Shaped by the Sound Around Us: Furthering an Ecological Dynamics Approach to Developing Instrumental Improvisational Skills

Nicholas James Calligeros

A thesis submitted in partial fulfilment

of requirements for the degree of

Masters of Music (Performance)

Sydney Conservatorium of Music

University of Sydney

2023

Declaration

This is to certify that to the best of my knowledge, the content of this thesis is my own work. This thesis has not been submitted for any degree or other purposes.

I certify that the intellectual content of this thesis is the product of my own work and that all assistance received in preparing this thesis and sources has been acknowledged.

Nick Calligeros

23/06/2023

Acknowledgments

To Phil Slater, thank you for the wonderful supervision and mentorship not only during this project but for the last 10 years. Thank you for setting the bar so high for many of us through your trumpet playing, improvising, and academic rigour.

To my wonderful partner Jaime, thank you for your immense grounding and support; for organising the wonderful writing breaks and the unsolicited learning of these esoteric ideas.

To my auxiliary supervisor Simon Barker, thanks for your council and support, and for being such a source of inspiration and encouragement for the creative improvised music community.

To Adrian Lim-Klumpes and Miles Thomas, thank you for contributing your wonderful playing and artistry to the creative work, and thank you to Richie Belkner for capturing it so beautifully.

Thanks to Monty Richmond for proofreading and the helpful formatting advice.

Thanks also to Helen Mitchell and Chris Coady for their guidance throughout; to Sam Gill for the advice and chats, and to my housemates for their help and patience.

A particular thank you to the Kathleen E. Armstrong Bequest Scholarship and the estate of Kathleen Armstrong for the financial support, and to Dean Anna Reid for the determination. Thanks also to Postgraduate Research Support Scheme (PRSS) for the financial assistance.

To my family, thanks always.

Abstract

This practice-led project investigates the development of improvisational skills for an advanced improviser through the application of ecological dynamics, a contemporary framework of learning and development from the fields of sports and human movement science. Ecological dynamics encourages the emergence of new, goal-orientated skills through the strategic application of constraints on the learner, task, or environment. The framework conceptualises skill development as an adaptive response where learners explore and eventually exploit the constraints and affordances (opportunities for action) within their performance environment. For this project, an experimental practice was undertaken wherein various audio and video materials featuring speech (obtained from publicly available online sources) were employed as a novel sonic constraint during a five-month period of daily spontaneous trumpet improvisations. Subsequently, a creative work was recorded, capturing the deployment of the newly embodied skills in their applicable context: an improvised ensemble performance. The research outputs of the project are presented as an (i) autoethnographic report of the practice experiment, (ii) taxonomy of techniques, approaches, and materials, as well as the (iii) resultant creative work. Following from Slater (2020) and Rapp (2023), this study aims to further the application of ecological dynamics to instrumental improvisation.

Table of Contents

Figures

Audio Examples

1 Introduction

This practice-led project investigates the development of improvisational skills for an advanced improviser through the application of ecological dynamics, a contemporary framework of learning and development from the fields of sports and human movement science. An experimental practice was designed and implemented featuring a period of spontaneous trumpet improvisation with a novel sonic constraint. A creative work was then recorded, capturing the deployment of the embodied skills in their applicable context: an improvised ensemble performance.

Ecological dynamics focuses on the strategic application of constraints on the performance environment, task, or individual, to encourage the emergence of new, goal-orientated skills (Araújo & Davids, 2011; Button et al., 2021; Kelso, 1995; Thelen & Smith, 1996). The framework conceptualises skill development as an adaptive response, as learners explore and eventually exploit the constraints and affordances (opportunities for action) found within the designed performance environment (Araújo & Davids, 2011; Chemero, 2003; Chow et al., 2011; Gibson, 1979; Seifert & Davids, 2017; Slater, 2020; Woods et al., 2020a). Ecological dynamics is a form of nonlinear pedagogy, wherein emergent skills are indeterminate and not always directly relational to their cause (Chow et al., 2016; Chow et al., 2011).

Ecological dynamics was first practically applied to musical improvisation by Slater (2020) in his doctoral thesis *The Dark Pattern: Towards a constraint-led approach to jazz trumpet*. This project aims to extend Slater's conceptualisation of instrumental improvisation as an ecological and dynamical activity through a similar practice experiment. Where Slater utilises various outdoor settings as environmental practice constraints, this project employs a novel sonic

constraint to see if new skills and techniques emerged. This study centres around an advanced practitioner foremostly seeking to develop original and creative skills for use in spontaneous improvisational performance settings. The term *skill* here encapsulates patterns of motor coordination, playing techniques, as well as novel musical materials, strategies, and approaches.

A self-regulated experimental practice was designed featuring 15 to 20-minute daily improvisations accompanied by an assortment of amplified speech-based audio material obtained from YouTube and Apple Podcasts. The mode of practice was creative, spontaneous improvisation without employment of predetermined musical structures or overarching parameters beyond those spontaneously generated during the practice. Further, the practice was self-regulated. Self-regulated learning is a recognised pedagogical approach where practitioners direct their own outcomes and evaluation in an unsupervised environment (McPherson et al., 2017; McPherson & Renwick, 2011; Zimmerman, 1986, 2002). A total of 56 sessions were logged over a five-month period. Sessions were recorded and reflections journaled. To my knowledge, this is only the third practice-led project after Slater (2020) and Rapp (2023) to apply ecological dynamics to musical improvisation, and the first to apply a sonic constraint.

Research outputs of this project are presented in Chapter Four as an autoethnographic recounting of the practice and taxonomy of developed skills, techniques, and materials. A further research output, the creative work of a recorded improvised performance, is detailed in Chapter Five. This creative work is an important and communicable component of the project, capturing the deployment of developed skills in an applicable setting: an improvised musical performance with a jazz ensemble.

Example 1

Example of the creative work

Example 2

Example of the practice experiment

1.1 Practitioner background and artistic problem

As the advanced practitioner in this practice-led and self-regulated project, I bring 11 years of professional experience as a trumpet player and composer. My career is focused within the field of contemporary experimental jazz and improvised music. I currently lead/co-lead four original projects and freelance with several original ensembles. Much of my professional practice exists in highly improvised and indeterminate musical settings characterised by minimal predetermined musical parameters (including limited harmonic, rhythmic, or structural material). My improvising approach foremostly values novelty, reactivity, expressiveness, and originality.

During my cumulative 14 years of both private and undergraduate study of jazz and improvisation, I have noted a lack of available pedagogical tools to develop skills for the indeterminate musical performance environments I often perform in. Moreover, I have observed the absence of processes taught to explicitly develop an original and idiomatic improvising approach, a long-held musical goal of mine and a revered musical characteristic within the wider jazz and creative improvising community (Ake, 2002; Berliner, 1994). Such a gap in improvisation pedagogy led to me to consider just how one might develop skills for more open and unstructured forms of improvisation. What might these skills look like? Does a method to encourage the development of a unique and original improvisational style exist?

Slater's (2020) doctoral thesis offered a compelling methodology addressing these queries. Slater applied ecological dynamics to instrumental improvisation in a year-long practice intervention of daily, spontaneous improvisations in a variety of outdoor locations. In his own words, the intervention "initiated many profound changes to my music-making abilities and aesthetics" (Slater, 2021, p. 10). Reflecting on his research, Slater (2021) suggests the adoption of such a methodology is "particularly well suited to creative spontaneous improvisation and creative forms of music making, as it strongly rejects the notion of an idealised, referential, or correct version of musical materials and events" (p. 10).

Ecological dynamics indeed offers an alternate model to traditional methods of jazz improvisation pedagogy, which largely rely on input of theory (such as chord-scale theory or pre-composed patterns), and the analysis and replication of idealised versions (see Section 2.3.8) (Borgo, 2007, 2022; de Bruin, 2015; Slater, 2020; van der Schyff, 2019; Yossef & Granot, 2023). Although such methods may benefit more structured or stylised forms of improvisation, their application to the development of an original or novel approach is limited (Borgo, 2007). Instead of loading improvisers with pre-planned information and having them undertake repetitious practice towards idealised models (as found in deliberate learning methods (Ericsson et al., 1993)), ecological dynamics utilises the act of performance and the performance environment as tools to discover original performance solutions (skills). Furthermore, recent research by Schiavio and Kimmel (2021) theorise how an ecological dynamics approach to instrumental practice may not only induce new patterns of coordination but initiate the emergence of creative and novel outcomes (see Section 2.3.1).

Upon commencing this study and exploring the literature it became clear that Slater's project exists within a subset of music research informed by contemporary cognitive science and its

appreciation how our environmental, bodily, and sociocultural orientations inform behaviour. But for all that has been studied in this emergent field of music scholarship, there remains a lack of practical investigation of these theories. This project contributes a practitioner- and practice-led perspective to this growing subset of music research with the aim to further our understanding of instrumental improvisation and pedagogy.

1.2 A practice-led approach

This project's methodology is informed by ecological dynamics and its key pedagogical principles, investigated within the mode of artistic practice-led research. Practice-led research is a well-established method of study centred around a practitioner and their undertaking of novel practice methodologies to achieve new research insights (Smith & Dean, 2009; Vear, 2021). This project is situated within a body of practice-led music research in Australia exploring the development of artistic instrumental techniques and materials (e.g., Barker, 2015; Botting, 2018; Dasika, 2021; Dobson, 2021; Gander, 2017; Gill, 2018; Hale, 2018; Kim, 2022; King, 2021; McLean, 2018; McMahon, 2022; Meagher, 2022; Oehlers, 2019; Rapp, 2023; Slater, 2020; Williamson, 2014).

Although the ecological dynamics literature discussed in Chapter Two underpins this project's methodology, my experience as an advanced practitioner has also informed the design, implementation, and outcomes of the practice experiment. This is demonstrated most clearly in the experimental modifications made to the sonic constraint in the latter part of the experiment, as outlined in Chapter Four. As such, ecological dynamics can be considered what Candy (2021) describes as an *active agent* in the practice process where, "not only does the theory inform practice, but the practice informs the theory as a dynamic process which can inform and shape new constructs and processes and, in turn, be subject to further development" (p. 209). Candy

(2021) suggests this reciprocal relationship between theory and practice can lead to new forms of knowledge not possible by either one alone.

1.3 NSW COVID-19 lockdown

The project's practice experiment was designed during a state-wide lockdown due to the spread of COVID-19, enacted from 25 June 2021 to 11 October 2021 (Hazzard, 2021). During this time, the New South Wales government passed laws restricting travel to within a person's local government area, as well as prohibiting the gathering of people in public and private spaces. This community constraint influenced the project's practice design, leading to the construction of an experiment wherein travel nor other participants were required. Speech was selected as a novel sonic constraint partially in response to this restriction. Further, improvising with human voices would allow for interaction with others in a time when such important communication was hindered. Speech was also chosen as a sonic constraint due to its novelty, free access, and wide availability, allowing variable conditions for each session (see Section 3.3). This project and the creative work can be seen as a response to the 2021 NSW COVID-19 lockdown.

1.4 Embedded audio

This thesis features embedded audio excerpts hosted on SoundCloud (htttps://www.soundcloud.com), an online service that enables audio files to be efficiently streamed without requiring download. Blue play buttons (Figure 1) throughout the document are hyperlinked to individual audio excerpts.

Figure 1

Example of hyperlinked play button

Clicking a blue play button will load a SoundCloud link in the reader's default web browser. Excerpts can only be accessed with an internet connection.

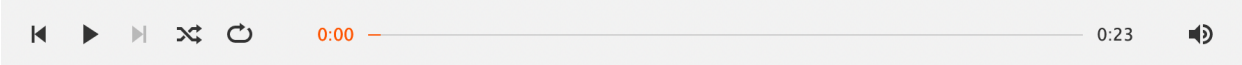
Using the SoundCloud player, listeners can stop, play, and repeat, as well as skip to specific sections within each excerpt by clicking on a section of the waveform visualiser (Figure 2), or the player panel at the bottom of the screen (Figure 3). No log in is necessary to access the audio excerpts.

Figure 2

Screenshot of SoundCloud player visualiser

Figure 3

Screenshot of SoundCloud player panel found at bottom of screen



1.5 Important terms

Affordance	Environmental properties perceivable by an organism that compel or allow action (Chemero, 2003; Gibson, 1979).
Constraint	A condition or limitation that restricts a system's degree of freedom (Balague, 2019; Kelso; 1980).
Complex system	A system composed of many subsystems but no central controlling component.
Environment	The sum conditions and objects of one's surrounding, including physical and auditory features (Merriam-Webster, n.d).
Spontaneous improvisation	Spontaneous musical creation with no predetermined musical structures or overarching musical parameters beyond those spontaneously generated during the act.
Performance	The presentation of music. Considered in this project as both the mode of practice, and audience-based performance.

Perturbance	Internal or external stimulus that may disrupt or destabilise a system, possibly resulting in new patterns.
Self-organisation	The emergence of coherent patterns of order and stability system with no central, controlling component (Kelso, 1995).
Skill	Conceptualised in this project as emergent, embodied, and cognitive qualities of playing, inclusive of motor coordination, strategies, approaches, and new and novel musical materials.
Speech material	References the audio or video used as a constraint in each practice

1.6 Chapter overview

Chapter 1	Introduction of project, including practitioner background and initiatory artistic problem.
Chapter 2	Literature review explaining the relevant concepts of ecological dynamics and its application to instrumental improvisation.
Chapter 3	Outline of details and considerations in the project's practice design.
Chapter 4	Results of the practice experiment presented in an autoethnographic manner, with accompanying practice excerpts embedded throughout.
Chapter 5	Details of the recorded creative work.
Chapter 6	Concluding remarks.

2 Literature review

This chapter explains the theoretical framework of ecological dynamics and elucidates how it underpins the project's methodology. I begin by contextualising the project within existing musical improvisation research and highlighting the influence contemporary cognitive science has had on the field and, in turn, this project. I then provide a general description of ecological dynamics,[1] drawing on relevant concepts and terminology from its subdisciplines, ecological psychology and dynamic systems theory. From this follows an account of the framework's application in sports and subsequently in instrumental improvisation. Finally, I briefly compare ecological dynamics with putative models of jazz and improvisation pedagogy.

2.1 Contemporary perspectives on musical improvisation

Musical improvisation is a complex activity. Through a multitude of bodily and mental tasks, and musical and extra-musical environmental considerations, an improviser can spontaneously construct cohesive, expressive, and novel musical outcomes (Pressing, 1984, 1988; Walton et al., 2015). In an attempt to understand how musicians are able to spontaneously execute such complex tasks, music scholarship has long turned to cognitive science, an interdisciplinary field drawing on neuroscience, philosophy, psychology, and anthropology, with the aim of furthering our understanding of the mind and all it encompasses (Borgo, 2018; Thagard, 2005; Varela et al., 1991). Theories of instrumental improvisation informed by cognitive science are given in

[1] For a more comprehensive detailing of ecological dynamics see: Buttons, 2022; Berge, 2022.

Sudnow (1978), Pressing (1984, 1988), Sloboda (1988), Johnson-Laird (2002), Berkowitz (2010), Hargreaves (2012), and others.[2] These theories reflect the predominant model of cognition prevalent throughout the 20th century known as cognitivism,[3] which views the brain as a processing *computer* necessary to interpret sensory information to allow for perception and action[4] (Pressing, 1988; Varela et al., 1991).

