes in brain, body, and environment. Cognitive processes are realized, not just in the brain, but also in the body and world.' K Aizawa 'Extended cognition' in Shapiro (n 8) 31.

38 Malinin (n 36) 5.

39 P Robbins & M Aydede *The Cambridge handbook of situated cognition* (2009).

environment coupling, implying thereby that theories of cognition might include ways in which organisms deploy tools as intermediaries in the realisation of their tasks. For Varela and his colleagues,[40] 'the enactive approach consists of two points: (1) perception consists in perceptually guided action and (2) cognitive structures emerge from the recurrent sensorimotor patterns that enable action to be perceptually guided'. From this definition, enactivist conceptions of cognition postulate a close relationship between perception and action and further propose that cognitive structures are emergent, in the sense that 'collective phenomena are collaboratively created by individuals yet are not reducible to individual action'.[41] Such structures, it follows, must needs be malleable to adjust to varying, moment-to-moment changes in the available information to be able to adapt to such changes on the fly.

As different research projects assign various degrees of emphasis to these four aspects, the distinctions between them in practice are not clear-cut. Rowlands argues that the new paradigm can effectively be reduced to only two aspects: embodied and extended. Given the importance of the idea of embodiment as a foundational critique of Cartesian cognitive science, embodiment itself (the fact that living organisms are embodied) seems crucial to this claim.

Rietveld and colleagues[42] have pointed to the need to recognise 'the ecological' as a potential fifth element, so that it becomes possible to speak of 5E cognition. In so doing, they point to contributions made to the discourse on cognition by ecological psychologists such as Gibson.[43] For these thinkers, perception is direct, and the senses are 'systems for perception',[44] as opposed to passive receivers of sense data. Barrett understands Gibson's notion of 'a perceptual system' as involving 'the entire nervous system because it requires the whole body to pick up

40 Varela et al (n 6) 173.

41 RK Sawyer 'The mechanisms of emergence' (2004) 34 *Philosophy of the Social Sciences* 266.

42 E Rietveld, D Denys & M van Westen 'Ecological-enactive cognition as engaging with a field of relevant affordances: The skilled intentionality framework (SIF)' in Newen et al (n 12) 40.

43 Gibson (n 3); Gibson (n 31).

44 Barrett (n 12) 96.

information, not just the sense receptors'.[45] One might argue that Rietveld and colleagues' claim is redundant, since a specific ecological niche always already requires perception-action couplings for engagement as per the tenets of extended and enactive cognition. It seems to me that these various conceptions of 4E cognition (as briefly outlined above) suffice, since embodiment presupposes interactions subject to specific environmental features.

The logical step forward from this conception rests on what is available to a specific organism within its *Umwelt*,[46] 'the world as it is experienced by a particular organism',[47] understood as that organism's immediate environment. Ecological psychologists such as Gibson speak of 'ecological niches', within which questing animals are on the move, actively seeking out information, and interacting with what is available to their specific sensoria. From this picture emerges an ongoing and intertwined connection between perception and action, strikingly different from the empiricist portrayal of the senses as mere information receivers.

Gibson's much-debated notion of affordances (defined as 'what [a given environment] offers the animal, what it provides or furnishes, either for good or for ill') provides the pathway, or the very grounds of possibility, for the intertwining of perception and action. Affordances as action possibilities play out in reciprocal relationships between creatures and their respective *Umwelten*. Gibson's direct realism implies that meaning arises through these relationships of reciprocity and do not require intermediate stages of interpretation by way of representations.[48] Through perception-action cycles,[49] animals actively engage with their environmental surroundings, sometimes modifying such niches for a

45 Barrett (n 12) 97.

46 J von Uexküll *A foray into the worlds of animals and humans, with a theory of meaning* trans JD O'Neil (2010).

47 Von Uexküll (n 46) 80.

48 With respect to notions of ecological validity, 'Gibson believed that the study of perception, in artificial laboratory settings, of impoverished stimuli devoid of content, misled scientists into thinking that internal inference – cognitive or computational processes, in today's terminology – was necessary to mediate between the reception of light and the perception of the world.' V Bruce & Y Tadmor 'Perception: Beyond Gibson's (1950) direct perception' in MW Eysenck & D Groome *Cognitive psychology: Revisiting the classic studies* (2015) 27.

