

**Somatosensory wearable technology in the dance making
process: investigating digital touch in the formation of creative
movement and kinaesthetic awareness**

by

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Abstract

The purpose of this research was to create, use, and study digital touch stimuli in the creative context of making dance. This was enabled by designing, producing, and using two prototypes in workshops with students, experienced dance artists, and educators. This research collected qualitative data via embodied methods, including video footage, the researcher as the participant/facilitator, field notes, and semi-structured interviews. Combining the movement analysis with the participants' perceptions of this experience led to the coding and identification of trends and themes over two projects.

These findings reveal that technologically assisted creativity in improvisation forms part of a multisensorial pre-reflective consciousness, that marks the continuum of present, past, and future. Subsequently, the coded loop of touch stimuli develops into a reference point, creating a heightened awareness of the moving body. The kinaesthetic awareness involved when wearing such a tool/aid became complicated by passive touch as the vibrations created through digital touch disrupted the perception of internal and external boundaries to the body. Consequently, the active presence of another, functioning as a focal or relational point for movement, impacted the experience of the body moving through somatoperception.

With longer periods of use, the participants developed various relationships with the prototypes which are framed as working '*through, with, against, and alongside*' and involving different attentional states in the making of dance. Perceptually, the use of prototypes dissolves the boundaries of the body, altering the participants' understanding of time and space and their use of interoception in their creative responses.

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1. Introduction

1.1 Background

This research journey began as I completed my MA Dance Studies dissertation examining adornment and dress in dance. I was struck by the complexity of what is worn across different dance forms, the experience of the moving body, the sensations, and its influence on identity formation. It was not until several years later that I connected wearable technology to this topic and I began considering what bearing it would have on the ideation and creation of movement.

As this research area involved the sensation of touch on a moving body, I realised that I needed to further understand how we sense our bodies moving in space, otherwise referred to as kinaesthetic awareness or proprioception. Despite this being an important topic in dance literature, there are differing opinions as to what this definition includes. For example, dance ethnologist Deidre Sklar uses “somatic sensation” to describe all proprioceptive awareness consisting of touch, movement, balance, pressure, tension, and temperature, and “kinesthesia” and “kinesthetic”¹ to specifically refer to the proprioception of the joint and muscle activity involved in a movement (Sklar, 2008, p. 104). While from a dance science perspective, ““proprioception” is the scientific term used for the physical feeling of your moving body” (Batson, 2008, p. 1). Over the following chapter, I will discuss the terms kinesphere and kinaesthetic awareness and their origins, but initially, it is important to highlight that within dance there are multiple related definitions situated under the umbrella of kinaesthesia.

The necessity of exploring the physical presence of technology on the skin arises from a growing body of work across fields on interoception (Tsakiris and de Preester, 2019) and the afferent nervous system. In widening our scope and considering sensation on top of the skin, in addition to that felt within the body, we might generate further knowledge and understanding as to the influence technologies have at the boundaries

¹ The spelling of the term varies: US English (‘kinesthesia’ and ‘kinesthetic’) or UK English (‘kinaesthesia’ and ‘kinaesthetic’). As I completed this thesis in the UK, I will adopt the latter version throughout.

of our body. By grouping somatosense with kinaesthetic awareness or proprioception, there is an opportunity to consider connections between how we use information from contact with our skin receptors and the associated internal muscle spindles. To this end, I will refer to kinaesthetic awareness alongside the somatosensory system to be inclusive of “monitor[ing] the contact of objects and surfaces with the skin... [and] to report the position of body segments in space and in relation to each other” (Tyldesley and Grieve, 2002, p. 180). Furthermore, to understand what effect digital touch has on the moving body and the perception of this experience, we should consider how this information coalesces. For that reason, when investigating how tactile stimulation influences the body, it must operate in tandem with the participant’s awareness of both their body and the surrounding environment.

Since the 1960s, academics have debated the possibilities of technology functioning as an extension of our bodies. In the book *Understanding Media*, Marshall McLuhan predicted our future relationship with communication technology, foreseeing a “numbing” of our senses attributable to “superstimulation... the stress of acceleration of pace and increase of load” (McLuhan, 1964, p. 46). McLuhan expected that the collective consciousness of the electrical age would supersede the fragmentation of automation, with humanity becoming interconnected through an extended nervous system (*ibid*, 1964, p. 46). The work of Mark Hansen further explores this from a phenomenological perspective, considering the potential for technology to create new “organs” and enhance our experience of embodiment (Hansen, 2015, p. 267). Significantly, Hansen distinguishes between the new media-driven “alien organs” and the extension of our existing nervous systems, but both examples provoke us to consider the communicative potential of technologies through a body that is connected beyond its physical boundary of the skin.

Furthering this notion, post-humanist theorists have developed hypotheses of how digital tools and prosthetics might function or adapt the body. Scholars including Donna Haraway (1991) and Katherine Hayles (1999) envisaged the end of the Anthropocene, leading to a future in which computers receive greater integration in human life and bodies, and consequently, different concepts of consciousness and subjectivity. Subsequently, the influence of the post-human condition on artwork

creation has generally associated the role of technology as extending or mediating our sensorium. As Jones outlines, technology can influence how the body interacts with the environment leading to experiences that are "amplified, shielded, channelled, prosthetized, simulated, stimulated, irritated" (Jones, 2007, p. 5).