In recent decades this computational model has been challenged by alternate theories that instead provide greater acknowledgment of the "living system in its entirety", including the influence our bodies, movement, experience, society, culture, and environment have on our behaviour (Schiavio et al., 2019; Schiavio & Kimmel, 2021, p. 3; Varela et al., 1991). These alternate theories consider knowledge as *situated* (within an environment, society, and culture), *distributed* (co-existing and co-realised between people and amongst communities), and *embodied* (informed by our physical and kinaesthetic nature) (Borgo, 2007, 2022; Brown et al., 1989; Hayes, 2019; Hollan et al., 2000; Linson & Clarke, 2017; Newen et al., 2018; Shapiro, 2019).

These contemporary perspectives have informed a new wave of music and instrumental

---

[2] These theories presuppose a highly structured form of jazz improvisation characterised by sophisticated harmonic progressions.

[3] Also known as representationalism or computationalism.

[4] Cognitivism has not only influenced theory and scholarship but is embedded in assumed models of learning and development, including in much music and jazz pedagogy (Borgo, 2005; 2007).

improvisation research. Embodied accounts of music have been explored in the theoretical work of Iyer (1998, 2002, 2016), De Souza (2017), and the practice-led projects of Mclean (2018) and Dobson (2021). Ecological perspectives that give greater consideration to environmental influences have been offered in Borgo (2007), Linson and Clarke (2017), Love (2017), Hannaford (2019) and Schiavio and Kimmel (2021), as well as practically applied by Slater (2020) and Rapp (2023). Van der Schyff et al. (2018) and Torrance and Schumann (2019) have theorised 4E[5] accounts that involve the study of enactive cognition. Finally, Borgo (2022) and Walton et al. (2014; 2015) have explored a dynamical-systems conceptualisation of musical improvisation.

These theoretical and practice-led studies have provided a renewed assessment of instrumental improvisation and pedagogy. Ecological dynamics and the fields that underpin it (ecological psychology and dynamic system theory) are considered situational and non-representational theories. This project positions itself within this growing body of contemporary literature in the hope of advancing our understanding of improvisation and improvisation pedagogy.

Finally, the mutual influence between learner and environment has been theoretically investigated from other non-computational perspectives beyond that of an ecological and dynamical approach. Two prominent ideas from which are *sense-making* from the cognitive

[5] 4E cognition is a coalition of embodied, enactive, extended, and embedded cognitive theories (Newen et al., 2018).

field of enactivism[6] (Thompson, 2011; Varela, 1984; Varela et al., 1991), and Dreyfus and Dreyfus' *skilful coping* from the philosophical school of phenomenology (Dreyfus & Dreyfus, 1986; Dreyfus, 2002, 2014). Although these ideas could offer a theoretical justification for this project[7], this project will focus on skill acquisition through the pedagogical framework of ecological dynamics.

2.2 Ecological dynamics

Ecological dynamics is a theoretical framework of skill acquisition and development within the fields of sports and human movement science. The framework was introduced in the 1990s by sports scientists Keith Davids, Craig Hanford, and Mark Williams who, influenced by evolutionary biology and dynamics systems theory, sought a "natural physical alternative" (Davids et al., 1994, p. 495) to the established computational model of sports behaviour (Araújo et al., 2020; Gray, 2015). Ecological dynamics thus offers a distinct assessment of skill, learning, the individual performer, and performance from putative skill acquisition models (Berge, 2022). Critically, it considers skill development as adaptation to environmental features, as learners explore, interact and eventually exploit surrounding information through performance-based practice (Araújo et al., 2006; Berge, 2022; Davids et al., 2008; Davids et al., 1994). In order to encourage the emergence of functional, goal-orientated behaviours, ecological

[6] Enactivism is one of the E's in the cognitive coalition that is 4E.

[7] Torrance & Schumann (2019) have employed both to explain both everyday improvised action and jazz improvisation.

dynamics-based pedagogues (e.g., coaches) strategically apply constraints, or manipulate existing environmental features within the performance ecology (Seifert & Davids, 2017; Woods et al., 2020b, p. 2). Often novel and atypical, these constraints perturb the learner's stable skill base but initiate new, functional, and flexible skill patterns as learners explore and begin to attune to a range of affordances offered by the novel constraints (Araújo et al., 2006; Berge, 2022, p. 25). This method is called a *constraint-led approach*[8] (Davids et al., 2008).

Ecological dynamics is a multidisciplinary framework combining ecological psychology and dynamic systems theory. Ecological psychology theorises the reciprocal relationship between environmental information and our action and perception, while dynamic systems theory describes the non-linear change seen in complex systems over various timescales (Davids et al., 2013; Gibson, 1979; Woods et al., 2020a). These complimentary theories offer useful analytical tools and terminology to describe and analyse learners and the learning ecology. As Araújo et al. (2006) explains, "ecological dynamics signifies an approach using concepts and tools of dynamical systems to understand phenomena that occur at an ecological scale – the scale where the relationship between individuals and their environments is defined" (Araújo et al., 2006, p. 656).

[8] Two other approaches within ecological dynamics are *non-linear pedagogy*, developed by Chow (2011; 2016), focusing on pedagogues' delivery and assessment of such motor learning programs, and *differential learning*, developed Schöllhorn (2012), focusing on developing flexible coordination patterns through the repetition of action in constantly varied tasks and conditions.

The ecological dynamics framework has been empirically tested in coaching applications with learners and athletes ranging from novice to professional, and is shown to elicit positive performance outcomes (Davids et al., 2013; Renshaw & Chow, 2019). In recent years this framework has been applied to music performance through practice-led projects by Slater (2021; 2020) and Rapp (2023).

2.2.1 Ecological psychology

Developed by James Gibson and others,[9] ecological psychology recognises how the action and perception of an organism is reciprocally coupled to information in its environment (Gibson, 1979; Heft, 2001). In *The ecological approach to visual perception*, Gibson opposes the established computation model of visual perception that states that our visual system requires enrichment from mental processes (e.g., expectations, predictions, and assumptions) to interpret sensory stimulus (de Wit et al., 2015; Egan & Orlandi, 2010; Gibson, 1979). In contrast, Gibson argues that the unique compositional properties of the visual environment, such as its myriad textures and densities, and the many ways they reflect light, constitute sufficient information for an organism's perceptual system to see (Chemero, 2003; Clarke, 2005, p. 18; Turvey et al., 1981). Gibson describes perception without intermediary mental processes as "direct" (Gibson, 1979, p. 139).

---

[9] The field is also credited to psychologists Roger Barker, Urie Bronfenrenner, Egon Brunswik, and Eleanor Gibson. As ecological dynamics is primarily influenced by James Gibson's *ecological approach*m this chapter explores ecological psychology from a Gibsonian standpoint (Davids et al., 1994; Araunjo et al., 2020).

The claim that we are in direct perceptual contact with our environment has consequences for our understanding of both human behaviour and the environment. Gibson explains that environmental features constitute rich perceptual information that compel us to act, and that subsequent movement (e.g., walking, grasping, ball-catching, jumping, etc.) allows access to distinct perspectives of environmental information (Gibson, 1979). Our sensory experience, then, is informed by action just as our action is informed by perception. Heft describes this action–perception loop using the example of grasping:

> An individual does not reach per se, but reaches toward something; and, importantly, the biomechanics of reaching vary as the relative location of the object to the body changes. In the same fashion, although it is possible to talk abstractly about the act of grasping, the expression of grasping is structured in part by the properties of the object about to be grasped. The biomechanics of grasping are co-determined by bodily processes and object properties, such as size, shape, and texture. (Heft, 2001, p. 110)

Gibson's ecological approach shows how action and perception are reciprocally coupled with environmental information (Gibson, 1979). Gibson's ideas have far reaching implications for visual perception and behaviour more broadly; as Mace (2014) highlights, it is Gibson's stress on the coupling of action and perception that has seen his ideas adopted by human movement researchers (p. XXVII).

2.2.2 Affordance

Coined by Gibson (1979), affordances are environmental properties that allow or compel an organism to act (Chemero, 2003; Gibson, 1979). Affordances are an integral aspect of Gibson's ecological approach and reflect his emphasis on the reciprocity between an organism and its

environment (Gibson, 1979; Heft, 1997). Building on Gibson's idea, Chemero (2003) outlines a contemporary definition:

> [Affordance is] a resource that the environment offers any animal that has the capabilities to perceive and use it. As such, affordances are meaningful to animals: They provide opportunity for particular kinds of behaviour. Thus, affordances are properties of the environment but taken relative to an animal. (Chemero, 2003, p. 182)

Both Gibson (1979) and Chemero (2003) stress that affordances are not merely environmental features but psychological properties; they are understood by organisms as opportunities for action and, as such, are relative to the structure, shape, and nature of organisms (Gibson, 1979). A chair, for example, affords sitting to a human but not to a shark; a banana affords to be held by an ape, but not a snake (despite affording sustenance to both). Moreover, physical and psychological change in an organisms may allow it to perceive new affordances (Chemero, 2003; Gibson, 1979). For example, as a newborn grows into a toddler, a banana begins to afford grasping. Pertaining to music, Slater (2020) describes key affordances of the trumpet:[10]

> For instance, the portable design, robust construction, and relative loudness of trumpets makes them suitable for a variety of performance contexts. The natural harmonic overtones of the air column within the trumpet affords a selection of pitches distributed in irregular interval configurations (decreasing in interval width as the player ascends in register). The size and shape of the mouthpiece cup affords different types

[10] De Souza (2017) discusses the idiomatic qualities of instruments and their affordance in performance contexts.

> of timbral combinations and articulation options. The three-valve design of a trumpet provides a chromatic scale affordance unavailable to valveless bugles. (p. 67)

In the context of performance and skill development, Araújo (2020) describes affordances as perceivable environmental features within the performance ecology (whether it be an object, sound, surface, or event) and the action it offers a performer. Berge (2022) states that an affordance "informs a person about the 'jumpability' of a barrier or the 'kickability', 'catchability' or 'throwability' of a ball" (p. 25). From an ecological dynamics perspective, to be skilful is to be able to recognise and act upon a broad range of affordances that support successful performance outcomes (Araújo et al., 2006; Berge, 2022, p. 25; Davids et al., 2015).

The concept of affordance provides an analytical tool by which to understand behaviour in relation to environmental information. The term affordance is used throughout this project to describe features of the sonic practice environment perceivable during practice sessions.

2.2.3 An ecological approach to aural and musical perception

Since his death in 1979, scholars have extended Gibson's ecological approach to visual perception system to both aural perception and the perception of music;[11] for instance, Iyer

[11] Notable ecological approaches to aural perception include VanDerveer's (1979) *Ecological acoustics: human perception of environmental sounds* (doctoral thesis) and Bregman's (1990) *Auditory scene analysis: The perceptual organization of sound.* Notable such approaches to music include Nonken's (1999) *Ecological approach*

(2016) notes that our aural perceptual system is "tuned to apprehend real-world sound sources in an environment, rather than only to pure sound itself" (p. 14). Further, Nonken (2008) suggests Gibson saw no disparity between our perception of visual and aural worlds, citing in a private correspondence: "structure, in sound and light, is inexhaustibly rich" (p. 288). The above reinforces the relevance of Gibson's core ideas to aural perception, and, by extension, justification for employing a sonic environmental constraint (Bregman, 1994).

2.2.4 Dynamic systems theory

Dynamic systems theory (DST) describes the non-linear change complex systems undergo over various timescales.[12] Initially conceived as quantitative models and differential equations in the field of mathematics, DST has grown into a theoretical framework; its terminology appropriated to explain diverse phenomena including the biological, non-biological, sociological, and psychological (Araújo et al., 2020; Smith, 2005, p. 279; Thelen & Smith, 1994, p. 50).

DST centres on change in complex systems. A system is considered complex when composed of an array of individual interacting components without an executive controlling program (Smith & Thelen, 2003; Thelen & Smith, 1994, p. 51). The moment-to-moment interaction of these many individual components form patterns of behaviour in a system (Hollenstein, 2007). The

---

to music perception: Stimulus-driven listening and the complexity repertoire (doctoral thesis) and Clarke's (2005) book, *Ways of Listening: An ecological approach to the perception of musical meaning.*

[12] Similar ideas have been studied as *chaos theory*, *complexity theory*, and *non-linear dynamics* (Clark, 1995).

human body, natural ecosystems, sports teams, and the economy are all examples of complex systems (Araújo et al., 2020; Ladyman et al., 2013; Thelen & Smith, 1994). Owing to their composite nature, complex systems exhibit unpredictable and non-linear behaviour (Thelen, 2005). Further, complex systems are dynamic (i.e., constantly changing and adapting) and inherently drawn to stable states. Disruptions to the system, known as perturbances,[13] may dislodge it from a stable state and induce a state of entropy towards instability (Kelso et al., 1987; Thelen & Smith, 1994). Perturbances can arise from a system's environment or surrounding stimuli (Kelso, 2012). Although perturbances force a system to exert effort to remain stable, such effort may stimulate new and stronger patterns of coordination (Thelen & Smith, 1994).

2.2.5 Self-organisation and nonlinearity

DST demonstrates how, in the absence of a controlling program, complex systems can spontaneously create patterns of order (Kelso, 1995; Kelso & Schöner, 1988; Smith & Thelen, 2003). This phenomenon is known as self-organisation. Examples of self-organisation can range from small-scale molecular formation or insect swarming to large-scale phenomena such as birds flocking and sand dune formation (Thelen, 2005). These spontaneous patterns are indeterminate as self-organisation is not simply the sum of a system's components but a complex interaction of its many components, organising without a central agent.

[13] Perturbances to a system are also known as *noise.*

Self-organising patterns are nonlinear: small perturbances may elicit large changes whilst a large disruption may only induce minor shifts (Thelen, 2005). Such nonlinearity can be seen in how a single grain of sand may cause the collapse of a sand dune, or how a small temperature change can suddenly shift the physical state of a liquid[14] (Di Marzo Serugendo et al., 2004). Nonlinearity contrasts with the standard cause-and-effect model of change seen in simpler systems, wherein a response is proportional to its cause (Chow et al., 2011). Further, DST states that self-organisation occurs within a system and its many sub-systems across overlapping timescales ranging from seconds to years (Clark, 1995).

Clark (1995), in applying DST to movement coordination, notes how the complex system of the human body, with its 100 billion neurons and 1000 muscles, is able to coordinate movement in an efficient, self-regulated manner. It is the self-organisation of our many bodily systems—from the neurobiological to the muscular—that allow us to walk without consciously coordinating individual muscles or eat without needing to synchronise our face, tongue, and throat. It is the self-organisation of the respiratory, muscular–skeletal, cognitive, and social systems that allow one to play trumpet without concurrent awareness of each system and their components.

2.2.6 Constraints

Constraint is a fundamental concept of DST and is essential to both this project and ecological dynamics more broadly. The self-organisation of a system is shaped by the various limitations—

[14] The sudden shift from one stable state to another is referred to as a phase transition.

constraints— found within the system and its environment (Davids et al., 2008; Davids et al., 2003; Newell, 1986). Contrary to the assumed conceptualisation of constraints as a limiting entity, systems can be shaped by or even exploit constraining parameters to develop new stable patterns of behaviour (Davids et al., 2008; Slater, 2020, p. 63). Seminal work by Kelso (1984; 1981) reveals that, as humans interact with environmental constraints, their movement self-organises, transitioning between different states of stable coordination (Woods et al., 2020a).

Newell (1986) identified three categories of constraint in human movement and behaviour: (1) those on the organism; (2) those from the environment; and (3) those on the task. From a human movement perspective, examples of each could describe (1) a person's height, (2) their surrounding socio-cultural milieu and physical environmental features, and (3) the parameters or rules of the activity (Clark, 1995, p. 175). Constraints are a central pedagogical tool in ecological dynamics, strategically applied within the performer–environment ecology to shape the emergence of new self-organised behaviours (see 2.2.8). In addition to existing constraints within my playing system (see Section 3.14) this project experimentally applies a sonic environmental constraint.

