Beyond Skill Acquisition: Improvisation, Interdisciplinarity, and Enactive Music Cognition

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The paradigm of enactive music cognition offers an anti-representational framework for understanding musical activity as both corporeal and culturally-situated. In this paper, I discuss live electronic musical improvisation as an exemplary model for the enactive framework in its ability to demonstrate the importance of participatory, relational, emergent, and embodied musical activities and processes. Following Gallagher, I argue that the Dreyfus model of skill acquisition, where performers develop from novices to experts who may eventually achieve a state of 'mindless flow', does not adequately account for what can happen during various forms of musical play. A critical study of improvisation reveals that a more generous conception of meaningful musical activity is needed, particularly in terms of who is able to take part as an improviser. I contextualise these ideas from the position of being an improviser of live electronic music performed on self-built, hybrid analogue/digital instruments, my background in creating expressive musical systems for people with profound and complex learning difficulties, and through my recent explorations of both pedagogical and research approaches to interdisciplinary improvisation.

Keywords: Improvisation; performance; pedagogy; interdisciplinarity; enactivism; embodied cognition

Introduction

Musical improvisation has recently drawn attention as a fertile practice to explore from various perspectives within cognitive science research. For example, David Sudnow's (1978) autoethnographic account of learning to play and improvise as a jazz pianist was rewritten to reflect the broader attention that it was receiving from these fields. His monograph offers in-depth description by way of both the phenomenological and physical aspects of embodiment as theorised by philosopher Maurice Merleau-Ponty

(Sudnow 2001). Sudnow provides a rich account of how 'knowledge in the hands' (Merleau-Ponty 1962, 144) is acquired over time. Within empirical neuroscience research, Charles Limb and Allen Braun have studied jazz pianists, using functional neuroimaging methods. They claim that,

> [t]he process of improvisation is involved in many aspects of human behavior beyond those of a musical nature, including adaptation to changing environments, problem solving and perhaps most importantly, the use of natural language, all of which are unscripted behaviors (Limb & Braun 2008, 1).

Other empirical studies related to musical improvisation have attempted analyses of recorded musical performance data (Goldman 2013); assessing the judgement of moments of joint action between pairs of improvisers (Eerola, Jakubowski, Moran, Keller, & Clayton 2018); and using complex dynamical systems to investigate how improvisers are able to coordinate their movements to produce new musical material (Walton, Richardson, Langland-Hassan, & Chemero 2015). Yet Vijay Iyer has raised the important issue of interdisciplinary 'clashes' of ideologies that have arisen through what is nevertheless a 'well-intentioned consideration of the arts' (Iyer 2004, 159) by scientists. In particular, he questions why much of this research—aforementioned examples aside—tends to focus on:

> the well-trodden examples from pre-1900 European classical tonal music, and eschew nearly every other form of music, including all non-Western music, any contemporary or popular work, or any works that might be categorized as 'experimental'. (Iyer 2004, 159).

In what follows, I discuss live electronic musical improvisation as an exemplary model for exploring the enactive framework (Varela, Thompson & Rosch 1991) in its ability to offer a site for participatory, relational, evolving, and embodied musical activities or processes to unfold. As George E. Lewis and Benjamin Piekut note:

musical improvisation continues to play an important role as a model for how various fields of scholarship pursue the identification and theorisation of improvisative structure and function in human endeavour more generally (Lewis & Piekut 2016, 13).

Specifically, I consider the domain of live electronic music as a candidate for developing highly experimental, technologically-mediated situations in which numerous aspects of human and musical behaviours can be studied. I contextualise these ideas through the lens of my own artistic practice as an improviser of live electronic music using self-built instruments, and my experience in creating expressive musical systems for people with profound and complex learning difficulties and disabilities. I offer two case studies where this thesis is evaluated. The first is an analysis of an undergraduate course in interdisciplinary improvisation that I established at Arizona State University in 2016. Students from fields as diverse as film-making, computer science, and music learn to collaborate across disciplines using improvisational techniques, combining practices from the visual, sonic, and new media arts. The second case study discusses the salient themes that emerged from a four day workshop that took place in 2018, where a select group of early-career researchers, working in various artistic realms, use improvisation to explore the boundaries of their practices, and forge new, or possibly 'non-disciplinary' (Andean 2013, 7) forms, and modes of co-creation.