49 Fuster (n 24).

better fit between the affordances at hand or under foot, so to speak.

It is important in this regard to note how affordances vary according to the individual creature's ability to pick out salient information from its niche. 'A leaf … can afford pulling to a worm, blowing to a person who knows how to handle a leaf blower, and collecting to a child.'[50] The worm *uses* the same leaf differently, then, from how the operator of the leaf-blowing tool and the child do; in other words, the leaf affords different affordances to the various organisms which come across it.[51]

As Clark states it:[52]

> Human minds, it can hardly be doubted, are at the very least in deep and critically important contact with human bodies and with the wider world. Human sensing, learning, thought, and feeling are all structured by our body-based interactions with the world around us.

At first glance, this seems like an uncontroversial definition of embodiment. With respect to 'the world around us', though, we have already seen how Varela and his colleagues have called the apparently objective status of this world into question. The ever-present danger is the temptation to fall back into the Cartesian anxiety by proposing a world out there with perception and cognition playing out in the confines of the human skull, and action subservient to the commands of an imaginary central processing unit.

While acknowledging the porosity and interconnectedness of the various E's in question, and further that scholars do not necessarily agree on such definitions, the following section considers to what degree

50 E Rietveld & J Kiverstein 'A rich landscape of affordances' (2014) 26 *Ecological Psychology* 327.

51 'This relational way of thinking about how affordances are specified is beneficial. It helps to clarify how the same objective environment can furnish different meanings for different perceivers.' JW Krueger 'Affordances and the musically extended mind' (2014) 4 *Frontiers in Psychology* 2.

52 A Clark 'Embodied, embedded, and extended cognition' in K Frankish & WM Ramsey (eds) *The Cambridge handbook of cognitive science* (2012) 275.

concepts from enactive cognition might be applied to the collective, goal-directed actions of musical ensembles.[53]

4 Musicking and enactive cognition

The purpose of this section is to consider how concepts from enactive cognition might be brought to bear on musicking. It's worth noting at the outset how enactivist debates have changed over time since the landmark publication of *The embodied mind* (1991), as do Ward and others. They identify 'three semi-distinct currents of enactivist theorising' (369), as follows: autopoietic, sensorimotor, and radical enactivism.[54] As before, each of these strands reflects different theoretical claims and warrants; they are nonetheless united with respect to placing the emphasis on action as fundamental to cognition. A growing body of literature emanates from research on specifically musical aspects of the embodied cognition paradigm.[55] These writings cut across the boundary lines of traditional

53 M Duby 'Minds, music, and motion: Ecologies of ensemble performance' (2020) *Music and Practice* 6.

54 D Ward, D Silverman, & M Villalobos 'Introduction: The varieties of enactivism' (2017) *Topoi* 36. For these authors, '[t]he "autopoietic strand" of enactivist theorising emphasises and develops [the] attempt to ground cognition in the biodynamics of living systems', whereas its sensorimotor counterpart 'is usually presented as a way of explaining the intentional and phenomenal characteristics of perceptual experience rather than a general account of the mind' (369 370). Finally, radical enactivism is 'an attempt to improve and unify anti-representationalist approaches to cognition' without necessarily competing with these earlier accounts (372).