DST provides useful concepts and terminology to both ecological dynamics and this project, including self-organisation, constraint, and perturbance. In contrast to conventional models of analysis that study individual components for linear causality, DST views the performance ecology and its numerous subsystems as complex wholes, exhibiting change in non-linear and indeterminate ways (Araújo et al., 2020; Borgo, 2022; Button et al., 2021).

2.2.7 Ecological dynamics in action: skill and development

Ecological dynamics combines Gibson's (1966, 1979) ecological approach and DST's account of self-organisation under constraints, yielding a rich and holistic perspective of the learner and their environment. Ecological dynamics views learners as complex systems composed of numerous sub-systems—e.g. perceptual, aural, motor-skeletal, affective, and socio-cultural systems—all self-organising across various timescales (Davids et al., 2013). As learners interact with their environment and its features, they self-organise toward new behaviours (i.e., skills) in search of stability (Davids et al., 2013). Skill development is thus seen as adaptation to the unique assembly of affordances and constraints in one's learning environment (Araújo et al., 2006; Davids et al., 2013; Woods et al., 2020a). Woods (2020) describes skill acquisition from this orientation:

> Learning, framed within this ontology, can be understood as a process by which an individual is empowered to progressively deepen knowledge of the environment and his/her place within it, exploring how action capabilities can be adapted to suffice an ever-evolving array of constraints. Accordingly, skill acquisition has been repositioned as skill "adaptation" within an ecological dynamics framework. (Woods et al., 2020, p. 2)

Within an ecological dynamics framework, learning is thus considered an act of exploration wherein learners *discover* behaviours that are economical, efficient, repeatable, and flexible, in attempt to achieve a state of stability robust against internal and external perturbances (Araújo et al., 2020; Chow et al., 2015; Davids et al., 2013; Slater, 2020; Woods et al., 2020a; Woods et al., 2020b). Skills emerging for this act of exploration are characterised by their emergence (they appear spontaneously), indeterminacy (they are not entirely predictable), and nonlinearity (they are disproportionate to their cause) (Chow et al., 2011; Davids et al., 2013).

The framing of skill acquisition as a self-organised phenomena contrasts putative computational learning models with a focus on information input to a central controlling agent and subsequent practice to practically realise the information (e.g., the brain) (Clark, 1995). Pedagogical examples of this model include idealised technical templates, mental representations, or commands from instructors. Clark (1995) likens these computational models to the rigidity of "a pianist playing a musical score" (p. 174); the pianist learns toward and in reference to a pre-set version (the composer's score). By contrast, ecological dynamics sees skill development as relative to the personal and environmental constraints of an individual, who in attempting to satisfy a task, may exhibit the emergence of unique and variable coordination solutions that contrast idealised models.[15] (Davids et al., 2015; Edelman & Gally, 2001). Moreover, unlike systematic, repetition-based methodologies (e.g., slowly playing one bar at a time) found in deliberate learning practices (Adams, 1971; Ericsson et al., 1993), ecological dynamics does not rely on repetition or compartmentalisation of actions, instead utilising the act of performance[16] as the mode of practice, e.g., a cricketer batting, tennis player rallying, or an instrumentalist improvising (Araújo et al., 2020; Clark, 1995; Davids et al., 2015; Woods et al., 2020b).

Instead of loading athletes or performers with rigid pre-planned schematics or idealised versions of movement, an ecological dynamics approach supports the development of skills that offer

---

[15] This concept is called degeneracy (see Edelmen & Gally, 2001).

[16] In this context, performance is considered an activity done in full, and in likeness to competitive performance activity, and does not infer performing in front of an audience.

flexibility, variability, and adaptability in unpredictable performance settings often found in sports (Araújo et al., 2006; Woods et al., 2020b). It is the prioritisation of these skill qualities that makes ecological dynamics particularly suitable for instrumental improvisers, who similarly perform in indeterminate musical performance environments (Slater, 2021; Slater, 2020). Such a comparison between sports and improvised musical environments is affirmed by Woods et al. (2020b), who evokes the metaphor of musical improvisation to describe the explorative nature of practice in ecological dynamics:

> The particular 'path' being navigated by the improvising musician is in the playing of music that unfolds, and the emerging 'vistas' they traverse are encompassed within the song's beat and tempo... a musician does attend to emerging information during the song that enables their continued improvisation of sound and timing to successfully 'find their way' through the sonic 'landscape' being created. It is this underlying and dynamic process, captured in the interaction between the musician and music (performer and environment), that helps them find their way through the song. (Woods et al., 2020b, p. 3)

Studies have shown that the application of ecological dynamics has led to shifts in athlete performance behaviours. Davids et al. (2012) describes the outcomes of a study by Araújo et al. (2006) who applied the framework to a variety of sports including sailing, basketball, and boxing:

> Changes in behaviours emerged during the action, such as a change in direction when dribbling past an opponent in basketball or selecting a jab instead of a hook in boxing. From several available performance solutions, a decision emerged based on an athlete's perceptual attunement to key information sources such as time needed to close a gap with an opponent (i.e. a defender in basketball or adversary in boxing). (pp. 113–114)

Reflecting on his application of ecological dynamics to jazz trumpet improvisation, Slater (2021) suggests:

> I learned to attune to the instrument, the other artists, and the performance space in a deeper, more refined and sensitive way. An outcome of the research is that my subsequent creative work is evolving into a kind of moment-to-moment contemplative practice of attention as opposed to trying to present any pre-existing musical materials. (p. 11)

In summary, ecological dynamics considers skill acquisition as a learner's adaption to the unique landscape of constraints and affordances in their performance environment. As learners explore and experiment, they develop the ability to better attune to and exploit environmental features (Araújo & Davids, 2011).

2.2.8 Constraint-led approach in learning design

Ecological dynamics practitioners and pedagogues (such as a coach) can exploit the self-organising tendencies of learners within the learning ecology by strategically constraining environmental information to shape goal-directed, functional movement solutions (Chow et al., 2015; Davids et al., 2013; Newell, 1996). Balgue (2019) defines the application of constraints within this framework as "boundary conditions, limitations, or design features that apply restrictions to the degrees of freedom of a system, thereby indicating the trajectories that the system may exhibit" (Balagué et al., 2019, p. 1; Kugler et al., 1980). The strategic implementation of constraints on the performance ecology to shape skilful adaptation is central to ecological dynamics' pedagogical approach. Within ecological dynamics, this methodology is known as the *constraint-led approach* (Davids et al., 2008).

Constraints may be placed on the environment (e.g., sounds, temperature, space), task (e.g., task and equipment modification), and performer (e.g., physiology, knowledge, emotions) (Davids et al., 2013; Kelso, 1995; Newell, 1986; Renshaw & Chow, 2019; Slater, 2021). Constraints create a unique "affordance landscape" that prompts the performer to respond in varied and novel ways[17] (Renshaw & Chow, 2019, p. 58; Woods et al., 2020b). While constraints on the environment–performer system may initially perturb or destabilise a learner's existing skill base, they offer new opportunities for actions that initiate the discovery of flexible and functional patterns (Davids et al., 2012). As van der Schyff (2018) remarks: "one must depart from established patterns of activity, resulting in the system entropy . . . however this is necessary to create new and richer possibilities for thought and action" (pp. 8-9). In this context becoming skilful is to become better able to adapt to constraint manipulation and attune to a greater range of affordances across the performance ecology (Clark, 1995; Davids et al., 2013; Seifert et al., 2013).

When implementing constraints in a practice design, ecological dynamics stipulates the practice environment be representative of performance conditions, allowing learners to build skills transferable to performance settings (Renshaw & Chow, 2019). Further, learning environments should feature variable conditions (i.e., changing constraints) to encourage the emergence of

[17] The idea of constructing an affordance landscape to shape behaviour has been explored in the field of behavioural economics through nudge theory, popularised by Thaler and Sunstein (2008), who coined the term *choice architecture* to describe the deliberate design of policies and public features to *nudge* consumers to certain decisions.

flexible behaviours resilient to a broad range of perturbances (Davids et al., 2008).

In summary, pedagogues or performers within the ecological dynamics framework strategically apply constraints on either the practice environment, task, or the individual learner to shape emergent, goal-directed behaviours.

2.3 Ecological dynamics in musical development and performance

Several recent studies have applied ecological dynamics to music (Rapp, 2023; Schiavio & Kimmel, 2021; Slater, 2020; van der Schyff & Schiavio, 2022). The implementation of a sports-based skill-acquisition framework to instrumental improvisation is fitting, as both disciplines share key qualities: both require the intricate coordination of body mechanics to achieve complex tasks; and, further, athletes and musicians must both navigate and respond to dynamic and unpredictable performance contexts under strict time constraints.

Slater (2020) was the first to study the application of ecological dynamics to music performance and development in his practice-led doctoral thesis *The Dark Pattern: Towards a constraints-led approach to jazz trumpet* (2020). Through a constraint-led approach to jazz trumpet, Slater designed an original, self-regulated practice experiment consisting of spontaneous improvisation in various outdoor locations over a 12-month period. Slater labelled these practice environments "atypical performance contexts" (Slater, 2020, p. 100). Reflecting on this practice, Slater (2021) notes "the variable conditions of the outdoor contexts afforded radically different situations within which to perform, and initiated many profound changes to my music-making abilities and aesthetics" (p. 10). This musical development was presented in an original jazz album entitled

The Dark Pattern (2019), which demonstrates Slater's new embodied skill in the context of original compositions with a jazz ensemble.

Slater (2021) suggests an ecological dynamics approach to the development of improvisational skills "offers alternative approaches to learning that are more dynamically rich and responsive to moment-to-moment performance conditions" (p. 4). Rapp (2023), who similarly applied a constraint-led approach to the development of her vocal improvisation techniques through practice in both natural and acoustically treated settings, reported that "in transferring my improvised singing from the atypical practice settings to the recording studio I noticed an enhanced flexibility in performing in different environments and musical situations" (p. 89).

These two studies demonstrate that musicians can develop new improvisational skills by applying ecological dynamics to instrumental improvisation practice. Results from Slater (2020) and Rapp (2023) show a strengthening of attunement and response to the variable and indeterminate performance conditions of improvised music settings (Schiavio et al., 2019; Schiavio & Kimmel, 2021; Slater, 2021; Slater, 2020).

2.3.1 Creative outcomes

Although athletes and musicians both execute complex tasks within similarly dynamic environments, they diverge with regard to their primary objectives; whilst athletes develop skills in order to succeed within competitive sports settings, improvisers generally aspire to artistic and expressive outcomes. Despite this juxtaposition, recent studies suggest that ecological dynamics may not only aid in the development of technical or strategic skills but also generate creative and original outcomes (Hristovski et al., 2009; Hristovski et al., 2011; Schiavio & Kimmel, 2021; Slater, 2020; van der Schyff et al., 2018). Such a claim is rooted in human

movement science research, which deems novel yet functional movement solutions *creative* (Hristovski et al., 2009; Hristovski et al., 2011; Memmert & Roth, 2007; Orth et al., 2017; Wyrick, 1968). Orth (2017), who in studying creative motor outcomes through the application of ecological dynamics, defines motor creativity:

> [C]reative motor actions are as much a function of the individual, as the task and environment (Hristovski et al., 2011). They can arise in the temporal coupling between the organism and environment, while the action unfolds. Thus, rather than referring to ideas that are uniquely generated by a (creative) cognitive system, we use the term 'creative' as a descriptive for unfolding actions that are original (relative to the individual or group) and functional (i.e., they support task success). (Orth et al., 2017, p. 2)

Hristovski et al. (2009; 2011) and Orth (2017) suggest that creative motor actions emerge through practice interventions that facilitate the exploration of changing constraints. In this way, creative outcomes can be considered the emergent adaptive products of an organism realising functional and unique movement solutions to constraints (Hristovski et al., 2011; Orth et al., 2017; van der Schyff & Schiavio, 2022). Further, Hristovki et al. (2011) notes how under equivalent task constraints, performers demonstrate unique and idiosyncratic movements that likely arise from their unique personal constraints (e.g., physiological and psychological characteristics) and pre-existing motor tendencies. This suggests that an individual's creative outcomes are not only new and novel but may be distinct from those of others (Edelman & Gally, 2001; Woods et al., 2020c).

Applying this to ecological dynamics, Schiavio and Kimmel (2021) suggest that adaptive creative actions shaped by environmental constraints may not only help practitioners succeed in competitive performance environments but that "the interactions between agents and their material or social ecology can nourish and move forward the creative process" (Schiavio &

Kimmel, 2021, p. 5). The notion of environmental influence on new and novel outcomes aligns with contemporary research into creativity, which has shifted from considering the phenomenon an internal, cognitive condition (Guilford, 1967) to one *distributed*, or co-realised across people, tools and environments (Csikszentmihalyi, 1990, 2014; Glaveanu, 2013; Glăveanu, 2014; Sawyer, 1999; Sawyer & DeZutter, 2009). As such, a performer can be seen to adaptively co-create original and novel outcomes with their performance environment and its constraints.

Informed by existing research in movement science, ecological and dynamical perspectives see creative outcomes as new, original, and functional adaptive solutions. That an ecological dynamics approach to skill acquisition can not only induce motor development but advance creative and original outcomes further justifies its adoption by creative practitioners with a focus on originality and novelty.

2.3.2 Musical environments and improvisation

How one's musical environment influences music performance and creative musical outcomes has been considered by Walton et al. (2015). Applying mathematical tools from DST, Walton and colleagues devised an experimental study to examine how, in a duet of improvising keyboardists, shifts in musical environment influence body movements and thus creative musical outcomes. By changing the backing track from the jazz standard *There is no greater love* to a dyadic drone, Walton and colleagues observed that, when accompanied by the latter, the two pianists demonstrated a heightened level of bodily coordination. The researchers suggest that this was due to the reduced musical stimulus (i.e., less rhythm and harmony) offered by the drone, demanding of the pianists a heightened level of co-creation to establish musical structures (van der Schyff et al., 2018; Walton et al., 2018).

This study demonstrates that musicians indeed adapt to differing musical environments, with Walton et al. concluding that "understanding music improvisation is not only about the brain and the body, but also the environment" (van der Schyff et al., 2018; Walton et al., 2015, p. 2). Commenting on this study, van der Schyff and Schiavio (2022) notes how the musicians in Walton's study felt "most creative in environments that afforded a balance of freedom and constraint, where varying degrees of instability could be introduced and resolved cooperatively." (p. 15). Such a balance between freedom and constraint, in addition to the introduction of instability through perturbance, are considerations in my project's practice design.

2.3.3 Comparison with traditional instrumental and improvisation music pedagogy

Although this study does not attempt to assert ecological dynamics as a generalised improvisational pedagogical framework, a brief comparison of this model of skill acquisition with established models of instrumental and improvisation music pedagogy is useful to highlight similarities and differences.

It has been noted that many traditional and institutionalised jazz pedagogical methods (e.g., Aebersold, 1967; Baker, 1989) rely on information-input models that impart theorised knowledge to learners who then practice such material with the aim of eventually employing them in performance settings[18] (Borgo, 2007, 2022; de Bruin, 2015; van der Schyff, 2019;

[18] This is considered *a top-down* model of skill learning (Sun et al., 2001).