Enactive Music Cognition and Theories of Improvisation

There have been various attempts to theorise musical improvisation ([Benson 2003] and see [Lewis 2013; Nettl 2013]). When I survey a class of students on which things they count as improvisation, their responses usually begin with the performing arts, moving on to sports, then everyday activities such as conversation, and finally to 'most things in life'. In order to theorise improvisation we must move beyond attempts to identify what does or does not count as improvised. Rather, we can consider how improvisation

manifests through various lenses associated with a specific field or disciplinary area(s). I approach this from the enactivist perspective, where the type of knowing that is required for improvisation—an activity that is generally understood to involve some sort of spontaneity—does not require the accumulation of internal programs for action. Instead, as will be explicated below, it is firmly grounded within the historically rich sensorimotor interactions of a person in the world, and the diachronic reciprocity that occurs between bodies as part of the process of social cognition (Gallagher 2017).

Jeff Pressing's work is notable in presenting a foundational model based around the notions of instrumental skill and flow (Pressing 1988). In this model, knowledge is acquired over time, through practice, despite improvisation often being understood to be a spontaneous activity. For Pressing, this type of embodied knowledge can be both musical and cultural. Drawing on ideas from biological and cultural evolution, Rodger Dean and Freya Bailes (2016) develop Pressing's theory in relation to how creativity in general might be understood in cognitive terms:

> Pressing's model, together with an enhanced emphasis on process as a separable element, and on interaction as an additional dimension, may be thought of as Interactive Object/Feature/Process (IOFP) model. This appropriately brings to mind many of the core concepts of the cognitive processes in creativity in general. (42)

In the case of musical improvisation, their IOFP model would comprise three stages: firstly, musical material is generated by a performer, although arguably this could be initiated by a machine; then, this material is explored in order to determine its most salient or useful features; finally, a refinement or selection stage takes place. Their research demonstrates just one of many recent 'radically interdisciplinary' approaches to theorising improvisation, which Lewis has claimed are now crucial, given that the

breadth of literature now surrounding the field 'may be a bit more than music scholars alone can handle' (Lewis 2013, 1).

The nascent field of enactive music cognition, which offers an anti-representational framework for understanding musical activity as both corporeal and culturally-situated action, provides another such perspective. While the nuances of the various implications for understanding musicking in its various forms—and for musicking to advance the field of cognitive science—continue to be fleshed out (see, for example, [Matyja & Schiavio 2013]), the fundamental principles of this approach draw on the four distinct, yet related understandings of cognition. According to this view, cognition is non-computational and non-representational, but is dependent on the body—beyond just the brain—for forming, and constraining, cognitive processes: it is embodied. Being embedded, cognition is deeply dependent on both the physical and sociocultural environments in which we live. Thirdly, cognition is extended into the environment, which not only co-determines cognition, but actually constitutes it when cognitive load is distributed onto other beings and technologies. Finally, enactive cognition arises from these three previous tenets as cognition is formed through co-adaptive couplings between beings and their environments. While these principles overlap and scaffold one another, they are often referred to collectively as 4E cognition (see, for example, [Schiavio & van der Schyff 2018], for further discussion of this). Being so closely reliant on the other three elements, and concerned with how cognition is formed as a function of the histories of organisms, the enactive framework can be particularly useful within the study of musical performance.

While research in this field is largely theoretical, the potential applications of these ideas in various contexts can be further educed. For example, in the field of music

pedagogy, Dylan van der Schyff and his co-authors call for an enactive approach to music education in which teachers and students learn to:

> loosen sedimented or taken-for-granted attitudes, and thus imagine and explore possibilities for new and more ethical ways of being and knowing as the autonomous, embodied, social and creative creatures they are (van der Schyff, Schiavio & Elliott 2016, 100).

My own work has involved large-scale, pedagogical projects that explore inclusive and embodied approaches to music education with young people through the use of new technologies in schools (Hayes 2017). In this work, improvisation, exploratory play, and do-it-yourself instrument building are key strategies for engendering creative musical activity. In another field, that of music therapy, for example, improvisation has been a key technique due to 'its capacity to encourage both coherent interaction and personalized novelty of expression' as well as the 'communication and regulation of emotions' (Dean & Bailes 2016, 50). Dean and Bailes note the difficulty that music which is stylistically free presents in its ability to be analysed by therapists, who must determine a psychological understanding of meaning and progression over time in such improvisations. In my own collaborations with people with profound and complex learning difficulties, I have worked outside the domain of therapy, focusing more on facilitating person-centred creativity through new technologies, which has afforded me the freedom of musical world-building based on the specific physiological requirements and sociocultural environment of a particular person (Hayes 2015).