55 EF Clarke *Ways of listening: An ecological approach to the perception of musical meaning* (2005); WL Windsor & C de Bezenac 'Music and affordances' (2012) 16 *Musicae Scientiae* 102; M Duby 'Affordances in real, virtual, and imaginary musical performance' in M Grimshaw-Aagaard, M Walther-Hansen & M Knakkergaard (eds) *The Oxford handbook of sound and imagination* (2019) 97; JW Krueger 'Music as affective scaffolding' (2018a) *Music and Consciousness II: Philosophical, Psychological, and Cultural Perspectives* 1; JW Krueger 'Musical worlds and the extended mind' (2018b) in *Proceedings of a Body of Knowledge – Embodied Cognition and the Arts Conference* CTSA UCI 8-10 December 2016 1; JW Krueger 'Doing things with music' (2011) 10 *Phenomenology and the Cognitive Sciences* 1; A Schiavio et al 'Enacting musical emotions. Sense-making, dynamic systems, and the embodied mind' (2016) *Phenomenology and the Cognitive Sciences* 1; D van der Schyff & A Schiavio 'Evolutionary musicology meets embodied cognition: Biocultural

musicology and are inter-disciplinary by definition, providing evidence that some scholars are thinking laterally across, as opposed to within, such boundaries. Van der Schyff and Schiavio, for instance, ground cognition firmly in what we might term 'the embodied biocultural,' proposing that such a move calls for a fresh approach to musical cognition:[56]

> The biocultural approach sees (musical) cognition as an emergent property of situated embodied activity within a developing socio-material environment. Because of this, it requires a rather different view of cognition than the information-processing model associated with an adapted (modular) brain.[57]

Consider the need for responsiveness in goal-directed action: 'In order to achieve their goals, expert agents – eg, athletes – must be able to control their actions, responding in an appropriate manner to the demands and contingencies of the situation.'[58] No less than athletes, musicians must also adjust their embodied actions to respond appropriately as the music emerges.

As someone who has spent a lifetime engaging with musical instruments, I firmly believe that these 'tools of the trade' offer much more than they are generally given credit for. Musical instruments afford possibilities to make creative contributions to the emergent sonic landscape under construction, as it were. As Rietveld and Kiverstein[59] state it:

> What our view of affordances opens up is that an animal's engagement with an affordance always involves the exercise of an ability in a specific context. We argue that the affordances the environment offers are dependent on the abilities available in a particular ecological niche.

coevolution and the enactive origins of human musicality' in A Nikolsky (ed) *The evolution of music* (2020).

56 This grounding of cognition in creaturely biology reflects some concerns of the Santiago school of Varela and his colleagues (what might be termed early enactivism).

57 Van der Schyff & Schiavio (n 55).

58 M Segundo-Ortin & M Heras-Escribano 'Neither mindful nor mindless, but minded: Habits, ecological psychology, and skilled performance' (2021) *Synthese* 2.

59 Rietveld & Kiverstein (n 50) 326.

This view acknowledges the reciprocity between animals and affordances within specific niches and suggests that maximising the potential benefits of such affordances depends on the animal's grasping such possibilities according to its abilities. Recall the discussion of the multifaceted affordances of the leaf above and how these varied according to the perspective and sensory capacities of those engaging with it. In the context of musical performance, musical instruments and voices provide more complex analogues of the simple piece of vegetation in question insofar as they 'speak back' to the musician, providing direct immediate feedback on the outcomes of the performers' actions. Instruments are sometimes treated metaphorically as 'voices', so that the contrabassist Ray Drummond can plausibly speak of 'finding your voice on your chosen instrument'.[60]

Much of what follows is grounded in my own lived experience of managing ensembles of novices in teaching situations as well as working with experts in professional settings as a jazz performer. I argue that aspects of 4E cognition and the literature on affordances together provide a framework for understanding the differences which emerge from such settings.

Changes in environmental settings also play their part. I observed over time that moving a student ensemble from the more or less comfortably familiar setting of the rehearsal room to a different live venue produced a new set of challenges for the participants. A less familiar venue tended to introduce new challenges for the ensemble to negotiate,[61] since the very nature of the available sensory information was transformed as a consequence. A simple example is that of sightlines.