Yossef & Granot, 2023). In jazz pedagogy this includes the teaching of chord-scale theory, pre-composed and memorised patterns, as well as the analysis, replication, and imitation of idealised examples, exemplified by the act of transcribing.[19] These approaches can be helpful for modes of improvisation featuring various pre-determined musical parameters (such as substantial harmonic and rhythmic structures), or when aiming to play in a stylistically informed manner. Borgo (2007), however, suggests that a focus on practicing musical products leaves little time for the development of other critical performance qualities such as self-expression, experimentation, and reactivity, which, although prized amongst players and listeners (Ake, 2002; Berliner, 1994), are seldom taught due to their ethereal nature.

In contrast to putative information-input models that distinguish learning from performance, ecological dynamics employs performance (e.g., musical improvisation) as the mode of practice. From this perspective, skills are adaptively realised through exploration of, and discovery within, the learning environment and its changing constraints (Araújo et al., 2020; Chow et al., 2015; Davids et al., 2013; Slater, 2020; Woods et al., 2020a; Woods et al., 2020b).[20] Due to shifting constraint and thus variable learning conditions, emergent skills are characterised by their flexibility and robustness in dynamic performance environments (Davids et al., 2012, p. 112; Davids et al., 2013; Davids et al., 2008; Schöllhorn et al., 2009; Woods et al., 2020a). As Schiavio and Kimmel (2021) suggest, "through exploration and selective refinement, different forms of coupling come to be stabilized and grow more structured, while also becoming more

[19] These pedagogical methods largely employ deliberate learning approaches (Ericsson, 1993).

[20] This is considered a *bottom-up* model of skill learning (Sun et al., 2001).

adaptable to context variations" (p. 5). Slater (2021) proposes that due to its development of flexible and adaptive skills, an ecological dynamics approach is especially beneficial for creative musicians who perform spontaneously organised settings:

> [T]his method is particularly well suited to creative spontaneous improvisation and creative forms of music making, as it strongly rejects the notion of an idealised, referential, or correct version of musical materials and events, in part due to the prioritisation of variability, flexibility, spontaneity, and individual agency in music making. (p. 10)

Thus, within an ecological dynamics framework, emergent skills are not developed toward preconceived or idealised models but assembled in relation to the unique characteristics of the individual learner and their surrounding environmental information.[21] Unbound to an ideal model, this approach supports the emergence of novel and creative outcomes (see Section 2.3.1) that may aid in the development of not only self-expression, responsiveness, and experimentation (Borgo, 2007), but possibly an original and personal improvisational approach.

2.3.4 Jazz backing tracks

One jazz improvisation methodology that parallels the application of a novel sonic constraint are pre-recorded jazz backing tracks, a technique made famous by jazz saxophonist and educator Jamey Aebersold and his *Play-A-Long* series (Aebersold, 1967). Such resources feature notable

[21] This may also address the notable separation jazz trumpet improvisers' note between technical instrumental practice and creative improvisation, as outlined by Ball (2004).

jazz songs— standards—pre-recorded by a jazz rhythm section of piano, guitar, bass, and drums, without a lead melodic or solo component, allowing musicians to perform melodies and improvisations atop the recorded rhythm section. Backing tracks have become popular due to the convenience of being able to practice and perform without requiring other musicians. In more recent years, a broad range of jazz backing tracks in a variety of styles, tempos, and keys have become widely available online. Like jazz backing tracks, speech features a near-constant stream of durational and harmonic material, albeit arrhythmic and atonal. Unlike an atypical performance context, backing tracks do not provide novel and variable affordances and constraints to respond, and are propositional of a particular musical style and playing approach.

2.4 Summary

The chapter has introduced the skill-acquisition framework of ecological dynamics, as well as its theoretical concepts and terminology drawn from ecological psychology and dynamic systems theory. Its application in sports and instrumental improvisation has also been discussed. Ecological dynamics reframes learners as complex systems and adopts an ecological perspective that views their behaviour as shaped by environmental information. From this orientation, pedagogues strategically place or manipulate constraints within the learning environment to induce new patterns of coordination within the learner as they adapt (or self-organise) to constraints through exploration-based performance. Constraints may perturb a learner's existing skill base but ultimately foster the emergence of new behaviours. A survey of ecological dynamics in contemporary music scholarship highlights how positive performance benefits have emerged in existing practice-led studies. In addition, new theoretical research supports the idea that ecological and dynamical approaches to improvisation pedagogy can induce creative and novel outcomes. Overall, I believe the adoption of an ecological dynamics framework in this

project provides a strong account of skill acquisition and the potential for the emergence of new and original improvisational skills.

3 Practice Design

Adapted from Slater (2020), the practice design featured four core components:

1. Spontaneous, *referent-free* trumpet improvisation (see Section 3.11);
2. 15 to 20-minute duration of each session (see Section 3.4);
3. A novel sonic constraint;
4. Daily[22] sessions over a five-month practice timeframe.

Like Slater (2020), the practice design featured daily sessions of spontaneous improvisation. Practices were completed in a single sitting. Unlike Slater's (2020) practice within atypical performance contexts, I performed with various novel sonic constraints of audio featuring speech. The total timeframe of the project was altered from one year to five-months.

3.1 Speech material

Speech material refers to the audio and video stimuli used as a sonic constraint. These were sourced from YouTube and Apple Podcasts. The visual components that accompanied speech material were not visible when playing. Speech-based audio material was chosen as a novel sonic constraint due to its wide availability, free access, and range of material, allowing variable conditions for each session (as outlined in Section 3.3).

[22] Several days were missed due to sickness and travel.

3.2 Speech material selection

A new video or audio track featuring conversational or oratorial speech was selected each practice session. Speech material included recorded lectures, reviews, news, interviews, panels, sports commentary, and podcasts. I select media featuring speakers from diverse gender, cultural backgrounds, and contexts to ensure the practice experiment did not bias playing with a particular speaker. All but one of the chosen speech materials were in English as semantic content emerged as an affordance throughout the experiment.

Initially, speech material lasting 20 minutes or longer was selected through algorithmically recommended videos and podcasts. These suggested materials featured content and speakers reflective of my general interests and media consumption. As the experiment progressed, I selected speech material based on speaker qualities I was interested to experiment the effect of improvising with.

3.3 Ecological dynamics practice design considerations

A practice task informed by ecological dynamics features key design principles. One such consideration is *variable conditions.* Differing and unpredictable performance conditions act as a perturbance to the task, disrupting a performer's stable skill base but influencing the emergence of skills that are robust, adaptive and flexible to variable environmental conditions (Davids et al., 2008; Schöllhorn et al., 2009; Woods et al., 2020a). Variable conditions were met by playing with previously unheard speech material each session.

A further principle is *representative learning design*, where the practice intervention is

representative of a learner's regular performance parameters (Brunswik, 1956; Chow, 2010; Pinder et al., 2012; Pinder et al., 2011). Woods et al. (2019) suggests that through representative learning design "learners will be exposed to relevant affordances within practice, supporting the coupling of their actions to key information sources available in competition" (p. 6). The practice task of improvising with a sonic constraint was representative of listening and responding to musical accompaniments in performance, such as an ensemble or backing track. Further, speech can be seen as a constraint in likeness of a musical stimulus due to speech prosody: the melodic qualities of speech including its intonation, duration, timbre, and volume (Bolinger, 1989; Glaser, 2000; Ladd, 2008; Wennerstrom, 2001). Unlike regular musical features, speech was a novel constraint as its melodic qualities are atypical of conventional musical structures and thus perturbed my existing stable skill base to initiate skill adaptation (Davids et al., 2012; van der Schyff, 2019).

Finally, Woods et al. (2020a) advises pedagogues to design "information-rich landscapes that consist of affordances that learners can perceive and learn to utilise toward the achievement of a task goal" (p. 5). Due to the dynamic and near-constant nature of speech, in addition to the variable qualities of different speakers and settings, I hypothesised speech would create an information-rich practice environment that would afford a diverse range of responses.

3.4 Practice duration

The practice duration of each session was between 15 and 20 minutes. This was adapted from Slater's (2020) strict length of 20 minutes due to video length dictating practice time, as well as physical and mental fatigue due to intense playing. Slater describes how 20 minutes of near continuous trumpet playing could "provide enough constraint to the physical system to promote

adaptations of strength and conditioning, and to initiate physical and mental fatigue as an exploratory strategy" (p. 100). Near continuous trumpet playing for 15 to 20 minutes would often lead to physical and mental fatigue in my playing and was representative of that felt in performance settings. Also, the duration of 15 to 20 minutes allowed for practice sessions to be completed regularly.

3.5 Spontaneous improvisation

The mode of practice throughout the experiment was spontaneous improvisation, that is, improvisation without pre-determined musical structures or overarching parameters beyond those spontaneously generated during the act. This improvisational approach is labelled by Borgo (2018) as "referent-free" (p.1017), characterised by a "lack of underlying scheme or formal image to facilitate the generation and editing of improvised behaviour" (p. 1021). Within this approach, Borgo (2018) acknowledges that even without predetermined or referential material, "self-imposed and shared stylistic constraints do often play a generative role in the development of the music" (p. 1024). Further, embedded within this form of improvisation is "a lifetime of musical engagement, experimentation, and expectation that is evident at both short-term and long-term timescales." (p. 1024). As Borgo suggests, although my improvisational approach was spontaneously generated, the influence of experience and aesthetic preference, and the unplanned generation of self-imposed constraints and structures were present throughout the practice experiment.

3.6 Volume and distance parameter

The volume of speech material and the distance between myself and the sound source were important features of the practice design. I elected to amplify the speech in part to emulate a speaker. Further, I wanted the volume of each stimulus to match the decibel level of live human speech. Studies have found that, in common environments, conversational speech averages 55-65 decibels when speakers are one metre apart (a conventional conversational distance in regular conversation) (Pearsons et al., 1977). Before improvising each session, I used the DecibelX iPhone app to ensure speech material was not louder than 65db. Speech material was amplified from a JBL Flip 5 portable speaker (Figure 4), placed approximately one metre from the bell of my trumpet. Improvising with speech material at this volume was a perturbing aspect of the practice design, as outlined in Section 4.25.

3.7 Data collection: recording, logging and journaling

Each practice was recorded on a Zoom H5N hand recorder (Figure 4) and logged into a Microsoft Excel spreadsheet. Recordings were not played back throughout the practice period. Parameters logged from each session included the date, title of speech material, URL to speech material, recording file name, recording back-up confirmation and journal notes.

Figure 4

Picture of the JBL Flip 5 speaker and Zoom

H5 used throughout the practice

The logging activity included journaling thoughts and observations of each practice. Journaling is considered an effective method to enhance self-regulated learning outcomes (Cazan, 2012; Nückles et al., 2020). The subject matter of journal entries included reflections, observations, and feelings, as well as musical materials, strategies, and developments that arose. Journaling entries were typed shorthand in an informal tone to quickly note down thoughts. Reflective writing on my playing is a practice I have conducted for the last 10 years and felt comfortable extending to this project. Throughout the experiment, journaling became an important part of my overall practice process; not only did it facilitate and document self-reflection but offered autoethnographic insights upon compiling the projects results.

Figure 5

Example of journal entries

Session 26 - 19/02/2022
-Less air because of Cornell's very relaxing voice-interesting! Different tone and feel.
-Feeling very perturbed still! Hard to find room with all the speaking, especially in a conversation between two people.
-Low riff in Cornell's low register.
-Interesting playing with him and different tone and inflections. Still not paying entire attention to the media all the time, often playing over it or independent of it.

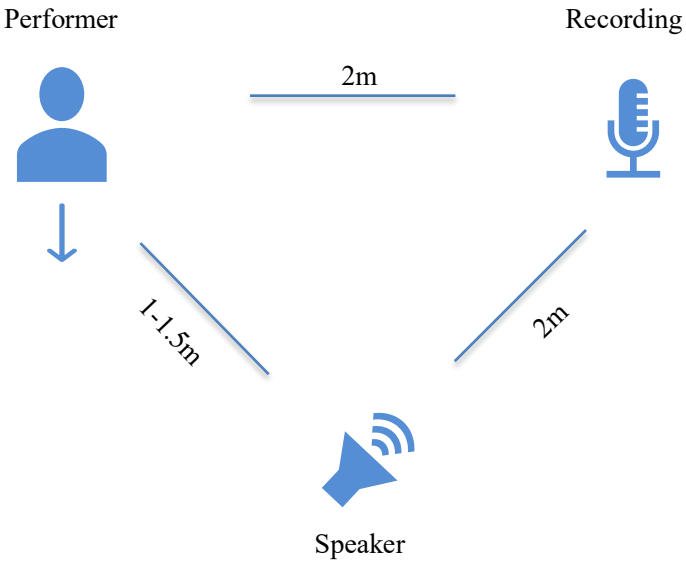
Session 27 - 20/02/2022
-Much easier to play with!
-More space and the exaggerated and oratorical style of a speech with pauses and more dramatic intonation. Going to play with more speeches!
-Further exploration of soft breathing although kind of difficult today - maybe because speech was delivered with a more bellowing tone.
-Also much exploration of different dynamics in a phrase.
-Using dynamics as a cadence too! I like this way of playing and would like to explore more.
-Articulation: end of phrase articulation.

3.8 Space and configuration

Of the 56 practice sessions, 51 were conducted in a small room, with five practices completed in other spaces due to travel. I chose to amplify speech material to establish a sonic environment, as opposed to conducting the experiment with headphones. Further, appreciative that the total sonic environment was inclusive of not only the sonic constraint but the acoustic space and ambient sounds, I completed as many sessions as possible within the same space. Practices were completed seated. The speaker and recording device were placed on features at a similar height to the bell of my trumpet.

Figure 6

Configuration of practice space



I refined the configuration of myself, the speaker, and the recording device throughout the experiment to best capture a balanced recording of the trumpet and speech material. Initial recordings featured both the trumpet and speaker facing the recording device. In this configuration, it was difficult to discern the speech material upon playback due to the volume of the trumpet. I began playing facing 45 degrees away from the speaker, as well as angling the speaker towards the recording device to ensure a more balanced recording of the two sound sources (see Figure 6).

3.9 COVID-19 NSW lockdown

This practice experiment was devised during the state-wide COVID-19 lockdown enacted from 25 June 2021 to 11 October 2021 in the Australian State of New South Wales (NSW). In

response to the spread of COVID-19 in NSW, the state government mandated restrictions on travel and gatherings with others (Hazzard, 2021). It was essential to consider these restrictions during the design of the practice and, as such, an experiment was designed that could be completed without the need for travel or other participants.

3.10 Modifications

Modifications to the practice design were experimentally trialled and implemented in response to sustained perturbances arising from the practice task. Modifications were not an initial practice design component and are thus considered a research outcome. They are discussed as part of the project's results in Chapter 4.

These modifications are supported by Smith and Dean's (2009) *iterative cyclic web* model, outlined in their book *Practice-led research, research-led practice in the creative arts* (2009). Through this model, Smith and Dean (2009) introduce the term *research-led practice* to describe how inverse to practice-led study, "scholarly research can lead to creative work" (p. 7). The application of ecological dynamics to instrumental improvisation can be considered a research-led approach. Smith and Dean further describe how research-led and practice-led approaches can exist in a cyclic relationship, as practitioners move between modes at various points across a project. (Smith & Dean, 2009). They further describe sub-cycles where iterations to project details and design are explored, compared and implemented (Smith & Dean, 2009).

My modifications reflect Roger and Dean's model where a practice-led approach, informed by my embodied knowledge as an advanced practitioner, led to me to experiment with the practice design to overcome sustained task demands. They also reflect the iterative aspect of the model,

where iterations of each modification was compared, assessed and implemented (Smith & Dean, 2009).