Within the study of technology use in performance - including light, sound, and interactive landscapes - there have been findings that suggest that technology may "augment [a] participant's proprioception" (Wilde, 2011, p. 79) and that these types of interactive tools enable the extension of the performing body in motion. Bisig and Palacio propose that by the very nature of working with sound or visuals in an interactive environment promotes the performer to develop their multi-sensorial communication (Bisig and Palacio, 2016). If the use of technology in such environments enables a greater awareness of the body, perhaps more able to cope with the demands of different types of information, then what might happen when the technology is attached to the body? This thesis aims to address this question and interrogate how a digital tool/aid - worn and making touch contact with the body – might impact kinaesthetic awareness and how this might inform the creative process of choreography? The research questions of this thesis further delve into what influence the digital touch stimuli have on the dancers'/choreographers' experience? Lastly, how the different prototypes and types of digital touch can be utilised by dancers/choreographers in making dance?

My position as the researcher is one of a necessary sceptic. I do not deny the potential for different technologies to extend our proprioceptive abilities, but the literature covering creative movement and body perception during this process would benefit from supplementary analytic layers to further convince me of this claim. Further research in dance academia investigating how we move with the addition of body-worn technology may demonstrate future creative technological possibilities. As Davidson highlights, "...few studies exist that specifically address and analyse contemporary corporealities emerging in artistic practices integrating digital technology, and further, that are capable of explaining precisely how the body interacts with technology" (Davidson, 2019 quoted in Choinière *et al.*, 2019, para 10.5). The research in this thesis will address the use of body worn technology,

compiling the perceptions of both users and the movement created, and consider this alongside recent research in cognitive science, anthropology, philosophy, HCI, music, and dance studies. By taking this approach, it has been possible to knit together the micro-level of the data gathered from the projects to the interdisciplinary terrain involved with physical computing and creative response.

As this work is concerned with using an object attached to the body for a specific purpose, I will address such aspects as theories of tool assimilation. In general, these theoretical discussions are based upon phenomenological literature that considers tools in the mechanical sense and provides examples pre-dating the third industrial revolution (the digital age). We must revisit and discuss how a tool or an aid can be incorporated into our bodily frame of reference, complemented by current research into cognition/ behaviour and the connections between movement and thinking. This is particularly necessary as creative decisions concerning choreography occur in the act of moving, with theories of thinking through movement within cognitive science and philosophy collectively recognising this as embodied cognition.

As Johannes Birringer suggests, artistic endeavours with digital and electronic processes and products necessitate the development of new methods. Future research must address the complexities of technology involved in creating art and how recent variations require different means when considering and analysing both the body and its conjoined experience with our senses (Birringer, 2008, p. xix). For that reason, I chose an inductive approach in this research, enabling an openness to the relationships between different forms of data and restricting any possible assumptions as to the cause and effect or input/output of digital touch within the dance making process. At the forefront of this research has been an attempt to reduce personal bias, supported by the influence of embodied methods and sensory/dance ethnography. My position as an insider in dance - trained in contemporary dance, with 20 years of teaching and lecturing - is equally weighted by my outsider experience with physical computing, design, and prototyping. Having grown up in an analogue world before entering adulthood in a digital one - often described as a 'Xennial' – I inhabit a platform comfortably straddling the middle ground, both recognising technology's

enabling potential but equally questioning the claims and narratives associated with its developments.

This investigation into the creative process of making dance with body-worn technology seeks to help further the development of strategies for creation, the possible frameworks for supporting adaption to new tools, and the greater criticality of the product. David Parisi's consideration of haptics emphasises why greater analysis is integral to technological progress.

It is not enough to say that haptic interfaces extend touch itself into virtual worlds. Instead, we must be attentive to the specific parameters and biases of each particular device, to the specific values and strategies embodied and encoded in the various design paradigms. This allows us to confront, rather than obscure, touch's thorough technogenetic transformation during the epoch of haptic interface. (Parisi, 2018, p. 261)

Studying the responsive movement of a participant to a certain type of tactile sensation only forms part of the wider picture and so subsequently, we require a consideration of the prototype creation to provide the means to respond contextually. As suggested by anthropologist Csordas:

Because attention implies both sensory engagement and an object, we must emphasize that our working definition refers both to attending "with" and attending "to" the body. To a certain extent it must be both. To attend to a bodily sensation is not to attend to the body as an isolated object, but to attend to the body's situation in the world. The sensation engages something in the world because the body is "always already in the world." Attention to a bodily sensation can thus become a mode of attending to the intersubjective milieu that give rise to that sensation. (Csordas, 1993, p. 147)

This multi-layered framework enables criticality, connecting both the creative processes and their outputs to how we produce and communicate meaning through our interaction with others, objects, and environmental affordances. I firmly plant this

contribution to new knowledge in the ontology and epistemology of technologically-assisted creativity in dance making; to further this, I have analysed movement in conjunction with how the wearable technology influences the participants' perceptions of their bodies moving in space.

1.2 Aims

- To investigate the relationship between the dancer's kinaesthetic awareness and the digital touch created by body-worn/wearable technology.
- To consider the influence of digital touch on creative movement choice and structure in tasks/approaches and hypothesising theory for technologically-assisted creativity.
- To employ an interdisciplinary research approach to provide a deeper understanding of the technology and its implementation, including developing prototypes, devising and facilitating workshops, and creating frameworks for analysing different forms of qualitative data.

1.3 Objectives

- The creation of somatosensory wearable technology (SWT) prototypes for their specific use in workshops.
- The completion of workshops and movement analysis, comparing this data with the participant's subjective experiences of touch; what they sense and how this impacts their body use when creating movement.
- To synthesise data sets to establish themes and trends across whole participant groups using different forms of digital touch.