Beyond the Tropes of Improvisation Discourse

In their work developing the field of critical improvisation studies, Lewis and Piekut strive to highlight some of the many tropes that surround discussions of improvisation. Whether it is surprising or not that improvisation was a commonly practiced skill in pre-nineteenth century Europe, they suggest that it is neither helpful to mourn this decline

of improvisation nor to, on the other hand, '(over)valorize' (Lewis & Piekut 2016, 4) the practice. Indeed, while 'instant composition' is often used to describe a purported, special type of spontaneity that improvisation affords, Misha Mengelberg, co-founder of the Instant Composers Pool, had a much less grand connotation in mind; that of 'instant coffee' (Whitehead 2019). Lewis and Piekut also highlight that, historically, an emphasis has been placed on virtuosity and the mastery of instrumental skill as a crucial aspect of improvisation research. It is this historical framing of improvisation which focuses on a certain type of technical virtuosity, along with the persistence of the various tropes that Lewis and Piekut point out, I will suggest, that leads to a narrow conception of the practice, and ultimately excludes numerous valuable contributions from any discussion of its implications or discourses. Raymond MacDonald and Graeme Wilson have voiced similar concerns, suggesting that while the study of expert improvisers might produce more observable results in, for example, neuroimaging, this is essentially missing a much larger opportunity to engage with 'social psychological processes within a musical context' (MacDonald & Wilson 2014, 105), which is in no way a reductionist account. This also aligns with Iyer's concerns about focusing on one particular social group or geographic location: 'After all, how can one make assertions about cognitive universals of music without studying the music of more than one culture?' (Iyer 2004, 159). Particularly in European music history, there is a complex relationship between notation, improvisation, and accessibility. Dean and Bailes suggest that this is not acknowledged in music psychology research, which is 'often interested in improvisation primarily as a simple departure from score-based music rather than as a sophisticated object in itself' (Dean & Bailes 2016, 44).

So what, then, do the practices surrounding live electronic music research have to add to the discussion of improvisation and the cognitive sciences? Firstly, it should

be noted that some of the literature surrounding improvisation involving technology attempts to address—and at the same time, perpetuates—the unhelpful binaries between composition and improvisation (see, for example, [Eigenfeldt 2007]). Yet within these discussions are abundant descriptions of possibilities for exploring human-machine co-creation, automation, and issues of imbuing agency throughout an improvisational system. As Lewis notes,

> Since its inception in the early 1970s, the loosely constituted field of interactive computer music has drawn on artificial intelligence (AI), cybernetics, and socio-musical aesthetics that include machines as central actors... Musical computers were designed to stake out territory, assert both identities and positions, assess and respond to conditions, and maintain relativities of distance - all elements of improvisation, in and out of music (Lewis 2017, 91).

Dean and Bailes also comment on the potential for empirical studies to, in turn, contribute to improvisational processes through technological applications. Specifically, they suggest that real-time analysis of musical features could be used in conjunction with virtual cognitive models 'of whatever degree of elaboration is available' (Dean & Bailes 2016, 52). Neural network software simulations for musical purposes are readily available for this sort of collaborative work.

Hubert and Stuart Dreyfus developed a now commonly cited model of skill acquisition where, in the musical case, improvisers mature from novices to experts (Dreyfus 2004), who eventually may achieve a state of what many often describe as a 'mindless flow'. In attempting to deal with the issue of 'scaling-up' the enactivist model from simple action-perception processes, to more complex cognitive phenomena such as imagination and memory, philosopher Shaun Gallagher has argued that situated or embedded 'reflecting thinking... *contra* Dreyfus, is a *skill* as much as... physical coping [is]' (Gallagher 2017, 201). Following this, I suggest that a discourse that focuses on aspects of technical virtuosity does not adequately account for the dynamic relationships

that are reified during musical play. Firstly, this type of language—often used by improvisers themselves—seems to valorise the practice, reinforcing the myth that '[m]usical improvisation is, to many in the Western world, an activity shrouded in mystery' (Ashley 2009, 413). A critical study of improvisation suggests an opening up of how and what we can conceive of as complex musical activity, and who is able to participate in that.