3.11 Self-regulated learning

Ecological dynamics traditionally relies on a pedagogue (e.g., a coach) to oversee the design and implementation of practice scenarios.[23] In contrast, this project was practitioner-led and self-regulated. Self-regulated learning is a recognised pedagogical approach where practitioners direct their own outcomes and evaluation (as well as other practice details) in an unsupervised environment (Carvalho & Araújo, 2022; McPherson et al., 2017; McPherson & Renwick, 2011; Zimmerman, 1986, 2002).

My daily instrumental practice over the last 10 years has been largely self-regulated, focusing on the systematic development of technical and artistic goals. As a result, I felt comfortable extending this mode of learning to the project. As de Bruin (2018) recognises, "expert music performers utilize extensive self-regulatory processes involving planning, strategic development, and systemized approaches to learning and reflective practice" (p. 483).

[23] More recently Caravalho and Araújo (2022) have accounted for self-regulated learning through an ecological dynamics perspective.

3.12 Skill development, discovery, and selection

Within this practice design, spontaneous improvisation was conceptualised as an act of exploration, experimentation, and discovery- distinct from a public-orientated musical performance. This explorative approach spontaneously revealed many musical materials, approaches and techniques which were discovered, developed, or abandoned in conscious and unconscious ways (Slater, 2020). These included patterns of motor coordination, playing techniques, musical materials, and strategies. Slater (2020) suggests the discovery and selection of new musical products in this practice model occurs through both deliberate task-planning, thinking and projecting in playing (e.g. strategising) and reflective contexts (Ericsson et al., 1993), as well as off-task activities such as spontaneous thought, mind-wandering, and non-linear associations (Dobson, 2018). The selection and development of musical products occurred over various time scales, from a session, to across the entire experiment, and the development of musical products explored across my career.

Although the melodic qualities of speech were a primary affordance in the practice experiment, this study was not attempting to intentionally analyse or imitate speech, as has been done by several contemporary musicians including Brazilian composer and multi-instrumentalist Hermeto Pascoal (Neto, 2020; Pascoal, 1984) jazz saxophonist John Coltrane (Coltrane, 1964; Porter, 1985), jazz pianist Jason Moran (Moran, 2001a, 2001b) and contemporary electric bassist Dwayne Thomas Jr aka MonoNeon (MonoNeon, n.d.). Instead, the practice directive was to spontaneously improvise without predetermined strategies (see Section 3.5).

3.13 Personal constraints

A key consideration in situated theories such as ecological dynamics (as well as ecological psychology and dynamics systems theory) is how an individual's unique characteristics shape diverse developmental outcomes (Clark, 1997; Davids et al., 2012; Malafouris, 2013; Renshaw & Chow, 2019; Thelen, 2005). Personal characteristics include the psychological and physiological nature of an organism, surrounding socio-cultural milieu, past experiences, and aesthetic preferences (van der Schyff & Schiavio, 2022; van der Schyff et al., 2018). As Davids et al. (2019) explains, personal constraints mean that environmental features will afford "different behaviours from different individuals" (p. 136). Further, De Souza (2017) notes how the idiomatic qualities of each instrument (e.g. their material, size, and shape) afford different capabilities to performers. Within this project, I implemented a myriad of musical and extra-musical choices informed by my personal characteristics, circumstances, experiences, instrument, and preferences (Berkowitz, 2010; Chelariu et al., 2002; Coste et al., 2019; Slater, 2020). This practice experiment would yield different results for other practitioners depending on their expertise, location, physiology, instrument, past practice, and aesthetic preferences. As such, the results of this study are considered unreproducible.

4 Results

The results of this project are presented below in an autoethnographic report and taxonomy of emergent materials and approaches. The autoethnographic report details observations made across the study, including the emergence of strategies to manage sustained perturbances arising from the practice task. Strategies include *autonomous* approaches and long-tones, as well as changes in breathing and articulation. This report also outlines experimental modifications made to the practice design to reduce perturbances. The following critical observations, experimental modifications, and taxonomy of emergent materials and approaches are considered primary research outcomes of this project. The results of this practice design are shaped by personal constraints and aesthetic preferences and would yield disparate outcomes for other practitioners based on their experiences, expertise, instrument, artistic preferences, and other qualities. As such, the following results are considered unreproducible and unique to this study.

A total of 56 practice sessions were completed over a five-month period (refer to Appendix A for tabled information of each session), with 44 sessions recorded. Excerpts from the recorded sessions are embedded as audio examples throughout the chapter. Excerpts have been chosen over musical transcriptions as they are direct artefacts of the practice experiment and demonstrate the interaction between my trumpet playing and the sonic constraint. Multiple excerpts are provided as no single model exists for each material or approach. Embedded audio from these recordings represents a period of exploration and experimentation, and should not be considered complete musical products. Quotations from the practice journal are included throughout the chapter in the shorthand manner they were written. In this Chapter, excerpts from the journal are presented in italicised block quotes.

4.1 Method of analysis

At the completion of the practice period emergent materials and approaches were collated and organised through the following method of analysis:

-emergent materials and approaches written in the journal were listed in a table;
-practice recordings were analysed for additional materials and approaches and added to the table;
-insights and reflections from the rehearsal and recording of the creative work were added to the table;
-similar musical products were grouped (e.g., imitative approaches, autonomous approaches);
-each practice recording was analysed for audio examples of listed musical products;
-audio excerpts were exported from the digital audio workstation Ableton Live and labelled in a spreadsheet.

A total of 175 excerpts were collected, varying in length from 8 to 168 seconds. Excerpts from each practice session were numbered and paired with practice session numbers (see Appendix A) to form unique codes (e.g., the three excerpts from Session 15 are S15-1, S15-2, S15-3). The volume of each audio excerpt was matched for uniformity.

4.2 Autoethnographic account

4.2.1 Initial perturbance

Upon commencing, I recognised the challenging nature of the practice task due to speech's dense, constant, and fast-moving qualities, and the volume limit placed on the sonic constraint

(see Section 4.2.4). I hypothesised during the design of the practice experiment that speech would be an effective practice constraint replete with affordances due to its melodic qualities. Yet, sonic information I identified as affordances when listening became less discernible and exploitable when playing. I noted this disparity in the journal:

> *I feel more capable of discerning the melodic qualities of speech when listening back to these recordings.*

I perceived the speech as a constant stream of *notes*—the speaker being akin to an instrumentalist—however each of these notes felt too ephemeral to act upon. In response, many of my initial responses were imitative of broad features such as phrase length, phrase contour or simple pitch or rhythmic elements (see Section 4.4). The dense and unbroken qualities of speech contrast the scarcity of stimulus found in several of Slater's (2020) atypical performance contexts.

Example 3

Example of initial perturbance

S15-3

S09-6

After 20 sessions I continued to find the practice task challenging. I journaled after Session 23:

> *Still feeling quite perturbed playing with speech.*

Aware environmental perturbances can initiate self-organisation in complex systems, I continued without modifying the task. As van der Schyff and Schiavio (2022) states, it can be necessary for musicians to "take risks, experiment and be willing to enduring uncomfortable periods of instability and negotiation in order to enact new affordances" (p. 17).

4.2.2 Autonomous approaches

Due to the demanding nature of the experiment, I was unable to sustain attention to and interaction with the speech constraint for more than a few moments at a time. I labelled improvisational material generated while inattentive of the constraint as *autonomous*.

Example 4

Example of autonomous approaches

S04-5 S18-3 S27-2 S46-7

I would improvise in response to a notable feature of the sonic constraint but then develop the new material without further attention to or interaction with the constraint. I labelled this variation a *dip-in* approach. This occurred both whilst improvising and from a period of pause. Notable features of speech I interacted with included intervals, melodic cells or contours, words, rhythmic cells, and textural features. When deploying a dip-in strategy, I would often repeat or melodically develop material (see Example 5).

Autonomous approaches emerged as a response to the overwhelming nature of the sonic environment–unable to engage with environmental features, I reverted to playing independently of them. This level of independence from the sonic constraint felt counter to the requisite attention and interaction required during improvised performances with an ensemble. Desiring to be more attentive to the constraint, I explored modifying the practice design to reduce the demands of the practice task, as detailed in Section 4.2.

Example 5

Examples of dip-in strategy

S16-2 S21-1 S27-5 S37-1

Although I initially considered autonomous playing undesirable, I came to appreciate that this approach was the product of the experiment and its challenging nature. Furthermore, from these approaches generated new and novel materials. I journaled this reflection after Session 34:

> *Realisation that [I] don't need to necessarily be fully engaged with media and in fact ok to be mostly unengaged with media - still taking from it when I want and exploring new ideas and approaches germinating from it.*

Both variations of autonomous playing spontaneously emerged in the creative work of an improvised ensemble performance. Although listening and interacting is a vital improvisational performance tool, exploring autonomous approaches initiated compelling textures and structures against other members of the ensemble. Moreover, the repetition and development of musical

products through the dip-in approach provided thematic material for the improvised group performance.

4.2.3 Pitch

The intonational qualities of speech provided experimentation with pitch-based ideas (as outlined in Section 4.4). Throughout the practice, I primarily took an atonal harmonic approach instead of playing harmonically organised material (e.g., chords and scales). Atonality complimented the density and complexity of speech. Moreover, I often detected atonal and microtonal pitch cells in the sonic constraint which further influenced this approach. During the experiment, I recognised the limitations of the 12-tone system in imitating the micro-tonal qualities of speech and explored alternate fingerings in response to this (see Section 4.4.2). I was unable to distinguish precise pitch information due to the fast rate of speech but did discern broad pitch ideas such as intervallic directions and register which I explored by imitating, as outlined in Section 4.4.

Example 6

Examples of atonal approach

S23-2 S31-1 S49-6 S51-1

I also explored self-imposed pitch cells and harmonic centres. I would often combine these self-imposed harmonic approaches with the imitation of other melodic aspects of speech such as phrase length, rhythm, dynamics, and timbre with fixed pitch material. Harmonic centres were

explored more frequently later in the later part of the practice period.

Example 7

Examples of limited pitch set and harmonic centres

46-8 47-2 48-4

4.2.4 Volume and dynamics

A primary perturbance throughout the practice was the soft volume of the speech material (set at limit of 65db). A natural affordance of the trumpet is its volume, with the instrument historically used for attracting attention or sending messages (Slater, 2020). Working against this instrumental affordance was demanding on my playing system, and I would often involuntarily revert to playing louder than the constraint. This occurred most frequently when playing in my upper register, and when physically and mentally fatigued. Due to this, several recordings feature clipping and distortion (e.g., Example 8: S16-3) in the latter parts of the sessions. Being unable to hear the speech constraint encouraged autonomous approaches (see Section 4.2.2.). Across the practice period approaches emerged to sustain playing at softer volumes, including changes in my breathing and air flow, as outlined in Section 4.2.5.

Example 8

Examples of soft playing


S11-1


S21-2


S22-1


S16-3

4.2.5 Breathing

The low volume of the speech constraint led to the exploration of methods to sustain playing at a lower volume. One method involved reducing the volume and speed of air blown into the trumpet. I perceived this as a shift from blowing to *releasing* air through the trumpet. This technique arose from the imitation of the seemingly effortless exhale of speakers when talking. I noted this during Session 26:

> *Less air because of speaker's very relaxing voice... interesting! Different tone and feel.*

When executed successfully, this reduction in air volume and speed allowed me to sustain softer playing for longer periods and produce a darker and more resonant sound.

Example 9

Examples of breathing


S26-1


55-4

4.2.6 Long tones

Playing long tones emerged early in the practice period as a strategy to counteract the dense and constant nature of speech. Playing long notes allowed speech to *surface* from the sonic mid-ground to the foreground and become the focal *melodic* line. This contrasted the primary texture of joint trumpet-speech lead lines. In this approach, I experimented with the application of common musical devices such as guide-tone lines (Example 10: S24-1, 27-4) and counter-point lines (Example 10: 23-1).

Example 10

Examples of long tone and guide-tone lines

S24-1 S23-1 S27-4 S28-1

Long tones allowed me to maintain a softer dynamic range when playing as to not drown out the speech material. I noted the utility of long tones in this way after Session 15, where I journaled:

> *Volume: considering softer to be under speech and play "guide-tones."*

Long tone and its iterations allowed me to explore subverting the trumpet's established role of playing lead-line melodies in music ensemble settings.

4.2.7 Articulation

Investigating playing at a lower volume (Section 4.2.4), and with less air (Section 4.2.5) led me to explore breath-attacked entries. Although most breath attacked notes did not sound immediately, I was compelled to explore this articulation type as when executed successfully it produced a more resonant tone than when tongued. Breath attacks afforded the playing of specific notes and register, leading me to begin phrases in the trumpet's low register. As the experiment developed, I was able to coordinate a mix of both breath attacks and tongued attacks as phrase entries (see Example 12).

Example 11

Audio examples of breath attacked entries

S22-2 S32-2 S24-2 47-8

Example 12

Audio examples of mixed articulations

S14-2 S16-1 S52-1 S52-1

4.2.8 Structure

Across the practice experiment a common temporal structure emerged during sessions: alternating between periods of playing and pause. After three to six minutes of playing I would often briefly rest for 30 seconds to two minutes, before recommencing with another period of playing. This pattern emerged partially in response to autonomous playing; pausing allowed me to draw my attention back to the speech constraint and detect features. It also allowed rest after playing a demanding passage on the trumpet.

Example 13

Examples of pause between playing

S53-12

S46-6

4.2.9 Breaks in practice

Two fortnight-long breaks were taken during the practice period due to illness. Upon returning to the practice after each break, I felt a renewed creative approach to playing with speech material. This was noted in the journal:

> *[T]he break has seemingly allowed for a recontextualization... I am playing different material and taking different approaches... gaps can be good, too.*

Although not planned, these breaks offered me a renewed perspective on the practice and would endorse their implementation in similar practice projects.

4.2.10 Practice variability

Across the experiment period, performing with the constraint felt significantly variable. Sessions fluctuated between feeling unsuccessful (due to artistic or technical deficiencies) and feeling fruitful. This was reflected in the journal, where the tone of each entry varied between sessions. In a particular week, I journaled both satisfaction with the practice and a desire to unearth more novel materials and approaches. This variability persisted throughout the experiment. Listening back to these sessions, I was often surprised to hear they sounded stronger and more successful than I felt at the time of practice.

4.2.11 Development

Analysis of practice recordings revealed an increased level of attunement to the speech constraint in the later sessions. The final 15 practice recordings demonstrated sustained engagement with environmental information and a blending of materials and approaches. This period did not produce new materials or approaches but showed a strengthening of my attention and attunement to environmental information. Further, I was able to deploy multiple materials or approaches in a single phrase (see Example 14). This was affirmed in a journal entry after Session 41, noting:

> *Feel like am able to pay more attention to the material and can improvise 'with it' more... can sustain my attention on it while I play more than taking material from it and doing my own thing.*

Due to sustained engagement with the constraint, excerpts exported from these final practices were, on average, double the length of those from the first 10 practice recordings (e.g., 52

seconds compared to 23 seconds). Due to sustained perturbances felt across the experiment, I was unable to recognise these developments during the practice period.

Example 14

Example of playing in final sessions

S52-8 S53-1 S55-1 48-5

4.3 Constraint modifications

After experiencing a sustained level of perturbance, I experimentally modified the practice design to reduce the demands of the practice task. Modifications included constraining speech material criteria as well as slowing down the speech constraint. These experimental modifications were not part of the initial practice design and are considered a research outcome of the project.