1.4 Thesis Structure

Within this introductory chapter, I discussed both my background and the origins of this research idea, followed by a rationale for why this research area requires further investigation. Before summarising the structure of the thesis, I outlined its aims and desired outcomes and overarching research questions.

Chapter 2 expands upon the terminology used within the research. The purpose of this chapter is to clarify the contextual meaning of this research and to ensure that a wider readership can understand its interdisciplinary nature and subjects.

Chapter 3 covers both the emergence of digital dance and the foremost academics discussing theories of technology, including a brief historical overview of how practitioners have developed this area within dance studies. Next, this chapter concentrates on wearable technology used in dance performance and choreography, before leading to the central focus of kinaesthesia and technology within dance and design interaction.

Chapter 4 outlines the research design and explains how this process involved both a literature review and audit of existing body-worn technologies later enabling prototype development and the application of SWT in choreographic workshops. I present further details on the methods of gathering, combining, and analysing qualitative data, followed by a methodological rationale for the research discussing my selection and deployment of mixed methods during both projects.

Chapter 5 follows Project 1: *Digital Intervention Project* from conception through to prototyping and the pilot. I discuss the emergent themes within the workshops and the subsequent findings, including vibration enabling *foci* and *magnified internal sensation*, the *influence of vibration on the rhythm and quality of movement*, dominant *movement initiation from the location of the prototypes*, and the *division of body parts to the whole body*. I give greater consideration to conscious and/or automatic body movement during improvisation - including the pre-reflective process - and the different relationships between participants and the technology.

Chapter 6 - Project 2: *Digital Touch* considers the areas of learning from Project 1 and its resultant changes. As with chapter 5, this section documents both the prototype development and their subsequent use by six practitioners. I present findings relating to *attentional states*, *heightened awareness*, *focus*, and *changing relationships* with the two prototypes used. Other subthemes include the impact of the *coded loop*, *listening and hearing* in a multisensorial experience, *entrainment*, and *trajectories*.

Chapter 7 amalgamates the findings and themes from both projects, structuring an extended discussion examining what the prototype and the human body do when acting together (in partnership), how the body/brain/ prototype relate and connect, the affect, and what is brought forth during the process. In response, I discuss the identification of the heightened awareness of the body concerning the fluidity of interoception and exteroception. This chapter suggests different relationships and attentional states based on the developing connection between digital touch and creative movement composition.

The concluding chapter summarises this research's contribution to knowledge. Due to the physical reminder of the body created through digital touch and somatosense a heightened consciousness of the moving body is developed. The utilised prototypes reveal different working relationships which is framed as '*through, against, with, and alongside*', brought about through the attentional states involved in making dance. Although this research specifically looked at digital touch as stimuli, the findings reveal multimodal forms of the creative thought process, including a merger of information through the senses involving the kinaesthetic imagination. I discuss how perceptually, using the prototypes dissolves the body's boundaries, subsequently altering the participants' understanding of time and space, alongside an examination of how interoception plays a significant role in this creative process.

2. Context and Definitions

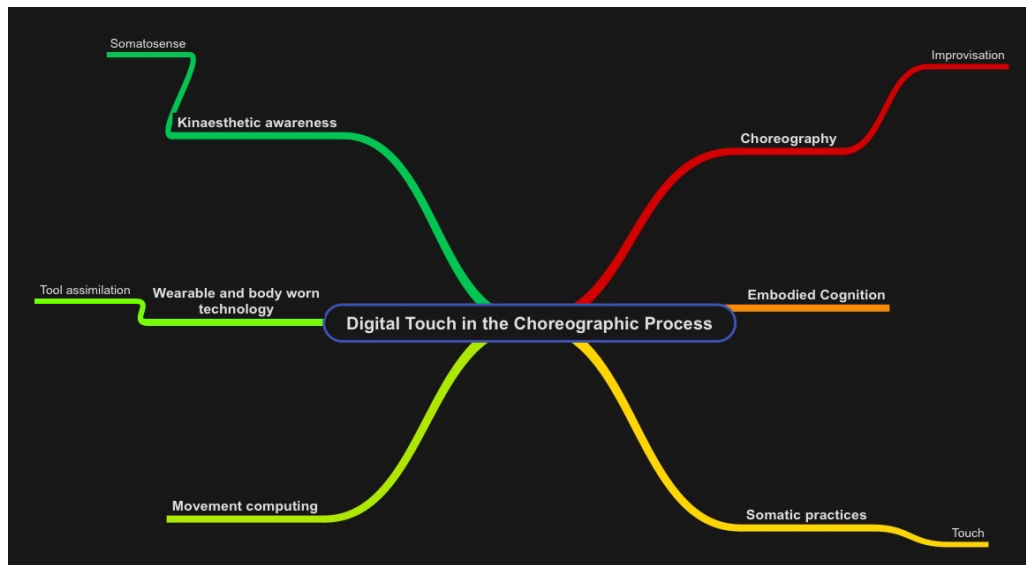


Figure 1. Map of areas related to Digital Touch in the Choreographic Process

The research question borders differing domains of knowledge and is connected to several disciplines by the very nature of working with computers and movement. As illustrated below, many consider first-person, subjective experience central to answering questions about the body and its relationship to objects and the environment, while others concentrate on empirical and quantitative results of experiments studying how the body and brain respond to stimulus and receive information. I will continue the methodological argument in chapter 4, but firstly, I will explain the associations to assist in creating a framework for discussing definitions and contextual information.