The case studies that I discuss below demonstrate that, through the lens of—and practices associated with—live electronic musical performance, improvisation can be an activity that does not need to be framed within the novice/expert model at all. Here, we emphasise that the improviser's knowing emerges from their experiential histories of interactions with many different materials and objects, digital media, spaces, as well as social roles and norms. Specifically, this makes evident that the knowing-experiencing of improvisation does not depend on markers of skilful musical instrumental expertise at all, but rather on the instantiation of multiple sensitivities of the person as a whole. This has been evident over the last decade of my work with interactive computer systems for improvisation, used within numerous different social contexts.

Without undermining the highly-developed practices of improvisers around the world, we can rapidly move away from the romantic idea of the mindless, immersed virtuoso. This trope relies on viewing musical improvisation within a very specific domain, where skill is taken to be the accurate implementation of expert cognitive programs in a state of flow. Rather, the enactive view preferences the flexible and diachronically emergent capacities of humans, which allow us to modulate and regulate improvising situations with recourse to numerous holistically embodied sensitivities. Furthermore, as cognition is not a solipsistic process, this modulation can readily occur through moments of joint action and coordination with others. Henceforth, a much

broader variety of moments of skilful improvisation can be examined. From the enactivist position, we can understand how such instances of musical coarticulation can be elicited in those who may not consider themselves to have an established practice of improvisation. Namely, this occurs due to the richly embodied histories that are brought together within collaborative improvisation, irrespective of any virtuosic/amateur positioning. Two examples of this interpretation—one related to pedagogy, the other, a creative practice research project—are described below.

A Pedagogy of Interdisciplinary Improvisation

Moving from working in music departments to a wholly interdisciplinary department—the School of Arts, Media and Engineering (AME), at Arizona State University—I've been tasked to design courses that can appeal to students from a variety of backgrounds and disciplines. Our undergraduate programme in Digital Culture enables students to major in a variety of disciplines from art, to film, media processing, English, and music. In addition to a focus on technical skills, such as coding for new media design, along with a drive towards critical thinking, we have a strong 'maker' theme that runs through many of our courses, supported by state-of-the-art technologies. Research-led teaching is encouraged within AME in general, and on approaching improvisation with technology from a pedagogical perspective it was important to consider: how could improvisation be incorporated successfully into the aforementioned undergraduate program as a way of making sense of both digital technologies and digital culture? How could this be approached from an inclusive, interdisciplinary angle, given my background in live electronic music? What could be learned about the role of improvisation in relation to music research within the cognitive sciences, particularly when working with people who are being introduced to its practices for the first time?

How could all this be approached from the cultural diversity of the students within our program?

Methodology

As with my earlier pedagogical methodologies (Hayes 2017), students are motivated to find their own personal and encultured responses to creative challenges by being guided through a series of scaffolded techniques throughout the duration of the course. Beginning with music and movement-based improvisational practices, the class works to develop collaborative multimedia performances. Instead of being another course where students learn a new technique such as, for example, creative coding software, we critically explore the technologies they are learning to use in other classes through a practice-based, creative sense-making. We ask questions such as: what sorts of things can be easily translated between artistic disciplines? Do we arrive at a state of disciplinary mixing or something more 'non-disciplinary' (Andean 2013, 7)? How can techniques from electroacoustic performance practice be incorporated into this task? What is the role of documentation in this, and can it become part of the performance itself?

Before attempting to improvise using instruments or other technology, students are directed through a series of techniques including those for listening, such as, for example, Pauline Oliveros' *Deep Listening* methods (Oliveros 2005), and simple movement and somatic exercises for attentive sensory awareness. Well-established free improvisation exercises are practiced as a class and in smaller groups, along with expanded multimodal versions. For example, John Stevens' *Click Piece* (Stevens, Doyle & Crooke 2007), can be performed using voice, body percussion, acoustic instruments, and also lends itself to electronic and digital instruments—simply operating an ON/OFF

switch will always be enough to achieve the desired *click*. But, it can also be combined with similar techniques that are used within movement practices (Meador, Rogers, O'Neal, Kurt & Cunningham 2004). In the case of this simple exercise, there is the potential for a class of thirty untrained improvisers to co-create a compelling performance in a very short amount of time, often producing what David Borgo has referred to as having the characteristics of swarm dynamics (Borgo 2005). Not only is sensorimotor exploration involved, but musical meaning is brought forth through an emergent extended cognitive network that involves complex relationships between the improvisers involved, technology, and the space in which the performer-instrument pairings are distributed.

INSERT FIGURE 1 HERE

Figure 1. An augmented reality improvisation ensemble.