4.3.1 First modification: constraining criteria

During the initial sessions, I chose a broad range of speech material featuring varied genders, speech accents, contexts, and number of speakers (e.g., from monologues to dialogues between two, three or more speakers.) This material commonly featured informal, conversational speech. During Session 27, I arbitrarily chose a public speaker orating in a formal and declamatory tone. This session was noticeably less perturbing than previous sessions which had featured conversational material. The orator's dramatic pauses provided defined cadences, which acted as

points to play or pause within, while their relaxed pacing and distinct pronunciation allowed me to distinguish and respond to durational and intonational information more successfully. In the practice journal I noted:

> *Much easier to play with! More space and the exaggerated and oratorical style of a speech with pauses and more dramatic intonation - going to play with more speeches!*

Example 15

Examples of improvisation with oratorial speech


S25-1


S27-2


S28-3


S41-6

After the successes of Session 27, I realised that the qualities of informal and conversational dialogue—fast rate of speech, less defined melodic qualities, and absence of pauses—created a dense and indecipherable sonic environment, resulting in difficulties in discerning and thus responding to environmental information. This was noted in the previous session (Session 26) where I journaled:

> *Feeling very perturbed still! Hard to find room with all the speaking, especially in a conversation between two people.*

Due to the reduced demands when improvising with oratorical speech, I decided to only improvise with public speakers. Upon enacting this modification to the selection criteria I was better able to discern durational and intonational qualities of speech and thus attune to speakers' unique vocal qualities, such as their register, inflection, cadence, and rhythm. I began to

appreciate the unique vocal qualities of speakers and the varied responses their unique qualities afforded. I further utilised the more frequent moments of silence as cadence points during which to rest or play solo. This contrasted my experience with the unbroken feed of sound in conversational dialogue. Lastly, enacting this modification allowed me to engage with the constraint for longer periods. Overall, oratory speech material produced a more defined sonic landscape with more perceivable affordances. From this comparison of conversational and oratorical speech constraints, I recognised that a *rich* sonic landscape is not one necessarily filled with information but one that strikes a balance between information and space.

4.3.2 Second modification: playback speed

After applying the selection criteria modification for 14 sessions, I recognised I was still frequently reverting to autonomous approaches and speculated that oratorial speech may still be highly perturbing. This led me to experimentally trial additional modifications to further reduce the demands of the practice task. I decreased the playback speed of speech material to decrease the complexity and density of speech. I trialled two methods of changing the playback speed: transposing audio down nine semitones in the digital audio workstation Ableton (Session 44), and setting the playback function embedded in the YouTube player to 50% of the original speed (Session 45).

Example 16

Example of improvisation with slowed speech

S44-1

S45-3

Reducing the playback speed greatly altered the nature of the speech constraint. The elongation of each word reduced the overall density and complexity of the sonic environment. Sonic features became more discernible and thus created a more well-defined sonic landscape. This allowed me to extend my attention longer when improvising. This modification also allowed me to better discern single pitches within speech, as I noted in the journal entry from Session 36:

> *Continued experimenting with slowed down speech material. Definitely eliciting different responses and material. Slower and lower. Easier to find exact pitches also!*

The shift in playback speed also lengthened the silence between phrases which provided greater variety between speaking and silence.

Although this modification did further reduce the perturbing nature of the task, the digital artefacts produced from slowing down audio material, and the unnatural vocal tone produced by the pitch-shifted method were not enjoyable to play with. After two sessions, I returned to the initial modification of selecting oratorical-based material.

4.4 Taxonomy of imitative materials and approaches

Speech's melodic nature afforded many imitative responses across the experiment. Although I seldom employ imitation in live improvised performances, it was the device I used most frequently across the practice experiment. I imitated several aspects of speech's melodic characteristics, including rhythm, pitch contour, phrase length and articulation.

Imitation also emerged as a primary strategy to generate new and novel materials. I experimented imitating many features of the sonic constraint and selected and developed

materials I deemed valuable (see Section 3.13). No performances of these materials were identical; each were informed by moment-to-moment environmental factors and other playing considerations. As the experiment progressed, I desired less imitative interaction with the sonic constraint and thus explored imitative approaches less. A taxonomy of imitative materials and approaches are listed below with audio excerpts provided as examples.

4.4.1 *Sketching*

Sketching emerged as a technique to imitate the flurry of pitches heard in a spoken phrase. Unable to precisely reproduce the rapid collection of pitches on the trumpet, I imitated the large collection of notes by improvising a flurry of approximate pitches that would *skid* across the trumpet's registers. Exact pitch material was not a consideration in this technique.

I named this approach inspired by the vague and rapid nature of sketching; the exact placement of notes was less significant than the general contour and rapidity of the line. This approach first emerged as a response to a speaker with a markedly fast rate of speech. This was an approach that spontaneously appeared during the recording of the improvised creative work as a device to deal with high-intensity musical material played by the piano and drums.

Example 17

Examples of sketching


S20-3


S31-3


S35-7


S33-3

4.4.2 Pitch repetition

One of the first approaches to emerge from the experiment was the development of strategies to imitate the quick repetition of a single pitch heard from a speaker. The trumpet afforded imitation of this feature through the application of instrument-specific techniques such as double tonguing and alternate fingerings which allowed the rapid repetition of a single pitch. This was explored across the entirety of the practice period.

Example 18

Examples of pitch repetition

S29-1 S34-3 S48-1 S46-9

4.4.3 Phrase imitation

Speech phrases (the length of speech between pauses) afforded imitation as they were easier to discernible than individual pitches. I experimented with imitating both phrase lengths and the general melodic contour of a phrase. I experimented with a variety of melodic material within a phrase length, including long tones (see Section 4.2.6) and dense pitch material. Imitating phrase lengths would at times create an echo effect against the speech material. This technique was explored less frequently later in the experiment.

Example 19

Example of phrase imitation

S27-1 S24-3 28-3 S22-1

4.4.4 Intervallic imitation

Large intervals (a fifth or more) were frequently heard in the speech material. Although difficult to execute on the trumpet and not material I often previously used when improvising, I experimented with imitating them. I did not attempt to imitate exact intervals.

Example 20

Example of intervallic leaps

S11-3 S15-4 S21-5 S39-5

4.4.5 Dynamic contrast

Playing with speech alerted me to the dynamic range found within the phrase of a speaker. I experimented imitating these by similarly implementing a range of dynamics within a single musical phrase. I found this approach compelling as it created both interest and added an expressive quality to my playing and, as such, I adopted it through much of the practice experiment. Dynamics contrasts were most noticeable in oratorical speakers. I also briefly

experimented with employing dynamics contrast as a cadence tool at the end of phrases (i.e., becoming louder or softer at the end of a phrase).

Example 21

Examples of dynamic contrast

S29-1

S35-3

S43-5

27-2

4.4.6 Semantic

Semantic content emerged as an affordance within the constraint. I experimented with sonically interpreting notable words. In Example 23 (S15-6) below, upon hearing the word *cascading* I begin playing fast descending passages. Further in Example 23 (S10-1) as I am repeating a melodic idea I hear *short and sharp* and continue the phrase with each note staccato. This approach was always aesthetically varied but overall it strengthened my ability to quickly identify and respond to notable performance features.

Example 22

Example of imitation of semantic content

S15-6

S10-1

4.5 Summary

The application of recorded speech material as a novel sonic constraint created a dense and persistent sonic environment that I found challenging to improvise within and enact affordances from. Overall, I felt highly perturbed across the experiment period. Numerous approaches emerging in response to this sustained perturbance including autonomous approaches and long-tones, as well as changes in my breathing and articulation. To mitigate this, I experimented with modifications to the practice design to create a less dense and complex sonic landscape. I experimented with constraining the selection of speech material to only single orators, as well as trialled slowing down speech material. I enacted the former modification for the remaining 22 practices (from a total of 56 practice sessions).

A by-product of the information-intensive, sonic environment was the emergence of numerous imitative devices and materials. Further, the intonational and durational qualities found in speech afforded many imitative responses. Overall, although a sustained level of perturbance was felt throughout the practice experiment, developments in the level of attunement to the speech constraints were observed, including sustained engagement with environmental information.

5 Creative work - studio recording

The project's creative work has been conceived as a studio recording featuring an improvised musical performance with a jazz ensemble. Entitled *Shaped by the sound around us*, this recording is an important and communicable component of the project, wherein skills developed throughout the practice experiment are deployed in their applicable setting of an improvised ensemble performance. The trumpet performance is considered to embody the original knowledge acquired from the project. It is to be considered a complete research product without analysis or exegesis. In addition, this is an artistic work featuring the creative expression of each player.

The recorded performances from all members are improvised, with no prearranged material. Several takes feature the simple structural constraint of being 18-20 minutes in length, as to imitate the length of a practice session. Structural edits were made to tracks.

The ensemble features professional improvising musicians Adrian Lim-Klumpes on piano and Miles Thomas on drum set. It was recorded by Richard Belkner at Rancom St studio, Botany on 27 March 2023, who subsequently mixed and mastered the recording.

Due to personal circumstances a greater period elapsed between the practice experiment and the studio recording than anticipated. I periodically improvised with speech material to reinforce and maintain skills developed throughout this practice experiment. In this way, this creative work highlights skills that were robust enough to remain within my stable skill base throughout this period.

Throughout the rehearsal and recording of the creative work new insights regarding the project surfaced. Undertaking the creative work was ultimately a vital and rewarding part of the project's process, allowing me to realise these new skills in a performance context with other improvisers.

.

6 Conclusion

This practice-led project aimed to determine whether a period of daily instrumental improvisation with a novel sonic constraint of recorded speech would develop new skills, creative approaches, and musical materials. The project was underpinned by ecological dynamics: a theoretical framework of skill development from the fields of sports and human movement science. Informed by key principles from this framework, a self-regulated practice experiment was designed and implemented over a five-month period. From this practice experiment new improvisational strategies and materials emerged, including changes to my breathing, articulation, volume, in addition to the emergence of numerous imitative approaches and materials. Subsequently, a creative work deploying the emergent, embodied skills in an improvised ensemble performance was recorded. Both the results and creative work form part of the outcomes of this project.

In Chapter 1, I introduced the project and outlined my artistic problem that led to this research. In Chapter 2, I elucidated the theoretical and pedagogical components of ecological dynamics, including its application in music performance and pedagogy. In Chapter 3, I outlined details of the practice design. In Chapter 4, I presented the results of the experiment in an autoethnographic report and taxonomy of materials and approaches. In Chapter 5, I presented the resultant creative work of an original, live improvised recording.

This project furthers the application of ecological dynamics to music improvisation by Slater (2020) and Rapp (2023), whose studies explored practice in atypical outdoor performance contexts. This project implemented a novel sonic constraint of recorded speech, amplified within my practice room. This project was further informed by the 2021 New South Wales

COVID-19 lockdown and its mandated restrictions on travel and gatherings with others. A sonic constraint allowed me to implement the practice experiment without the need to travel or engage other participants. To my knowledge, this project is the first to feature a novel, sonic constraint and highlights how an atypical performance context (Slater, 2020) can be applied within the confines of one's room.

The task of improvising with recorded speech was challenging and perturbing. I found speech dense and demanding, particularly material featuring conversational speech between two or more speakers. In response to sustained perturbance, I modified the selection criteria for speech material and experimented with reducing the playback speed of the material, to minimise the demands of the practice task. These modifications were not components of the initial practice design and are considered outcomes of this project. These modifications led me to realise a more fitting sonic practice constraint may provide a greater balance between sonic information and space. This is affirmed by Walton et al. (2015) who suggests constraints that allow a large degree of freedom to musicians may afford more exploration and outcomes. As such, future research may wish to experiment with less information-dense sonic constraints. Naturally, the effectiveness of a constraint will depend on each practitioner's experiences, and artistic preferences.

As van der Schyff et al. (2018) suggests, further empirical studies in music research could develop a constraint continuum that can reveal a constraint "sweet spot" to maximise musical adaptation and creative outcomes for an individual (p. 12). Two further suggestions for future research are the application of an interactive or responsive novel sonic constraint, as well as the exploration of constraints in other aspects of the performance domain, such task, tool, or technology.

Regardless of the effectiveness of recorded speech as a sonic constraint to my playing, I have found implementing an ecological dynamics approach to my instrumental improvisation to be a rewarding task. I have particularly enjoyed employing spontaneous improvisation as a daily mode practice. From this practice I have observed change in my overall improvisational aesthetic, including the emergence of new playing techniques and improvisational strategies and materials. Further, I have developed a greater level of attunement to musical stimulus, and a broadening of musical choices in improvised performance settings. Overall, I believe this project has contributed to the development of an emerging, original improvisational trumpet approach. I hope practitioners from diverse disciplines can experiment and creatively implement this methodology to create new and original artistic outcomes of their own.

References

Adams, J. A. (1971). A closed-loop theory of motor learning. *Journal of motor behavior*, *3*(2), 111-150. https://doi.org/10.1080/00222895.1971.10734898

Aebersold, J. (1967). *How to play jazz and improvise* (Vol. 1). Jamey Aebersold Jazz.

Ake, D. (2002). Learning jazz, teaching jazz. In M. H. Cook, D. (Ed.), *The Cambridge companion to jazz* (pp. 255-269). Cambridge University Press. https://doi.org/10.1017/CCOL9780521663205.015

Araújo, D., & Davids, K. (2011). What exactly is acquired during skill acquisition? *Journal of Consciousness Studies*, *18*(3-4), 7-23. http://www.imprint.co.uk/jcs.html

Araújo, D., Davids, K., & Hristovski, R. (2006). The ecological dynamics of decision making in sport. *Psychology of sport and exercise*, *7*(6), 653-676. https://doi.org/10.1016/j.psychsport.2006.07.002

Araújo, D., Davids, K., & Renshaw, I. (2020). Cognition, emotion and action in sport: An ecological dynamics perspective. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of sport psychology* (4 ed., pp. 535-555). https://doi.org/10.1002/9781119568124.ch25

Baker, D. (1989). *David Baker's jazz pedagogy: a comprehensive method of jazz education for teacher and student*. Alfred Music Publishing. https://www.alfred.com/jazz-pedagogy-for-teachers-and-students-revised-1989/p/00-2751/

Balagué, N., Pol, R., Torrents, C., Ric, A., & Hristovski, R. (2019). On the relatedness and nestedness of constraints. *Sports Medicine-Open*, *5*(1), 1-10. https://doi.org/10.1186/s40798-019-0178-z

Ball, E. (2004). *The fundamentals of a new practice method for improvising trumpet players* [Master's thesis, University of Melbourne, Victorian College of the Arts].