The rationale for this chapter is two-fold; to both clarify and provide further information relating to the research questions. This approach attempts to introduce particular elements prior to discussing the project findings, providing the reader with a secure foundation for the interdisciplinary topic within. The figure above is not merely an interdisciplinary can of worms but illustrates how different fields/disciplines are connected through a desire to understand how a moving body makes choices. As the research investigates the role of the prototype in the formation of creative movement, it also encompasses areas including the choreographer's intention, cognition, and the

involvement of sensation and bodily awareness with touch. As a result, this chapter explores embodied cognition and ‘thinking through movement’, moving onto a discussion of phenomenological inquiry and the nature of how we come to respond to stimuli (consciously or unconsciously) and communicate these experiences. Inevitably, the use of a body-worn device presents questions about the boundary of the body or the binaries - outside and inside – and subsequently the discussion will cover the use of touch in somatic practices. More importantly, participant experiences do not occur in isolation and therefore, I include a discussion of social and mediated touch.

2.1 Dance Making

This research’s inductive approach necessitated a wide parameter for considering the various stages of the creative organisation of movement. It also encompassed the diverse ways participants might use the prototypes, amalgamating body-worn technology into their usual frames and strategies for creating movement.

Consequently, I have employed the term ‘dance making’ for describing the process of generating movement with creative intention.

As Jo Butterworth and Liesbeth Wildschut explain in their edited book ‘Contemporary Choreography’, "Choreography is the making of dance" (*ibid*, 2009, p. 1). However, choreography in its broader context occurs in a range of settings as live events through to different forms of media and is situated in a range of environments - community, site-specific, and theatrical. It is beyond the remit of this work to add to the philosophical discussion surrounding what constitutes dance, however, in what follows, I will briefly outline the expanding definitions of choreography before I explain why the term ‘dance making’ has been selected in this research.

The parameters defining choreographed movement have evolved and continue to broaden. When asked to contemplate choreography, most would visualise the codified steps of ballet or ballroom dance, or at least the authoritative figure of the choreographer didactically communicating which dance movements the dancers should perform. While these practices still exist within a choreographic environment, the creation of movement is instead often produced through the shared collaboration

of multiple parties, and unrestricted to human bodies alone. Over the last 20 years, the concept of choreography has developed beyond the body, particularly regarding 'choreographic objects'². William Forsythe's essay called for a development of what one might term choreographic thought, calling for the consideration of movement beyond bodies towards such abstract concepts as movement, space, and qualities. Due to this research focusing on what the body and technology can yield together, the dancer's/choreographer's body very much remains a concern and therefore, the framework of the workshops concentrates on the human form working with the prototypes.

Ordinarily, when choreographers work towards a final artistic product there are many more people involved than one individual, and consequently, concept formulation in the subsequent artistic output is as much to do with the creative response of the dancers, set and lighting designers, composers, and costume makers. Most Western theatrical dance pieces include a development period - usually within a dance studio or space - with movement generated, structured, and refined over several weeks to create the final product. Chapters 5 and 6 will discuss the workshops in more detail, but, significantly, the workshops in both projects are condensed studio sessions and therefore, are simplified scenarios with only one or two dancer/choreographer participants. These workshops are more aligned to the concept of the 'Choreographic Lab' articulated by Bacon and Middelow throughout their work at the University of Northampton:

The processes explored have drawn on the imagination, the felt sense, the critical, the analytical and the physical, and have brought together theorizing and dancing, conflating the dancing body and theoretician's (traditionally a static writing) body. (Bacon and Middelow, 2010, p. 5)

² William Forsythe is an American-born choreographer who works across the genres of contemporary dance and ballet. He has been responsible for many innovations of dance and technology, including his essay and work on 'choreographic objects' which refers to objects that communicate spatial-temporal organisation and can assist in the knowledge of movement and actions.

In the case of this research, the participants are both simultaneously creating and performing on/with their own body and so to acknowledge this dual process, each will be referred to as a 'choreographer/dancer'. All participants in Projects 1 and 2 possess experience choreographing and co-creating; both having made their own dance pieces and/or having worked as dancers for choreographers and having been involved in generating movement based on set tasks/prompts under a choreographer's direction/facilitation.

While chapter 4 will further explain the contents of the projects and workshops during its outline of the methodology, I will here clarify certain words about the dance making process to ease the burden of explanatory footnotes. Likewise, the methodology chapter will include a discussion around subjective experience and the ephemerality of dance, but at this juncture, it is important to note that the research parameters are limited to 'dance as an art form' and ultimately, the dance making process as an artistic creation. This does not deny social, cultural, and political influence on artistic production, nor on the movement generated during the workshops forming this PhD research. But as my interest lies at the intersection of moving bodies and technologically-assisted creativity, its focus falls on the creative process in the dance studio. Ravn (2017) argues that all manner of factors may influence choreographers, but as artists, they also challenge the existence of societal constructs:

Dance, bodies and spaces are in that sense loaded with meaning before the dancers even begin thinking about dancing in the studio, on the stage or at the sites. However, it would be a mistake to think of the dancers' practices and their ways of unfolding their bodied potentials in performance only as a matter of displaying the outcome of a specialised socialisation and culturalisation of their bodied potentials... the artistic domain of dance is also characterised by the practitioners' ability to challenge, break and confront habitual ways of conceiving themselves, sensing and being with others and the environment. (Ravn, 2017, pp. 61-62)

Across Projects 1 and 2, participants experienced varying durations of time with the prototypes, in general the data collection was greater during the improvisation stages.