Drawing on different areas of live electronic music research, such as laptop orchestras and networked performance, the class also explores the idea of collaborative instruments, where, for example, thirty individual laptops can be used to control parameters within one main sound-making software instrument. Again, here the interesting dynamics appear not out of individual physical virtuosity, but in how the many-to-few mappings affect the sonic result, how agency is distributed throughout the human(s)-machine(s) system, and how performers can attempt to subvert any rules that are established within a system. For example, rather than physically triggering a certain sound or changing a particular parameter, some students quickly modified the code on their own local machines, employing algorithmic processes—for example, setting up clocks—in order to automate certain activities at rates that would not be possible by human action alone. Other elements of the class included experimental strategies for

incorporating more than one discipline, such as, for example, amplified painting using contact microphones attached to a canvas, or using gestural controllers to create both visual material and at the same time manipulate digital sound. The largest component of assessment is via final class performances, which comprise collaborative group improvisations. These have, to date, encompassed a vast range of materials and media techniques, including incorporating food, augmented reality (see Figure 1), and breakdancing.

INSERT FIGURE 2 HERE

Figure 2. Persian dance, self-built and augmented instruments, and networked performance using low-cost hand tracking.

While they focus largely on traditional musical instruments in their discussion of enactive music pedagogy, Andrea Schiavio and Dylan van der Schyff note that,

> If the body plays a key role in determining musical learning, so does the socio-material and cultural environment in which it is embedded. However, these dimensions are not separated from the body. Rather, they become manifest through the body and are co- determined by actions and interactions with other bodies and things in socio-culturally meaningful contexts (Schiavio & van der Schyff 2018, 9).

We can take this proposal seriously by developing and augmenting improvisational practices that build collectively on individual musical and creative sociocultural histories that individuals bring to the table. For example, one trio that emerged during the course comprised a practitioner of Persian dance, who performed while wearing a low-cost hand tracking system, which, in turn, controlled parameters of the sound being produced by two musicians. One had built her own hybrid acoustic-digital percussion instrument using self-taught wood-working techniques, and incorporating piano strings which could be plucked, hit, or scraped; the other was performing using an augmented

electric guitar (see Figure 2). This repurposing of tools, which can be 'co-opted and redefined through a completely different performative act' (Andean 2013, 8), has been a practice long used by both improvisers and electronic musicians. The performance was relational, but not only though the usual modes of non-verbal communication such as eye-contact and gesture, as well as, of course, listening: the particular sounds being made would affect the dancer's movement, which, in turn, would directly process these sounds in real time. Another larger group comprised live projected drawing, Bharatanatyam dance techniques, and several custom-built electroacoustic instruments (see Figure 3). In this group, continuous adaptation to numerous auditory and visual cues demanded sophisticated behavioural coordination by the group. While some of this may have been visibly highly gestural to the audience, other elements were not. No comparison to other ensembles could be made, as it is likely that none such identical assemblages have existed. As someone who is not trained in dance, I could not assess this work from the perspective of technique alone. Yet, these types of interdisciplinary improvisations demonstrate that complex and, at times, highly compelling unfolding of creative activity can be co-articulated between multiple performers, and this can be evaluated by viewing these processes from a historically-emergent, rather than linear purely skill-based perspective.

INSERT FIGURE 3 HERE

Figure 3. Live projected drawing, analogue and digital instruments, and Indian dance.

LLEAPP: an Interdisciplinary Model for Creative Practice Research
The Laboratory for Live Electronic Audio Performance Practice (LLEAPP) is a participatory workshop for postgraduates and early career researchers that was

established in 2009 at the University of Edinburgh, UK. Conceived while I was a masters student at the same institution, at a time when my co-creators Owen Green, Jules Rawlinson, and Sean Williams—all then doctoral students—and I were navigating the recently created degree programs in creative music practice. Indeed, the catalyst for this series of workshops was our grappling with how to approach this type of research:

> What is the place of live electronic music research in the wider endeavour of musical research? How are its knowledge claims established, and to whom—and how—are they communicated? What is the scope of these claims? Where are the borders of our enquiry? How do "practice" and "research" relate? Who is doing this research? Why? (Green 2014, 1).

As Green notes, these are questions with answers that have not yet been adequately formalised by those working in the sub-discipline of live electronic music research.