Barker, S. (2015). *Korea and the western drumset: Scattering rhythms*. Routledge. https://doi.org/10.4324/9781315251042

Berge, B. (2022). *A scoping review of the ecological dynamics approach to skill learning in sport: A knowledge synthesis of empirical studies* [Master's thesis, Norwegian School of Sport Sciences]. https://nih.brage.unit.no

Berkowitz, A. (2010). *The improvising mind: Cognition and creativity in the musical moment*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199590957.001.0001

Berliner, P. F. (1994). *Thinking in jazz: The infinite art of improvisation*. University of Chicago Press. https://doi.org/10.7208/9780226044521

Bolinger, D. (1989). *Intonation and its uses: Melody in grammar and discourse*. Stanford University Press. https://doi.org/10.1515/9781503623125

Borgo, D. (2007). Free jazz in the classroom: An ecological approach to music education. *Jazz perspectives*, *1*(1), 61-88. https://doi.org/10.1080/17494060601061030

Borgo, D. (2018). The complex dynamics of improvisation. In R. Bader (Ed.), *Springer handbook of systematic musicology* (pp. 1017-1027). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-662-55004-5_52

Borgo, D. (2022). *Sync or swarm, revised edition: Improvising music in a complex age* (Vol. 2nd). Bloomsbury Publishing. https://doi.org/10.5040/9781501368875

Botting, T. (2018). *Developing a personal vocabulary for solo double bass through assimilation of extended techniques and preparations* [Doctoral disseration, University of Sydney]. Sydney eScholarship. http://hdl.handle.net/2123/20352

Bregman, A. S. (1994). *Auditory scene analysis: The perceptual organization of sound*. The MIT Press. https://doi.org/10.7551/mitpress/1486.001.0001

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32-42. https://doi.org/10.3102/0013189X018001032

Brunswik, E. (1956). *Perception and the representative design of psychological experiments*. Berkeley: University of California Press. https://doi.org/10.1525/9780520350519

Button, C., Seifert, L., Chow, J. Y., Araújo, D., & Davids, K. (2021). *Dynamics of skill acquisition: An ecological dynamics approach* (2nd ed.). Human Kinetics. https://doi.org/10.5040/9781718214125

Carvalho, A., & Araújo, D. (2022). Self-regulation of learning in sport practices: An ecological dynamics approach. *Asian Journal of Sport and Exercise Psychology*, *2*(1), 3-7. https://doi.org/10.1016/j.ajsep.2022.03.003

Cazan, A.-M. (2012). Enhancing self regulated learning by learning journals. *Procedia-Social and Behavioral Sciences*, *33*, 413-417. https://doi.org/10.1016/j.sbspro.2012.01.154

Chelariu, C., Johnston, W. J., & Young, L. (2002). Learning to improvise, improvising to learn: A process of responding to complex environments. *Journal of Business research*, *55*(2), 141-147. https://doi.org/10.1016/S0148-2963(00)00149-1

Chemero, A. (2003). An outline of a theory of affordances. *Ecological psychology*, *15*(2), 181-195. https://doi.org/10.1207/S15326969ECO1502_5

Chow, J. Y. (2010). Insights from an emerging theoretical perspective in motor learning for physical education. In M. Chia & J. Chiang (Eds.), *Sport science and studies in Asia: Issues, reflections and emergent solutions* (pp. 59-77). World Scientific. https://doi.org/10.1142/9789814304092_0004

Chow, J. Y., Davids, K., Button, C., & Renshaw, I. (2015). *Nonlinear pedagogy in skill acquisition: An introduction* (1st ed.). Routledge. https://doi.org/10.4324/9781315813042

Chow, J. Y., Davids, K., Hristovski, R., Araújo, D., & Passos, P. (2011). Nonlinear pedagogy: Learning design for self-organizing neurobiological systems. *New Ideas in Psychology*, *29*(2), 189-200. https://doi.org/10.1016j.newideapsych.2010.10.001

Clark, A. (1997). *Being there: Putting brain, body, and world together again*. The MIT Press. https://doi.org/10.7551/mitpress/1552.001.0001

Clark, J. E. (1995). On becoming skillful: Patterns and constraints. *Research Quarterly For Exercise and Sport*, *66*(3), 173-183. https://doi.org/10.1080/02701367.1995.10608831

Clarke, E. (2005). *Ways of listening: An ecological approach to the perception of musical meaning*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195151947.001.0001

Coltrane, J. (1964). On *A Love Supreme [Album]*. Impulse!

Coste, A., Bardy, B. G., & Marin, L. (2019). Towards an embodied signature of improvisation skills. *Frontiers in psychology*, *10*(2441). https://doi.org/10.3389/fpsyg.2019.02441

Csikszentmihalyi, M. (1990). The domain of creativity. In M. A. Runco & R. S. Albert (Eds.), *Theories of creativity* (pp. 190–212). Sage Publications. https://doi.org/10.1017/CBO9780511763205.004

Csikszentmihalyi, M. (2014). Society, culture, and person: A systems view of creativity. In *The systems model of creativity* (pp. 47-61). Springer. https://doi.org/10.1007/978-94-017-9085-7_4

Dasika, N. J. (2021). *Applications of Béla Bartók's techniques of pitch organisation to jazz improvisation* [Master's thesis, Edith Cowan University]. https://ro.ecu.edu.au/theses/2408

Davids, K., Araújo, D., Hristovski, R., Passos, P., & Chow, J. Y. (2012). Ecological dynamics and motor learning design in sport. In *Skill acquisition in sport: Research, theory and practice* (2 ed., pp. 112-130). Routledge. https://doi.org/10.13140/RG.2.1.2297.0089

Davids, K., Araújo, D., Seifert, L., & Orth, D. (2015). Expert performance in sport: An ecological dynamics perspective. In J. Baker & D. Farrow (Eds.), *Routledge handbook of sport expertise* (pp. 130-144). Routledge/Taylor & Francis Group. https://doi.org/10.4324/9781315776675-12

Davids, K., Araújo, D., Vilar, L., Renshaw, I., & Pinder, R. (2013). An ecological dynamics approach to skill acquisition: Implications for development of talent in sport. *Talent Development and Excellence*, *5*(1), 21-34.

Davids, K., Button, C., & Bennett, S. (2008). *Dynamics of skill acquisition: A constraints-led approach*. Human Kinetics.

Davids, K., Glazier, P., Araújo, D., & Bartlett, R. (2003). Movement systems as dynamical systems: The functional role of variability and its implications for sports medicine. *Sports medicine*, *33*(4), 245-260. https://doi.org/10.2165/00007256-200333040-00001

Davids, K., Handford, C., & Williams, M. (1994). The natural physical alternative to cognitive theories of motor behaviour: An invitation for interdisciplinary research in sports science? *Journal of Sports Sciences*, *12*(6), 495-528. https://doi.org/10.1080/02640419408732202

de Bruin, L. (2015). Theory and practice in idea generation and creativity in jazz improvisation. *Australian journal of music education*(2), 91-106.

de Bruin, L. (2018). Evolving regulatory processes used by students and experts in the acquiring of improvisational skills a qualitative study. *Journal of Research in Music Education*, *65*(4), 483-507.

De Souza, J. (2017). *Music at hand: Instruments, bodies, and cognition*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780190271114.001.0001

de Wit, M. M., van der Kamp, J., & Withagen, R. (2015). Visual illusions and direct perception: Elaborating on Gibson's insights. *New Ideas in Psychology*, *36*, 1-9. https://doi.org/10.1016j.newideapsych.2014.07.001

Di Marzo Serugendo, G., Foukia, N., Hassas, S., Karageorgos, A., Mostéfaoui, S. K., Rana, O. F., Ulieru, M., Valckenaers, P., & Van Aart, C. (2004). *Self-organisation: Paradigms and applications* International Workshop on Engineering Self-Organising Applications,

Dobson, C. (2018). Wandering and direction in creative production. In C. K., K. C., & F. R. (Eds.), *The Oxford handbook of spontaneous thoughts: Mind-wandering, creativity, and dreaming* (pp. 299-308). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190464745.013.31

Dobson, S. (2021). *The role of instrumental technique in creative process: Applying the 'canadian school of double Bass' to jazz performance* [Master's thesis, The University of Sydney]. https://ses.library.usyd.edu.au/handle/2123/24701

Dreyfus, H., & Dreyfus, S. E. (1986). *Mind over machine: The power of human intuition and expertise in the era of the computer*. Free Press. https://doi.org/10.1109/MEX.1987.4307079

Dreyfus, H. L. (2002). A phenomenology of skill acquisition as the basis for a Merleau-Pontian nonrepresentational cognitive science.

Dreyfus, H. L. (2014). *Skillful coping: Essays on the phenomenology of everyday perception and action*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199654703.001.0001

Edelman, G. M., & Gally, J. A. (2001). Degeneracy and complexity in biological systems. *Proceedings of the National Academy of Sciences*, *98*(24), 13763-13768.

Egan, F., & Orlandi, N. (2010). Vision. https://www.rep.routledge.com/articles/thematic/vision/v-2/bibliography/vision-bib

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological review*, *100*(3), 363. https://doi.org/10.1037/0033-295X.100.3.363

Gander, A. J. (2017). *Developing a polyrhythmic idiolect* [Doctoral dissertation, University of Sydney].

Gibson, J. J. (1966). *The senses considered as perceptual systems*. Houghton Mifflin.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Houghton Mifflin.

Gill, S. (2018). *Polyrhythm-based approaches to improvisation and composition for the composer-performer* [Master's thesis, University of Sydney].

Glaser, S. (2000). The missing link: Connections between musical and linguistic prosody. *Contemporary music review*, *19*(3), 129-154. https://doi.org/10.1080/07494467.2000.11689734

Glaveanu, V. P. (2013). Rewriting the language of creativity: The five A's framework. *Review of General Psychology*, *17*(1), 69-81. https://doi.org/10.1037/a0029528

Glăveanu, V. P. (2014). *Distributed creativity: Thinking outside the box of the creative individual*. Springer. https://doi.org/10.1007/978-3-319-05434-6

Gray, R. (2015, November 15 2015). Interview with Keith Davids, Sheffield Hallam University, Constraints-Led Approach to Skill Acquisition (No. 14C) In *Interview with Keith Davids, Sheffield Hallam University, constraints-led approach to skill acquisition*. https://perceptionaction.com/14c/

Guilford, J. P. (1967). Creativity: Yesterday, today and tomorrow. *The Journal of Creative Behavior*, *1*(1), 3-14. https://doi.org/https://doi.org/10.1002/j.2162-6057.1967.tb00002.x

Hale, C. J. (2018). *Ritual diamonds and bass hohŭp: Strategies for cross-domain creative engagement with Korean traditional rhythm* [Doctoral dissertation, University of Sydney]. Sydney eScholarship. http://hdl.handle.net/2123/20305

Hannaford, M. E. (2019). *One line, many views: Perspectives on music theory, composition, and improvisation through the work of Muhal Richard Abrams* [Doctoral dissertation, Columbia University]. https://doi.org/10.17613/qaa9-s909

Hargreaves, W. (2012). Generating ideas in jazz improvisation: Where theory meets practice. *International Journal of Music Education*, *30*(4), 354-367. https://doi.org/10.1177/0255761412459164

Hayes, L. (2019). Beyond skill acquisition: Improvisation, interdisciplinarity, and enactive music cognition. *Contemporary Music Review*, *38*(5), 446-462. https://doi.org/10.1080/07494467.2019.1684059

Hazzard, B. (2021). *Public health (COVID-19 Greater Sydney) order (No 2) amendment order (No 2) 2021*. New South Wales Government

Heft, H. (1997). The relevance of Gibson's ecological approach to perception for environment-behavior studies. In G. T. Moore & R. W. Marans (Eds.), *Toward the Integration of Theory, Methods, Research, and Utilization. Advances in Environment, Behavior and Design vol 4* (pp. 71-108). Springer. https://doi.org/10.1007/978-1-4757-4425-5_3

Heft, H. (2001). *Ecological psychology in context: James Gibson, Roger Barker, and the legacy of William James's radical empiricism*. Psychology Press. https://doi.org/10.4324/9781410600479

Hollan, J., Hutchins, E., & Kirsh, D. (2000). Distributed cognition: Toward a new foundation for human-computer interaction research. *ACM Transactions on Computer-Human Interaction 7*(2), 174-196. https://doi.org/10.1145/353485.353487

Hollenstein, T. (2007). State space grids: Analyzing dynamics across development. *International Journal of Behavioral Development*, *31*(4), 384-396.

Hristovski, R., Davids, K., & Araujo, D. (2009). Information for regulating action in sport: Metastability and emergence of tactical solutions under ecological constraints. In M. Raab, D. Araujo, & H. Ripoll (Eds.), *Perspectives on cognition and action in sport* (pp. 43-57). Nova Science Publishers.

Hristovski, R., Davids, K., Araujo, D., & Passos, P. (2011). Constraints-induced emergence of functional novelty in complex neurobiological systems: A basis for creativity in sport. *Nonlinear Dynamics-Psychology and Life Sciences*, *15*(2), 175.

Iyer, V. (1998). *Microstructures of feel, macrostructures of sound: Embodied cognition in West African and African-American musics* [Doctoral dissertation, University of California, Berkeley].

Iyer, V. (2002). Embodied mind, situated cognition, and expressive microtiming in African-American music. *Music Perception*, *19*(3), 387-414. https://doi.org/10.1525/mp.2002.19.3.387

Iyer, V. (2016). Improvisation, action understanding, and music cognition with and without bodies. In G. Lewis & B. Piekut (Eds.), *The Oxford handbook of critical improvisation studies* (Vol. 1). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780195370935.013.014

Johnson-Laird, P. N. (2002). How jazz musicians improvise. *Music Perception*, *19*(3), 415-442. https://doi.org/10.1525/mp.2002.19.3.415

Kelso, J., Schöner, G., Scholz, J., & Haken, H. (1987). Phase-locked modes, phase transitions and component oscillators in biological motion. *Physica Scripta*, *35*(1), 79. https://doi.org/10.1088/0031-8949/35/1/020

Kelso, J. S. (1984). Phase transitions and critical behavior in human bimanual coordination. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *246*(6), R1000-R1004. https://doi.org/10.1152/ajpregu.1984.246.6.R1000

Kelso, J. S. (1995). *Dynamic patterns: The self-organization of brain and behavior*. The MIT press.

Kelso, J. S. (2012). Multistability and metastability: Understanding dynamic coordination in the brain. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1591), 906-918.

Kelso, J. S., & Schöner, G. (1988). Self-organization of coordinative movement patterns. *Human Movement Science*, *7*(1), 27-46. https://doi.org/10.1016/0167-9457(88)90003-6

Kelso, S. J., Holt, K. G., Rubin, P., & Kugler, P. N. (1981). Patterns of human interlimb coordination emerge from the properties of non-linear, limit cycle oscillatory processes: Theory and data. *Journal of Motor Behavior*, *13*(4), 226-261. https://doi.org/10.1080/00222895.1981.10735251

Kim, Y. (2022). *How to get through: Developing coordination practice and solo improvisation on the drum set* [Master's thesis, University of Sydney]. https://ses.library.usyd.edu.au/handle/2123/29278

King, A. J. (2021). *Self-generated processes for integrating Balinese drumming and the drumset* [Doctoral dissertation, University of Sydney]. https://ses.library.usyd.edu.au/handle/2123/27225

Kugler, P. N., Kelso, J. A. S., & Turvey, M. T. (1980). On the concept of coordinative structures as dissipative structures: Theoretical Lines of Convergence. *Advances in Psychology*, *1*, 3-47. https://doi.org/10.1016/S0166-4115(08)61936-6

Ladd, D. R. (2008). *Intonational phonology*. Cambridge University Press. https://doi.org/10.1017/CBO9780511808814

Ladyman, J., Lambert, J., & Wiesner, K. (2013). What is a complex system? *European Journal for Philosophy of Science*, *3*, 33-67. https://doi.org/10.1007/s13194-012-0056-8

Linson, A., & Clarke, E. F. (2017). Distributed cognition, ecological theory, and group improvisation. In E. Clarke & D. M (Eds.), *Distributed creativity: Collaboration and improvisation in contemporary music* (Vol. 2, pp. 52). https://doi.org/10.1093/oso/9780199355914.003.0004

Mace, W. M. (2014). Introduction to the classic edition In J. J. Gibson (Ed.), *The ecological approach to visual perception: Classic edition*. Psychology Press. https://doi.org/10.4324/9781315740218

Malafouris, L. (2013). *How things shape the mind: A theory of material engagement*. The MIT press. https://doi.org/10.7551/mitpress/9476.001.0001

McLean, J. R. (2018). *A new way of moving: Developing a solo drumset practice informed by embodied music cognition* [Doctoral dissertation, The University of Sydney]. https://ses.library.usyd.edu.au/handle/2123/17989

McMahon, M. J. (2022). *Graded constraints: A practise methodology for solo piano improvisation* [Doctoral dissertation, The University of Sydney]. https://ses.library.usyd.edu.au/handle/2123/29255

McPherson, G. E., Miksza, P., & Evans, P. (2017). Self-regulated learning in music practice and performance. In D. H. Schunk & G. J. A. (Eds.), *Handbook of self-regulation of learning and performance* (pp. 181-193). Routledge. https://doi.org/10.4324/9781315697048-12

McPherson, G. E., & Renwick, J. M. (2011). Self-regulation and mastery of musical skills. In *Handbook of self-regulation of learning and performance* (pp. 234-248). Routledge/Taylor & Francis Group.