In the rehearsal room, the locations of the various performance accoutrements (piano, drum set, bass and guitar amplifiers, and so on)

60 Presentation JazzUV festival, Xalapa, 2011.

61 While the recital venue provided some aspects close to an actual live gig, there were some controlled conditions with respect to audience interactions, such that opportunities for feedback (applause) were limited to formal opportunities (conclusions of pieces), much like the circumstances of Western art music performance. It was not unknown for the audience to respond spontaneously to a particularly apt turn of phrase, but in general performance conditions reflected the formalities of the concert hall, not exactly laboratory conditions but perhaps approaching more closely the requirements of ecological validity.

were relatively fixed. The monitor speakers in fixed positions in this venue also necessitated minimal adjustments of seating or standing positions for the performers. These circumstances changed significantly when the ensemble performed elsewhere as participants in the final year recitals. Sometimes the individual musicians could not see each other due to compromised sightlines, unforeseen in the rehearsal but a glaring problem in the heat of live performance. Unobstructed sightlines mean that participants can easily draw from extra-musical cues to guide and manage their own contribution to the music as it emerges, and problems seem more likely to ensue when these are missing or compromised by environmental circumstances.[62]

All things being equal, the better prepared ensembles responded more adequately to unforeseen changes, so demonstrating resilience in the face of such changes and adapting more successfully when things went awry. It became apparent that the transition between different venues was a significant complicating factor. To address this, my colleagues and I decided to adapt the rehearsal schedule to allow the participants more time to adjust to the different circumstances of the recital venue.

Once the ensemble players had sufficient time to acclimatise to the new venue and complications of sightlines and monitoring had been addressed, they did seem to play with more confidence. In fairness, the initiative of allowing more time in the less familiar venue was rather to eliminate – or at least minimise as far as possible – unforeseen distractions to provide the performers with the best possible circumstances for carrying out their tasks. These examples are intended to demonstrate how local changes in environmental circumstances can affect group tasks in the context of musical performance (for better or worse).

Scholars have acknowledged the complex cognitive demands of expert musical performance, among these Brown, Zatorre, and Penhune. They observe how

> [p]erforming music requires experts to retrieve musical information from long-term memory and continuously plan their ongoing

62 Undoubtedly the higher risk involved in exit-level performance could not be ruled out as a complicating factor, so that the participants naturally enough experienced higher than normal stress levels in executing their tasks.

> performance in their working memory system. Performing music also requires experts to initiate and control complex movements and to monitor outcomes or feedback from those movements to make adjustments if needed.[63]

I agree with them that expert musical performance implicates long-term memory, planning, complex movements, and monitoring. At the same time, it seems that any musical performance (by experts or novices regardless) must also draw from a similar skill set. If so, then the difference between experts and novices may be one of degree rather than absolute quality. Considered in developmental terms, it takes time and a considerable amount of devotion for novices to become experts and here experience undoubtedly plays a vital part. As Di Paolo & Thompson[64] describe it:

> Given that sense-making is an embodied process of active regulation of the coupling between agent and world, social interaction – through patterns of bodily coordination and breakdown – opens the possibility of this process being shared among the interactors. This shared form of sense-making is what is meant by 'participatory sense-making'. It happens to various degrees, from orientation of individual sense-making (someone draws our attention to an aspect of the world we have ignored) to joint sense-making (a piece of work is literally created together through a process that would not be possible by the individuals involved on their own).

Returning to the fledgling ensembles, I observed how some participants became fixated on the sheet music to the exclusion of other useful visual information even when they were familiar with the musical structure. On other occasions, the musicians might fix their gaze on their chosen instrument as if for reassurance that the layout of the instrument had not somehow mysteriously changed since last they looked at it. These anecdotal observations seem trivial enough on the face of it but point to how variations in immediate surroundings can unsettle the novice performer.

63 RM Brown, RJ Zatorre & VB Penhune 'Expert music performance: Cognitive, neural, and developmental bases' in E Altenmüller et al (eds) *Music, neurology, and neuroscience: Evolution, the musical brain, medical conditions, and therapies* (2015) 59.