Methodology

The sixth LLEAPP workshop was held at Arizona State University in 2018, with previous iterations all taking place in the UK—twice at the University of Edinburgh (2009, 2013), the University of Newcastle (2010), the University of East Anglia (2011), and De Montfort University (2015)[i]. The roster of local and invited participants is dependent both on funding limitations and the location. The format is largely determined by the hosts and participants in each location, but generally follows a workshop model where participants collaborate over three days through a loosely structured process of self-organisation, and then show their work publicly, in whatever various stages of development or completeness they wish to present. Following this, a critical feedback and discussion session takes place, usually the following day. The only prescribed aims of LLEAPP are to provide both time and space to enable intensive creative practice research and foster a community of participants in order to approach some of the research questions noted above. For the 2018 edition, LLEAPP was not

restricted to practitioners with musical backgrounds, but instead focused on interdisciplinary improvisation as a theme. As such, we assembled a diverse group of international participants from four continents, with the majority—but not all—currently affiliated with academic institutions.

INSERT FIGURE 4 HERE

Figure 4. Opening concert with separation between dance and musical activities.

As has been the model for the past few LLEAPPs, the program began with an evening concert where all nine participants, most of whom had just met for the first time a few hours previously, performed together. This took place in iStage, an 8-channel surround sound performance space with a sprung dance floor, and multiple options for lighting effects, motion capture, and video projection. It was evident that there was a clear divide between performers with experience in movement-based performance practices, and those for whom it was fairly new. Firstly, in terms of positioning within the space, as we started to set up our equipment, people tended to frame the perimeter, some being further separated by the barrier of a table (see Figure 4). Without any prior discussion of strategy, I did not find any meaningful way to move from behind my station to explore the floor space in front. James Andean and Alejandro Olarte have reported similar boundaries occurring between dancers and loudspeakers within their interdisciplinary investigations:

> In general... the dancers find the loudspeaker to be something of a barrier, and are less comfortable engaging with the more mediated material it presents than with the performance of an acoustic performer, who is potentially more localised, whose actions may be more closely linked with their output, and who is more easily imagined as a part of a general choreography than the fixed and impersonal loudspeaker (Andean & Olarte 2012, 3).

In order to challenge this, we spent the remaining three days experimenting and devising strategies, games, and sharing techniques for exploring the various different practices and materials that we had brought with us. Flour, squeezable objects, mallets and beaters (see Figures 5 & 6), lighting, visual projection on the floor and a false paper ceiling were combined with instruments for live electronic musical performance including hybrid acoustic-analogue-digital instruments, purely software based improvisation systems, hybrid audio-visual systems, tangible and portable electronic instruments, and analogue feedback systems involving radio or wireless devices. Improvisational play allowed us to conceive ways to shake off disciplinary boundaries—noting that these did not necessarily exist for all of the practitioners involved. Through this, we were able to co-construct methods for, for example, moving through space as an ensemble by devising simple rule-based activities. One such instance of this included staying within the bounds of an algorithmic, geometric visual projection that one of the participants had brought to use in a different context. In another activity, we used sounding objects as a means of traversing space, while at the same time spatialising audio—both by way of this process, and simultaneously through the surround sound system. The final public presentation took the form of approximately forty-five minutes of performance in which the audience was positioned both at the edges of, and throughout the presentation space. The improvisation was structured only to the extent that the sounding, portable objects were positioned in the centre of the space at the beginning, with a pulsating circular geometric projection falling on them, inviting them to be picked up. Aside from this, many of the ideas, games, and techniques that we had established in the previous few days were drawn on by the performers at different times throughout the duration of the performance. In this way, the shared 'vocabulary' that we had rapidly developed became embedded in the

work itself.

INSERT FIGURE 5 HERE

Figure 5. Converging practices in space and with objects.

Yet, this shared sense of self-organisation emerged only from discussion, experimentation with, and ultimately rejection of—as a group—certain modes of interaction. For example, while many of the activities involved pushing us out of our artistic—and at times, personal—comfort zones, certain suggestions were too uncomfortable for some, given our broad range of sociocultural backgrounds, and were modified accordingly. One such example was the suggestion of contact improvisation, in which energy is transferred from person to person through direct touch. This was altered, instead, to involve exchanging an imagined, weighty physical ball. In their work on social interaction and enactive theory, Hanne De Jaegher and her co-authors comment on this tension between individual and group dynamics:

> not only is the interaction process autonomous in terms of its internal
> organization, it also depends, crucially, on the autonomy of the individuals
> participating in it. In this way, for enaction, interactional organization requires
> both interactional and individual autonomy (De Jaegher, Peräkylä & Stevanovic
> 2016, 6).

INSERT FIGURE 6 HERE

Figure 6. Movement, material, and light.