Meagher, A. P. (2022). *Waves & schemes: Reconciling Arvo Pärt's compositional processes and techniques within an improviser's practice* [Doctoral dissertation, University of Sydney]. https://ses.library.usyd.edu.au/handle/2123/29240

Memmert, D., & Roth, K. (2007). The effects of non-specific and specific concepts on tactical creativity in team ball sports. *Journal of Sports Sciences*, *25*(12), 1423-1432. https://doi.org/10.1080/02640410601129755

Merriam-Webster. (n.d). Environment. In *Merriam-Webster.com dictionary*. Retrieved April 11, 2023, from https://www.merriam-webster.com/dictionary/environment

MonoNeon [@mononeon]. (n.d.). Instagram. Retrieved May 9th, 2023 from https://www.instagram.com/mononeon

Moran, J. (2001a). Artist Ought To Be Writing [Song]. On *Artist In Residence*. Blue Note.

Moran, J. (2001b). Breakdown [Song]. On *Artist In Residence*. Blue Note.

Neto, L. C.-L. (2020). The first "sound of the aura" of Hermeto Pascoal (1984): Hearing the spoken voice as a sung melody. *IASPM Journal*, *10*(2), 20-37. https://doi.org/10.5429/2079-3871(2020)v10i2.3en

Newell, K. M. (1986). Constraints on the development of coordination. In W. M. G. & W. H. T. A. (Eds.), *Motor development on children: Aspects of coordination and control*. https://doi.org/10.1007/978-94-009-4460-2_19

Newell, K. M. (1996). Change in movement and skill: Learning, retention, and transfer. In L. M. L. & M. T. Turvey (Eds.), *Dexterity and its development* (pp. 393-429). Psychology Press. https://doi.org/10.1111/j.1365-2923.2009.03421.x

Newen, A., Gallagher, S., & De Bruin, L. (2018). *4E cognition: Historical roots, key concepts, and central issues* (1 ed.). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198735410.013.1

Nonken, M. C. (2008). What do musical chairs Aaford? On Clarke's ways of listening and sacks's musicophilia. *Ecological Psychology*, *20*(4), 283-295. https://doi.org/10.1080/10407410802189174

Nückles, M., Roelle, J., Glogger-Frey, I., Waldeyer, J., & Renkl, A. (2020). The self-regulation-view in writing-to-learn: Using journal writing to optimize cognitive load in self-regulated learning. *Educational Psychology Review*, *32*, 1089-1126. https://doi.org/10.1007/s10648-020-09541-1

Oehlers, J. (2019). *Night music (compositions, performance and improvisations) -and-developing a chromatic-intervallic approach to jazz improvisation through reflexive practice: An exegesis* [Doctoral dissertation, Edith Cowan University]. https://ro.ecu.edu.au/theses/2189/

Orth, D., Van der Kamp, J., Memmert, D., & Savelsbergh, G. J. (2017). Creative motor actions as emerging from movement variability. *Frontiers in Psychology*, *8*, 1903. https://doi.org/10.3389/fpsyg.2017.01903

Pascoal, H. (1984). Tiruliruli [Song]. On *Lagoa Da Canoa Município De Arapiraca*. Som Da Gente.

Pearsons, K. S., Bennett, R. L., & Fidell, S. A. (1977). *Speech levels in various noise environments*. Office of Health and Ecological Effects, Office of Research and Development. US Enviromental Protection Agency. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100CWGS.PDF?Dockey=P100CWGS.PDF

Pinder, R. A., Davids, K., & Renshaw, I. (2012). Metastability and emergent performance of dynamic interceptive actions. *Journal of Science and Medicine in Sport*, *15*(5), 437-443. https://doi.org/10.1016/j.jsams.2012.01.002

Pinder, R. A., Davids, K., Renshaw, I., & Araújo, D. (2011). Representative learning design and functionality of research and practice in sport. *Journal of Sport and Exercise Psychology*, *33*(1), 146-155. https://doi.org/10.1123/jsep.33.1.146

Porter, L. (1985). John Coltrane's" A Love Supreme": Jazz improvisation as composition. *Journal of the American Musicological Society*, *38*(3), 593-621. https://doi.org/10.2307/831480

Pressing, J. (1984). Cognitive processes in improvisation. In *Advances in Psychology* (Vol. 19, pp. 345-363). Elsevier. https://doi.org/10.1016/S0166-4115(08)62358-4

Pressing, J. (1988). Improvisation: Methods and models. In J. A. Sloboda (Ed.), *Generative processes in music: The psychology of performance, improvisation, and composition.* (pp. 129-156). Clarendon Press/Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198508465.003.0007

Rapp, M. C. L. (2023). *Retroreflection and waterfalls: Speaking and singing in extreme acoustic environments* [Doctoral dissertation, University of Sydney]. Sydney eScholarship. https://hdl.handle.net/2123/29962

Reader, S. M., & Laland, K. N. (2001). Primate innovation: Sex, age and social rank. *International Journal of Primatology*, *22*(5), 787-805. https://doi.org/10.1023/A:1012069500899

Renshaw, I., & Chow, J.-Y. (2019). A constraint-led approach to sport and physical education pedagogy. *Physical Education and Sport Pedagogy*, *24*(2), 103-116. https://doi.org/10.1080/17408989.2018.1552676

Sawyer, R. K. (1999). The emergence of creativity. *Philosophical Psychology*, *12*(4), 447-469. https://doi.org/10.1080/095150899105684

Sawyer, R. K., & DeZutter, S. (2009). Distributed creativity: How collective creations emerge from collaboration. *Psychology of Aesthetics, Creativity, and the Arts*, *3*(2), 81. https://doi.org/10.1037/a0013282

Schiavio, A., Gesbert, V., Reybrouck, M., Hauw, D., & Parncutt, R. (2019). Optimizing performative skills in social interaction: Insights from embodied cognition, music education, and sport psychology. *Frontiers in Psychology*, *10*, 1542. https://doi.org/10.3389/fpsyg.2019.01542

Schiavio, A., & Kimmel, M. (2021). The ecological dynamics of musical creativity and skill acquisition. In *Meaningful Relations: The Enactivist Making of Experiential Worlds* (pp. 121-158). Academia-Verlag. https://doi.org/10.5771/9783896659934-121

Schöllhorn, W., Mayer-Kress, G., Newell, K., & Michelbrink, M. (2009). Time scales of adaptive behavior and motor learning in the presence of stochastic perturbations. *Human Movement Science*, *28*(3), 319-333. https://doi.org/10.1016/j.humov.2008.10.005

Seifert, L., Button, C., & Davids, K. (2013). Key properties of expert movement systems in sport: An ecological dynamics perspective. *Sports Medicine*, *43*, 167-178. https://doi.org/10.1007/s40279-012-0011-z

Seifert, L., & Davids, K. (2017, 2017). Ecological dynamics: A theoretical framework for understanding sport performance, physical education and physical activity [Paper presentation]. First Complex Systems Digital Campus World E-Conference Cham.

Shapiro, L. (2019). *Embodied cognition*. Routledge. https://doi.org/10.4324/9781315180380

Slater, P. (2019). On *The Dark Pattern*. Earshift Music.

Slater, P. (2021, 1/05/2021). Phil Slater: An ecological approach to musical skill acquisition and creative development. *Loudmouth Music Trust E-Zine*, *2022*. https://doi.org/10.1093/acprof:oso/9780198508465.001.0001

Slater, P. J. (2020). *The Dark Pattern: Towards a constraints-led approach to jazz trumpet* [Doctoral dissertation, University of Sydney]. Sydney eScholarship. https://hdl.handle.net/2123/22727

Sloboda, J. A. (1988). *Generative processes in music: The psychology of performance, improvisation, and composition*. Clarendon Press/Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198508465.001.0001

Smith, H., & Dean, R. T. (2009). *Practice-led research, research-led practice in the creative arts*. Edinburgh University Press. https://doi.org/10.1515/9780748636303

Smith, L. B. (2005). Cognition as a dynamic system: Principles from embodiment. *Developmental Review*, *25*(3), 278-298. https://doi.org/https://doi.org/10.1016/j.dr.2005.11.001

Smith, L. B., & Thelen, E. (2003). Development as a dynamic system. *Trends in Cognitive Sciences*, *7*(8), 343-348. https://doi.org/10.1016/S1364-6613(03)00156-6

Sudnow, D. (1978). *Ways of the hand: The organization of improvised conduct*. Harvard University Press. https://doi.org/10.2307/430807

Taylor, A. H., Elliffe, D., Hunt, G. R., & Gray, R. D. (2010). Complex cognition and behavioural innovation in New Caledonian crows. *Proceedings of the Royal Society B: Biological Sciences*, *277*(1694), 2637-2643. https://doi.org/10.1098/rspb.2010.0285

Thagard, P. (2005). *Mind: Introduction to cognitive science* (2nd ed.). The MIT Press.

Thaler, R. H., & Sunstein, C. R. (2009). *Nudge: Improving decisions about health, wealth, and happiness*. Penguin.

Thelen, E. (2005). Dynamic systems theory and the complexity of change. *Psychoanalytic Dialogues*, *15*(2), 255-283. https://doi.org/10.1080/10481881509348831

Thelen, E., & Smith, L. B. (1994). *A dynamic systems approach to the development of cognition and action*. The MIT Press. https://doi.org/10.7551/mitpress/2524.001.0001

Thompson, E. (2011). Living ways of sense making. *Philosophy Today 55*, 114-123. https://doi.org/10.5840/philtoday201155Supplement14

Turvey, M. T., Shaw, R. E., Reed, E. S., & Mace, W. M. (1981). Ecological laws of perceiving and acting: In reply to Fodor and Pylyshyn *Cognition*, *9*(3), 237-304. https://doi.org/10.1016/0010-0277(81)90002-0

van der Schyff, D. (2019). Improvisation, enaction, and self-assessment. In E. D. J., S. M, & M. G. E. (Eds.), *The Oxford handbook of philosophical and qualitative perspectives on assessment in music education* (pp. 319-346). https://doi.org/10.1093/oxfordhb/9780190265182.013.15

van der Schyff, D., & Schiavio, A. (2022). Musical creativity in performance. In G. E. McPherson (Ed.), *The Oxford handbook of music performance* (Vol. 1, pp. 484). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190056285.013.30

van der Schyff, D., Schiavio, A., Walton, A., Velardo, V., & Chemero, A. (2018). Musical creativity and the embodied mind: Exploring the possibilities of 4E cognition and dynamical systems theory. *Music & Science*, *1*, 205920431879231. https://doi.org/10.1177/2059204318792319

Varela, F. J. (1984). *Living ways of sense-making: A middle path for neuroscience* Stanford international symposium on disorder and order [presentation paper], Standford.

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. The MIT Press.

Vear, C. (2021). *The routledge international handbook of practice-based research*. Taylor and Francis. https://doi.org/10.4324/9780429324154

Walton, A. E., Richardson, M. J., & Chemero, A. (2014). Self-organization and semiosis in jazz improvisation. *International Journal of Signs and Semiotic Systems*, *3*(2), 12-25. https://doi.org/10.4018/IJSSS.2014070102

Walton, A. E., Richardson, M. J., Langland-Hassan, P., & Chemero, A. (2015). Improvisation and the self-organization of multiple musical bodies. *Frontiers in Psychology*, *6*, 313-313. https://doi.org/10.3389/fpsyg.2015.00313

Walton, A. E., Washburn, A., Langland-Hassan, P., Chemero, A., Kloos, H., & Richardson, M. J. (2018). Creating time: Social collaboration in music improvisation. *Topics in Cognitive Science*, *10*(1), 95-119. https://doi.org/https://doi.org/10.1111/tops.12306

Wennerstrom, A. K. (2001). *The music of everyday speech: Prosody and discourse analysis*. Oxford University Press.

Williamson, P. (2014). *Developing technical control, ensemble interaction, and flow within jazz performance* [Doctoral dissetation, Monash University]. https://bridges.monash.edu/articles/thesis/Developing_technical_control_ensemble_interaction_and_flow_within_jazz_performance/4684198/1

Woods, C., McKeown, I., Rothwell, M., Araújo, D., Robertson, S., & Davids, K. (2020a). Sport practitioners as sport ecology designers: How ecological dynamics has progressively changed perceptions of skill "acquisition" in the sporting habitat. *Frontiers in Psychology*, *11*(654). https://doi.org/10.3389/fpsyg.2020.00654

Woods, C., Rudd, J., Robertson, S., & Davids, K. (2020b). Wayfinding: How ecological perspectives of navigating dynamic environments can enrich our understanding of the learner and the learning process in sport. *Sports Medicine-Open*, *6*, 1-11.

Woods, C. T., McKeown, I., O'Sullivan, M., Robertson, S., & Davids, K. (2020c). Theory to practice: Performance preparation models in contemporary high-level sport guided by an ecological dynamics framework. *Sports Medicine-Open*, *6*, 1-11. https://doi.org/10.1186/s40798-020-00268-5

Woods, C. T., McKeown, I., Shuttleworth, R. J., Davids, K., & Robertson, S. (2019). Training programme designs in professional team sport: An ecological dynamics exemplar. *Human Movement Science*, *66*, 318-326. https://doi.org/10.1016/j.humov.2019.05.015

Wyrick, W. (1968). The development of a test of motor creativity. *Research Quarterly. American Association for Health, Physical Education and Recreation*, *39*(3), 756-765. https://doi.org/10.1080/10671188.1968.10616608

Yossef, O., & Granot, R. (2023). Thinking outside the pattern-based box in jazz improvisation. *Jazz Education in Research and Practice*, *4*(1), 64-81. https://doi.org/10.2979/jazzeducrese.4.1.06

Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemporary Educational Psychology*, *11*(4), 307-313. https://doi.org/10.1016/0361-476X(86)90027-5

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice*, *41*(2), 64-70. https://doi.org/10.1207/s15430421tip4102_2

Appendix A: Practice log

Appendix A table 1. Practice log features session number (session no.), the date, title of speech material (hyperlinked to site), where it was sourced, and if the practice session was recorded (rec.). Recorded practices feature an "R". Each "R" is hyperlinked to the entire, unedited practice recording, hosted on audio streaming site SoundCloud (http://www.soundcloud.com). Below each row of data features the practice journal entry from that session. Sessions that feature a modification are marked next to the session number: (1) signifies material chosen due to featuring a single speaker speaking in an oratory style, while (2) signifies speech material whose speed was modified using digital means (as outlined in Chapter 4.3.2). For speech material listed more than once, time stamps are provided next to the title to denote the different sections used for each practice.

This information is redacted for privacy protection.