Due to the significance of improvisation within this research, I will discuss this term below. Additionally, when participants continued with structuring work, they produced a short 'phrase', or a sequence of movement, which American choreographer Doris Humphrey (1895-1958) explains as "...[having] a recognizable shape, with a beginning and an end..." (Humphrey, 1991, p. 68). The projects and manner with which participants used the prototypes were primarily concerned with the *process* of generating movement, and subsequently, the term 'dance making' situates this practice rather than choreography as a wider concept.

2.2 Improvisation

Dance improvisation is widely practised in many folk, popular, and theatrical dance forms, and within performance settings. It is also used to explore movement around a specific theme/idea/reference point in choreographic practice.

Dance improvisation fuses creation with execution. The dancer simultaneously originates and performs movement without preplanning. It is thus creative movement of the moment... allowing spontaneous and simultaneous exploring, creating and performing. (Blom and Chaplin, 1988, p. 6)

Of significance to this research is that the improvising dancer/choreographer is simultaneously gathering multisensory information from their bodies, space, and immediate environment, either making creative decisions in the moment or just before enacting them. Deborah Hay's explanation supports this, referring to this experience as "practice consciousness", explained as:

...moving freely while paying attention to the immediate visceral sensations created, fostering a direct relation between those internal sensations noted and their external realisation. (Hay in Sweeny, 2009, p. 43)

Similarly, choreographer and scholar Kent De Spain promotes utilising improvisation to further explore the connection between sensation and movement.

One such skill is a heightened sensitivity to what is happening during the improvisation, a layered, synchronic process of embodied cognition that I refer to as 'improvisational awareness'. To be able to assess the components of the moment, to form and filter the connections between myself and my surroundings, to investigate what I refer to as 'the landscape of the now', helps to slow the clock down and allows me to find a modicum of calm in the midst of what can feel like chaos. With this skill, improvisation can become more than just a real-time creative engine; it can also be a tool for investigating the complex and intimate relationship between being and making, between sensation and action. (De Spain, 2011, p. 26)

According to the practitioners' experiences presented here, there are obvious links between improvisation, thinking through moving, and the sensation-action relationship. Despite the temptation to further explain this at this moment, I must first clarify the means through which we gain bodily information.

2.3 Somatosensory feedback and the body

At the forefront of this research question is somatosense, whereby the somatosensory system uses information from across the body so that we can define it as:

...a component of the nervous system that detects and allows for the perception of the modalities (sense) of pain, temperature, head and body position (called proprioception), head and body movement (called kinesthesia), and touch. (Jacobs, 2011, p. 171)

Somatosense is the way our bodies use signals from receptors and sends these to the brain. Researchers consider this afferent system to be primarily influenced by skin receptors and to a lesser extent, muscles, organs, and tendons. 'Somatosensation' relates to the sensation created, for example, by a tickle or a pinch, while 'somatoperception' "refers to using somatosensory inputs to perceive specific objects — in the case of touch, the acknowledged interoceptive/exteroceptive duality of touch

(Katz, 1925/1989), which means that the content of somatoperception is both a stimulus object and the body itself". (Cheng and Haggard, 2017, p. 56)

This body of work appreciates that the senses work together; however, as the prototypes are designed to produce digital touch, I will provide a brief overview of touch-associated technology. I will also discuss further research concerning vibration to give context to the prototypes used in project 1. Eric Gunther makes the case for digital touch as part of immersive aesthetic experiences, presented within his PhD research 'Tactile composition' (Gunther, 2001, p. 10). This looks at a combination of auditory and vibratory tactile examples, effectively comparing the compositional qualities of both - separately and collectively. He distinguishes between "the exteroceptive sensations [which] are initiated by the tactile stimulation device while the interoceptive and proprioceptive sensations originate from within the body, the proprioceptive sensations in particular based on the position of the body" (Gunther, 2001, p.67). However, more recent research suggests that the brain processes this information as "an interaction between mechanisms underlying the perception of our body in relation to space, sensibility to internal signals, and awareness of our inner state" (Valenzuela-Moguillansky *et al.*, 2017, p. 11) and so, when investigating tactile stimulation, it must also be perceived in tandem with a participant's awareness of their body.

From a medical perspective, research has proven that the somatosensory feedback of vibration and noise registered through insoles worn on the feet can improve balance in elderly participants (Priplata, *et al.*, 2003). Consequently, we can link such somatosensory information from the stimuli to greater attention and awareness of the body and its interaction with the floor and in space. The purpose or aim of this study was to look at fall prevention, and so, therefore, how wearable (vibrotactile) technology develops kinaesthetic awareness does not explicitly fall under the study's remit. However, the directional aspect of vibration-induced postural shifts could suggest that cutaneous information from the stimulated areas contribute to proprioception and upper body spatial representation.

The work of Collins *et al.* demonstrates that vibration and manual stretching of the skin could induce imagined movement and provide evidence to suggest that the skin has a vital role in kinaesthesia: “cutaneous feedback provides accurate perceptual information about joint position and movement and this is integrated with feedback from muscle spindles to provide judgements of position and movement for joints throughout the body” (Collins, *et al.*, 2005, p. 1706). In this area of research, it is useful to align somatosense with proprioception/kinaesthesia, but we need to view this concurrently with how one attends to internal sensations. It is less clear what effect vibration has on the skin beyond postural stability. Therefore, we must reconsider what is defined as kinaesthesia, and by extension, address the somatosense before looking at its impact on movement choice.

2.4 Kinaesthetic Awareness

Termed by Henry Bastian in 1887, kinaesthesia is comprised of the two Greek words ‘kinein’ (move) and ‘aisthesis’ (sense-perception).