Conclusion

In their work on the emergence of interdisciplinarity as a research trend, Andrew Barry and Georgina Born (2013) suggest that problems can be framed positively, not as fixed entities that require a solution—as much interdisciplinary work purports to be tackling—but 'as a means of generating questions around which new forms of thought and experimental practice can coalesce' (10). Improvisation can be explored and studied as a highly inclusive, cross-cultural practice in which people co-create extra-musical worlds through the ongoing and reciprocal processes of exploring materials and the coordination of action. As the enactivist view makes evident, this is owing to the historically thick type of knowing involved, which allows such coordinations to occur without recourse to the discourses surrounding musical skill acquisition. I have discussed why an interdisciplinary approach—in my case, one that involves practices which incorporate technology for live performance—can create the potential for shifts within disciplinary ideologies and offer up techniques which allow people with or without prior experience of artistic improvising, performing, or indeed collaborating with others from a different field or cultural background to very rapidly participate in this type of creative endeavour. The case studies outlined—one pedagogical, the other research-based—have emerged from the theoretical framework of enactive music cognition, and should hopefully provide some suggestion as to the scope of improvisational practices that can be studied under this approach. In particular, I suggest we might take a more 'agonistic-antagonistic' (Barry & Born 2013, 13) stance in this interdisciplinary work, urging non-practitioners to immerse themselves fully in practice-based research in order to more fully understand the phenomena that they wish to study. 'Improvisation is a process that everybody can engage in; we are all musical improvisers at some level' (MacDonald & Wilson 2014, 117). I take MacDonald and

Wilson's statement to envision improvisation as at once prosaic, ubiquitous, and yet, at the same, providing a richly diverse range of opportunities for participation and study, more than is necessarily being explored within current cognitive science research.

Notes on Contributor

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References

Andean, J. 2013. "Electroacoustic Performance Practice in Interdisciplinary Improvisation." In *Proceedings of the Electroacoustic Music Studies Network Conference*.

Andean, J., and A. Olarte. 2012. "Sound, Music and Motion: Sound Art and Music in Cross-Disciplinary Improvisation." In *Third International Symposium on Music and Sonic Art.* Institut für Musikwissenschaft und Musikinformatik, Karlsruhe.

Ashley, R. 2009. "Musical Improvisation." In *The Oxford Handbook of Music Psychology,* edited by S. Hallam, I. Cross, and M. Thaut, 413–420. Oxford: Oxford University Press.

Barry, A., and G. Born. 2013. *Interdisciplinarity: Reconfigurations of the Social and Natural Sciences*. London: Routledge.

Borgo, D. 2005. *Sync or Swarm: Improvising Music in a Complex Age*. London: A&C Black.

Benson, B. E. 2003. The Improvisation of Musical Dialogue. Cambridge: Cambridge University Press.

Dean, R. T., and F. Bailes. 2016. "Cognitive processes in musical improvisation." In *The Oxford Handbook of Critical Improvisation Studies Vol. 1.,* edited by G. E. Lewis and B. Piekut. New York: Oxford University Press.

De Jaegher, H., A. Peräkylä, and M. Stevanovic. 2016. "The Co-Creation of Meaningful Action: Bridging Enaction and Interactional Sociology." *Philosophical Transactions of*

the Royal Society B: Biological Sciences 371 (1693), 20150378.
doi:10.1098/rstb.2015.0378.

Dreyfus, S. E. 2004. "The Five-Stage Model of Adult Skill Acquisition." *Bulletin of Science Technology & Society,* 24 (177). Sage.

Eerola, T., K. Jakubowski, N. Moran, P. E. Keller, and M. Clayton. 2018. "Shared Periodic Performer Movements Coordinate Interactions in Duo Improvisations." In *Royal Society Open Science* 5(2), 171520. http://doi.org/10.1098/rsos.171520

Eigenfeldt, A. 2007. "Real-Time Composition or Computer Improvisation? A Composer's Search for Intelligent Tools in Interactive Computer Music." In *Proceedings of the Electroacoustic Music Studies Network Conference.*

Gallagher, S. 2017. *Enactivist Interventions: Rethinking the Mind*. Oxford: Oxford University Press.

Goldman, A. 2013. Towards a Cognitive-Scientific Research Program for Improvisation: Theory and an Experiment. In *Psychomusicology: Music, Mind, and Brain* 23 (4): 210.