64 E Di Paolo & E Thompson 'The enactive approach' in Shapiro (n 8) 75.

Work by Malafouris[65] and Ihde & Malafouris[66] in relation to what Malafouris terms Material Engagement theory suggests that 'things' (such as musical instruments) are more influential in learning and development than they might appear at first glance. Far from mere objects, things decidedly play a material role in shaping cognition. On the face of it, expert performers appear to be more resilient (in the language of systems theory, more impervious to perturbations in the immediate environment) and novices more easily distracted, at least partly because experts have devoted more time to developing understandings of their musical instruments of choice.

It is hard to imagine what a classic computationalist might make of such interactions, since such aspects of embodied behaviour are by definition irrelevant to their project. For instance, what role might representations play in such undertakings? Chemero[67] draws from Gibson's concept of direct realism to propose an approach (Radical Embodied Cognitive Science) (RECS) which aims to eliminate representations altogether as mental 'intermediaries,' on which concepts are based both classic computationalism and connectionism, the second pillar of Table 1.

When embodiment is understood enactively, reaction time for high-speed decisions seems to preclude representational intermediaries. For example, Segundo-Ortin and Heras-Escribano[68] draw from Papineau's work on the sport of cricket, in which the time for the batsman to respond to the approaching ball ranges from 0,4 to 0,8 seconds. Papineau claims that within this brief window only 'automatic and reflex-like' responses to changing environmental circumstances are possible. Such responses dispense with representations because there is insufficient time for conscious decisions to be mulled over. Carvalho and Nolfi[69] cite two

65 L Malafouris *How things shape the mind: A theory of material engagement* (2013); L Malafouris 'Mind and material engagement' (2019) 18 *Phenomenology and the Cognitive Sciences*; L Malafouris 'Thinking as "thinging": Psychology with things'(2020) 29 *Current Directions in Psychological Science* 3.

66 D Ihde & L Malafouris 'Homo Faber revisited: Postphenomenology and material engagement theory' (2019) 32 *Philosophy and Technology* 195.

67 Chemero (2003) (n 13); Chemero (2011) (n 13).

68 Segundo-Ortin & Heras-Escribano (n 58) 4.

69 JT Carvalho & S Nolfi 'Cognitive offloading does not prevent but rather promotes cognitive development' (2016) 11 *PLoS ONE* 1.

examples (navigating a city's environment and the game of baseball)[70] to confirm that such activities can also be realised by heuristic methods.

Similarly, a musical piece executed at a fast tempo seems likewise to preclude the possibility of representations. When the virtuoso electric bassist Jaco Pastorius executes Bach's *Chromatic Fantasy* at a very brisk tempo,[71] one is hard pressed to consider intervening representations as constituting or influencing this execution. In general terms, one wonders what size and shape putative motor-representations might take and whether or not they are strictly necessary or even possible under such circumstances.

According to Donald,[72] an exogram represents a memory record 'stored outside the nervous system'. He lists 'clay tablets, papyri, printed books, government archives or electronic data banks' as typical examples. Their purpose is to allow for limited memory (engrams) to be off-loaded onto an external storage system for convenience and to facilitate cognitive off-load. It seems fair likewise to characterise musical scores as such. In the recital venue, it was customary for accompanists to consult musical scores as mnemonic reminders of the formal and structural elements of the music in question.

Two related questions emerge: Do jazz performers who negotiate scores depend on an imaginary mental picture, or road map, of the score when improvising on the form of the piece? While the score as exogram provides a snapshot for ease of reference, it also seems possible that improvisers may utilise other phenomena such as memory, entrainment, which assists in synchronising collective musical action, or extra-musical communicative cues[73] such as a soloist indicating a handover to his or

70 'For example, moving around in a city does not necessarily require an elaborate representation of the city's layout. The ability to recognize a limited number of turning decision points combined with the ability to just follow the street between decision points might suffice. Similarly, baseball players do not need to estimate the trajectory of the flying ball to be intercepted through complex calculations. They can simply adjust their running speed so as to maintain the relative angle between their eyes and the ball constant.' Carvalho & Nolfi (n 69) 1.