...under it are included, as its several components, cutaneous impressions, impressions from muscles and other deep textures of the limbs (such as fasciae, tendons, and articular surfaces) all of which yield conscious impressions of various degrees of definiteness; whilst, in addition, there seems to be a highly important set of unfelt... impressions which guide the volitional activity of the brain... and which serve to bring it into relation with the different degrees of contraction of all muscles that may be called into action. (Bastian, 1887, p. 5)

Bastian was not alone in considering the body this way, crediting other academics and their descriptions discussing the body's sense of moving, including "muscle sense" (Bell, 1826 quoted in Bastian, 1887, p. 9) and the recognition of weight through tactile and muscular tension (Weber, 1831 cited in Bastian, 1887, p. 10). As discussed in the introduction, kinaesthesia and proprioception are often used interchangeably, however, some fields consider these two terms to refer to distinct aspects. Proprioception has been associated with the sense of joint position and kinaesthesia

with the conscious awareness of the movement of the joints (Han *et al.*, 2016, p. 81). As a term, Sherrington (1906) initially promoted proprioception as incorporating both with the additional understanding of the whole body and limb position in space.

In this thesis, I will use kinaesthetic awareness to refer to the sense of the body and awareness of its movements. Within dance, academics also use kinaesthetic awareness to describe greater perception through several methods when articulating the moving sense. Farnell and Wood (2017) consider it to include:

... feedback as to the dynamic qualities of one's actions. This allows skilled dancers to calibrate such elements as the speed of their movements, precise timing, fluctuations in muscle tension, energy flow and the size of actions – the degree of extension (stretch) of limbs and so forth. This can be supplemented by a simultaneously inward corporeal awareness of other bodily sensations such as blood flow, balance and even digestive processes, awareness of which varies from dancer to dancer. (Farnell and Wood, 2017, p. 74)

While it may make sense to separate the elements of somatosense from a biological perspective, this thesis instead incorporates the evidence that they work collectively and will follow a holistic understanding of the sense of the body through movement and touch contact. Logically, holding an in-depth discussion on kinaesthesia requires consideration as to the perception of the subjective experience of movement within phenomenology.

Edmund Husserl's work provides a systematic analysis of how sight, movement, and perception work together. He uses the term "kinesthetic fields" (Husserl, 1907) to discuss the possibilities of movement with the environment and objects. Parviainen succinctly summarises Husserl's work, as follows:

Husserl suggests that the kinaesthetic system should be analysed as a whole, as 'kinaesthetic fields'. Motion appears to us simultaneously in inter and outer space. Within our capabilities of moving and understanding movement, we are

an inherent part of the moving world, moving and being moved. (Husserl, 1907 quoted in Parviainen, 2010, p. 319)

The valuable descriptions and discovery of conscious movement in Husserl's work highlight a relational and ongoing process, but his preoccupation with sight does not fully acknowledge the internal aspects of sense and perception. By comparison, the work of philosopher Maxine Sheets-Johnstone foregrounds kinaesthesia and body dynamics, possessing the influence of Husserl, Gibson's work on affordance (Gibson, 1986) in environmental psychology, and Luria's "kinetic melodies" (Luria, 1973, p. 176)³. Her scholarship develops important themes concerning the continuity of feedback produced by our individual movements, whereby only a disturbance caused by injury or learning a new skill creates an experience of greater awareness.

Kinesthetic consciousness is integral to wakeful world-consciousness, a consciousness "in constant motion." Its gradient awareness is, in fact, foundational to animation, that is, to the lives of animate forms. Two integral and interrelated aspects of this foundational awareness are of particular significance: habit and individual style. (Sheets Johnstone, 2006, p. 373)

Sheets-Johnstone promotes a *spectrum* of awareness; however, she believes that sensation of pressure, pain, and heat provide little more than a disruption to the everyday flow of the movement dynamics of an individual, and as such, their distinct puncture of points of space and time do not reflect the qualitative feel of conscious movement (*ibid*, 2011b, p.461). Sheets-Johnstone leaves unexplored the complexity of touch sensation *in conjunction with bodily movement*, including, for example, the impact of patterns of touch on the qualitative dynamics of the body. Later in this chapter, in the subsection on touch, I will discuss how tactile sensation influences the gradient awareness of the moving body and further thoughts as to how touch relates to kinaesthetic awareness.

³ Luria subscribed to the view that "with the development of motor skills the individual impulses are synthesized and combined into *integral kinaesthetic structures or kinetic melodies*". (Luria, 1973, p. 176)

Returning to the concept of kinaesthetic awareness in dance, there has been recognition of the importance of kinaesthesia within contemporary dance practice, with Shantel Ehrenberg specifically naming this as the “kinesthetic mode of attention” (*ibid*, 2015, p. 44):

the term... refers to a mode of intentional consciousness while dancing, which includes a number of elements, such as listening to the body’s movements, problem solving with the body, a curiosity about bodily feelings in conversation with different choreographic and performative contexts, and various types of embodied translation processes, such as a dancer translating verbal descriptions, which are heard from a choreographer, into kinesthetic sensations in the dancer’s attempts to match what the choreographer describes. (Ehrenberg, 2015, p. 44)

This description has similarities to that of Rouhiainen’s “somatic state of being” (*ibid*, 2003, p. 321), and highlights the parallels of both authors research, whereby both studied a group of dancers - and their practices - with both revealing use of kinaesthetic intelligence tied to movement and sensory feedback.