Green, O. 2014. "Four Small LLEAPPs for Electroacoustic Music Studies: Notes on Performance Strategies from a Series of Participatory Electronic Music Workshops." In *Proceedings of the Electroacoustic Music Studies Network Conference.*

Hayes, L. 2015. "Enacting Musical Worlds: Common Approaches to using NIMEs within both Performance and Person-Centred Arts Practices." In *Proceedings of the International Conference on New Interfaces for Musical Expression,* 299-302.

Hayes, L. 2017. "Sound, Electronics and Music: a Radical and Hopeful Experiment in Early Music Education." *Computer Music Journal* 41 (3): 36-49. MIT Press.

Iyer, V. 2004. "Improvisation, Temporality and Embodied Experience." *Journal of Consciousness Studies* 11 (3-4): 159–173.

Lewis, G. E. 2013. "Critical Responses to "Theorizing Improvisation (Musically)"." In *Music Theory Online* 19 (2). Society for Music Theory.

Lewis, G. E. 2017. "From Network Bands to Ubiquitous Computing: Rich Gold and the Social Aesthetics of Interactivity." In *Improvisation and Social Aesthetics*, edited by G. Born, E. Lewis, & W. Straw. Durham, NC: Duke University Press.

Lewis, G. E., and B. Piekut, 2016. "Introduction: On Critical Improvisation Studies." In *The Oxford Handbook of Critical Improvisation Studies Vol. 1.,* edited by G. E. Lewis and B. Piekut. New York: Oxford University Press.

Limb, C. J., and A. R. Braun. 2008. "Neural Substrates of Spontaneous Musical Performance: An fMRI Study of Jazz Improvisation." *PLoS ONE* 3.2 (2008): e1679.

MacDonald, R., and G. Wilson, 2014. "Billy Connolly, Daniel Barenboim, Willy Wonka, Jazz Bastards and the Universality of Improvisation." In *The Oxford Handbook of Critical Improvisation Studies Vol. 2.,* edited by G. E. Lewis and B. Piekut. New York: Oxford University Press.

Matyja, J. R., and A. Schiavio. 2013. Enactive Music Cognition: Background and Research Themes. *Constructivist Foundations*, 8 (3): 351–357.

Meador, W. S., T. J. Rogers, K. O'Neal, E. Kurt, and C. Cunningham. 2004. "Mixing Dance Realities: Collaborative Development of Live-motion Capture in a Performing Arts Environment." In *Computers in Entertainment* 2 (2).

Merleau-Ponty, M. (1945) 1962. *Phenomenology of Perception.* Translated by C. Smith. Routledge and Kegen Paul.

Nettl, B. 2013. "Contemplating the Concept of Improvisation and Its History in Scholarship." In *Music Theory Online* 19 (2). Society for Music Theory.

Oliveros, P. 2005. *Deep Listening: A Composer's Sound Practice.* Lincoln, NE: iUniverse.

Pressing, J. 1988. "Improvisation: Methods and Models." In *Generative Processes in Music: The Psychology of Performance, Improvisation, and Composition,* edited by J. A. Sloboda. New York: Oxford University Press.

Schiavio, A., and D van der Schyff. 2018. 4E Music Pedagogy and the Principles of Self-Organization. *Behavioral Sciences*, 8 (8): 72. https://doi.org/10.3390/bs8080072

Stevens, J., J. Doyle, and O. Crooke. 2007. *Search and Reflect: A Music Workshop Handbook*. Twickenham: Rockschool.

Sudnow, D. 1978. *Ways of the hand : The organization of improvised conduct*. London: Routledge and Kegan Paul.

Sudnow, D. 2001. *Ways of the Hand: A Rewritten Account*. Cambridge, MA: MIT Press.

van der Schyff, D., A. Schiavio, and D. J. Elliott. 2016. "Critical Ontology for an Enactive Music Pedagogy." In *Action, Criticism & Theory for Music Education*, 15 (5).

Varela, F. J., E. Thompson, and E. Rosch. 1991. *The Embodied Mind*. Cambridge, MA: MIT Press.

Walton, A. E., M. J. Richardson, P. Langland-Hassan, and A. Chemero. 2015. "Improvisation and the Self-Organization of Multiple Musical Bodies." In *Frontiers in Psychology* 6 (313).

Whitehead, K. 2019. "Instant Composers Pool History." Instant Composers Pool Orchestra. Accessed January 7 2019. http://www.icporchestra.com/history/

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[i] While most participants have only attended one LLEAPP, this latter iteration is the only LLEAPP that I have not attended personally.