71 J Pastorius *Word of mouth* (1981).

72 M Donald 'The exographic revolution: Neuropsychological sequelae' in L Malafouris & C Renfrew (eds) *The cognitive life of things: Recasting the boundaries of the mind* (2010) 71.

73 On memory and music, see, for instance, B Snyder *Music and memory* (2001), RI Godøy & H Jorgensen *Musical imagery* (2001). On musical entrainment, see

her successor, gestures of approval or otherwise, which since these are embodied responses once again do not figure in classic accounts of cognition.

One ought also not neglect the wide variety of traditional musical practices which do not utilise scores to coordinate concerted musical actions. How would putative mental pictures arise in such instances in the absence of a master score? For Chemero's RECS, any and all representations are surplus to requirements in keeping with the tenets of Gibsonian direct realism.[74] In fairness, this raises a concern as to instances where symbol manipulation seems intrinsic to thought, such as mathematics, chess, and other symbolic systems.

5 Conclusion

> The uncritical valorisation of 4E approaches in the humanities might be improved by more critical reflection on the challenges that emerge from these applications–both with respect to how the scientific perspectives of 4E might be legitimately (or illegitimately) used in the humanities, and how the humanities might broaden the perspectives of 4E (and cognitive science generally).[75]

The recognition of research-informed practice in the arts in South Africa as manifested in creative outputs[76] presents practitioners with new opportunities to bring forth the varieties of knowledge informing their work. Applications for creative outputs require an accompanying annotation with the purpose of explicitly relating practice to research.

M Clayton et al 'Interpersonal entrainment in music performance: Theory, method, and model' 38 *Music Perception* (2020); and regarding musical and other gestures, see E King & A Gritten (eds) *Music and gesture* (2006) and E King & A Gritten (eds) *New perspectives on music and gesture* (2016). On musical embodiment in general, see M Lesaffre et al *The Routledge companion to embodied music interaction* (2017).

74 Chemero (2011) (n 13).

75 J Carney 'Thinking *avant la lettre*: A review of 4E cognition' (2021) 4 *Evolutionary Studies in Imaginative Culture* 86.

76 BE Nzimande *Government Gazette* (28 April 2017). Higher Education Act 101 of 1997 Section 3 Policy on the Evaluation of Creative Outputs and Innovations Produced by South African Public Higher Education Institutions, 2017 .

The re-evaluation of cognition proposed by researchers working in the new paradigm provides practitioners with a robust framework within which to frame their creative work in a real-world setting. The broader contexts of cognitive archaeology and anthropology can in turn inform inquiries as to how makers engage with their materials of choice in mutually transformative encounters.

These concerns, as I have proposed, point to multi-disciplinary frameworks which encompass real-world actions by practitioners as a point of departure. I have argued that that musicology and musicking can both be enriched by taking on board critical tenets of 4E cognition as grounded in dynamic embodied action in real-world settings, in musicking's case cognitively extended through the deployment of instruments, so affording ecological validity if not clear-cut solutions to describing creative processes. The classic computational paradigm, which effectively disregards embodied activity, leaves no room for explorations of practitioners' engagements with their chosen materials. A thoroughgoing engagement with the new paradigm of 4E cognition (in this case, enactive cognition) seems to provide a better fit for describing such encounters but, as Carney warns, needs a critical stance so that the challenges emerging from the new paradigm are kept in mind. In this regard, the tenets of ecological validity suggest moving the field of inquiry from the research laboratory to a situation more accurately reflecting real world conditions, such as the recital venue. Under such circumstances, 4E cognition, for all that it is not a unified field, may enable the practitioner-researcher to maintain 'a middle path between the Scylla of cognition as the recovery of a pregiven outer world (realism) and the Charybdis of cognition as the projection of a pregiven inner world (idealism)'.[77]

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77 Varela et al (n 6) 172.

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