The basic premise is that this heightened kinesthetic perception is continually moving at the core of contemporary dancers’ experiential dancing knowledge. To be clear, this is not sensing in a solely passive way, but moving through this sensing... (Ehrenberg, 2015, p. 48)

Similarly, Ravn utilises the dancers’ perspective, highlighting their use of sensorial awareness in the formation of body image, albeit in a “body as a process” (*ibid*, 2017, p. 76) manner. Therefore, kinaesthetic awareness is used to survey and draw information about the body internally and externally in real-time, brought about through movement. Despite the similarities of first-person expositions, it remains unclear how conscious thought is involved in the process of kinaesthetic awareness.

Further thoughts on kinaesthesia - and by default kinaesthetic awareness - are foundational to the research of Stuart and her term “enkinaesthesia” (*ibid*, 2009):

We are deeply and naturally kinaesthetic and enkinaesthetic, aware of our bodily movement and our action in the world, but also able to affect others and be affected by them, moving and being moved [Bråten, 2007] within a reciprocal affective neuro-muscular dynamical temporal flow. The way in which these felt somatosensory relations fold and unfold — by bringing forth our world through our kinaesthetic imagination and associated somatosensory expectations — together influences how we will shape and adapt our world, how we will then adapt to those changes, and so on. (Stuart, 2009, pp. 179-180)

Stuart perceives intersubjectivity as meaning formed and communicated by agents through the moving and feeling body, whereby the dynamics between the environment and the bodies become as important as the sense of body in movement. It is logical to assume that if we process this information, albeit in a pre-reflective manner, then those processes might include the influence of others - both human and non-human - and of course vice versa.

Debates about the notion of kinaesthesia and its historical reception provide insight into its present use. Hanna Järvinen's work offers the connection between motivations for body health/ awareness and its potential as a cure for the perceived ill effects of modernisation (Järvinen, 2006, p. 73). These links between kinaesthesia and a return to 'natural movement' arose in parallel to concerns relating to industrialisation and automation. Considering present-day fears surrounding more sedentary lifestyles caused by the keyboard and screen interfaces, we must examine whether this argument remains relevant in the digital age. For this purpose, the following section includes an introduction to the body and related theory, and by extension, somatic practices for understanding its place and influence on embodiment, touch, and HCI.

2.5 The body

Clarifying the concept of the body applied in this thesis will assist in discussing wearable technology use in the projects and provide a context in relation to theories of

the body. This section will explore approaches, followed by a justification for merging different fields of thought. The work of Marcel Mauss and his theory of "Techniques of the Body" (Mauss, 2007), where the body acquires habitual movement through combined physiological, psychological, and sociological influences can explain society's influence on the physical shaping of the body through dance techniques. Equally, Michel Foucault's 'disciplined body' (Foucault, 1995), as a construct through the embodiment of social acts dictated by hierarchical structures, could reveal movement preferences. However, the pre-determined and homogenous actions outlined within these theories fail to accept different levels of engagement; and negate the individual's agency. Gail Weiss argues that "...too strong an emphasis on the social construction of our body images runs the danger of disembodiment by presenting them as merely the discursive effects of historical power relationships" (Weiss, 1999, p. 2). Pierre Bourdieu addressed this issue and acknowledged the individual agent through the concepts of "habitus and field" (Bourdieu, 1993, p. 4), that act as influences and connectors from an individual level to socio-economic and political realms. Undoubtedly, Bourdieu's theory respects the complexities of individuals within society but still renders the body somewhat passive in this construction.

For this reason, this thesis draws upon elements from Merleau-Ponty's phenomenological perspective on perception and movement of the body. Merleau-Ponty refused to view the distinctions between the mind and the body; instead, he conceived the physiological and the cognitive domains as combined in a manner called bodily knowledge gained through 'body schema' (Merleau-Ponty, 1945). Via an active means to perceive, Merleau-Ponty's emphasis on the subjective experience enables the individual to have a voice within the research. Despite the usefulness of concepts such as 'tool assimilation' within phenomenology, the active interaction with the environment and objects which Gibson outlines in his discussion of affordances (Gibson, 1986, p. 119) provides a broader consideration of the body and its co-evolving relationship with artefacts and body worn items.

With a focus specifically on the dancing body, Legrand (2007) suggests that professional dancers can experience their body pre-reflectively and distinguish between different states of self-consciousness during dancing.

...a body can be (1) an “opaque body” taken as an intentional object of observational consciousness, (2) a “performative body” pre-reflectively experienced as a subject/agent, (3) a “transparent body” pre-reflectively experienced as the bodily mode of givenness of objects in the external world, or (4) an “invisible body” absent from experience. It is proposed that pre-reflective bodily experiences rely on sensori-motor integrative mechanisms that process information on the external world in a self-relative way. (*ibid*, 2007, p. 493)

The ‘opaque body’ occurs when we learn a new movement, needing greater attention toward the body and movement control. When the skill/movement has been fully integrated and no longer requires such focus, this then becomes the ‘performative body’. However, the issue here is ‘presence’ in that the movement becomes automatic, but there remains an experience of the moment of execution and communication of intention by the dancer. The final category pertains to a lack of awareness of the body as an object, with attention to the world presented through coming into contact with external stimuli. Legrand suggests that dancers can use both the pre-reflective experiences of the ‘performative’ and ‘transparent’ body so that, consequently, there is no need to be reflective to account for the stimuli felt externally and internally in the moment of movement. Legrand's thoughts provide insights into the phenomenological inquiry of dancers in movement and provide questions about states of being while making dance.

This thesis considers the body in motion promoted by phenomenology (Merleau Ponty, 1945; Legrand, 2007) combined with enactive view of embodied cognition (Gallagher, 2017) and subsequently sees the body as utilising affordances as described by Gibson (1986). As a result, the body in discussion is available and thinking through these exchanges with the objects and environment. However, this research appreciates that socio-cultural and political dimensions, which also at different levels,

shape behaviour, thoughts and practices and therefore view the body as evolving through these multiple means and factors.

2.6 Somatic practices and use of touch

Somatic practices and Somatic Movement Education and Therapy are names related to a group of techniques or body practices that concentrate on developing deeper connections with the moving body. This umbrella term includes - but is not exclusive to – the Alexander Technique, Feldenkrais Technique, Bartenieff Fundamentals, and Rolfing. The founders of somatic education discovered that re-educating the body, and subsequently moving with greater ease and efficiency, allowed for pain-free movement and recovery from injury. Its influence on contemporary dance has been far-reaching, but of major interest to dancers is its encouragement of first-person dialogue between the internal and external body; “somatic intelligence constitutes a model of corporeal experience: a form of embodied knowledge that can also be described as a skill for sensing, relating and ‘revealing’” (Davidson, 2013, p. 6). Verbal guidance, movement exercises, and touch - facilitated by practitioners and teachers – generates this embodied knowledge and enables an integrated connection with the body.

The goal of the somatic movement professional is to heighten both sensory and motor awareness to facilitate a student-client's own self-organization, self-healing, or self-knowing. Movement includes the subtler movements of the breath, the voice, the face, and the postural muscles, as well as any large movement task, event, or expression. Somatic lessons often use touch to amplify sensory experience through the skin, the body's largest organ, and therefore more quickly awaken awareness. Touch is a primary tool, however, it is only a tool and is not always used in every somatic movement session or class. (Eddy, 2009, p. 8)

Bartenieff Fundamentals⁴ is an example of using touch to produce greater awareness of movement. Touch assists the practitioner/client in movement initiation (where movement originates from in the body) and in understanding the connection of its distinct parts in movement. It explores energy and the flow both within the body and within the space, so that “if a standing person feels that his energy is blocked from the knees downward, a light sliding touch down the lower legs may allow him to imagine and feel the flow of movement down his legs into the ground” (Hand, 2012, p. 120). Moreover, its use in this manner within dance and contact improvisation can assist partner-led movement exploration, using touch as an invitation to consider different body parts and initiate movement. Arguably, the external sensation of touch holds the potential to connect the body both within itself and with the external space.

Bonnie Bainbridge Cohen’s ‘Body Mind Centering’ draws attention to the different forms of information within the body and its developmental patterns. Her research on the sensory and perceptual-motor loop⁵ provides the means for further consideration of both touch sensation and action choice. The foundation of this includes assisting a person to direct their attention to sensory input to make decisions regarding what they respond to and how. This is significant as it suggests that specific focus can influence choice beyond habitual movement. However, she discourages the continued use of introspection, suggesting that it slows the process and ‘fluids’ – meaning the fluid system including the circulatory, lymphatic, and cerebral-spinal fluids (*ibid*, 1995, p. 267). She submits that with practice, faster and less conscious movement becomes a more efficient method of moving.

One of the things that I think is essential with sensing, is that we reach a point where we become conscious and then we let it go, so that sensing itself is not a motivation; that our motivation is action, *based on* perception. (Bainbridge Cohen, 1995, p. 186)

⁴ Bartenieff Fundamentals are a form of somatic practice created in the USA by Imgard Bartenieff. Bartenieff’s method is based on the concept of connectivity of the whole body.

⁵ “Sensory input- Perceptual interpretation- Motor planning- Motor response- Sensory feedback- Perceptual interpretation”. (Bainbridge Cohen, 1995, p. 196)

What we can gather is while one's perception of action is useful, slowing down can also prove counterproductive if used excessively. Other practitioners in somatic work deliberate on the differences between *touch* and *contact*; Gerda Alexander and her work 'Eutony' consider the former term to refer to the external layers of skin, with the latter representing deeper sensation. In her own words, Alexander considers touch as enabling "neutrality... you give the other organism the possibility to liberate his contractions in his inner space and open up his own radiation zone" (Alexander quoted in Bersin, 1995, p. 265). Describing contact, she expresses how this has the potential to "attack and stimulate" (*ibid*, 1995, p. 265), being dependent on the manner and the balance of the person initiating it, therefore, creating tension or energy and awareness in the body.

Similarly, Deane Juhan believes skin contact with both itself and the direct environment produces the information for forming the ongoing integration of the body image/body schema (Juhan, 1995, p. 363):

...the large variety of tactile sensations - are the foundations to self-awareness. Whenever I contact an object, two streams of information are opened up: one that gives me impressions about the objects, and another that gives me impressions about the body part that is doing the contacting and its relationship to the rest of me. Likewise, whenever I make a movement, I also initiate a double stream of sensory impression: one that registers the shape of the movement as a whole, and another that registers the size, shape, and specific qualities of all the body parts that are rubbed and pressed and distorted against one another in the course of the movement. (*ibid*, 1995, p. 375)

Despite the different approaches and means for exploring awareness of the body, we should recognise the possibility of touch to awaken the body through external stimuli on the skin. It is thereby assumed that a person might be unaware because of the habitual ways of moving their body. Speculation has been made regarding the influence of somatic practice on dance and the teaching of dance techniques (Fortin,

Long, and Lord, 2002) and this research acknowledges how those participating in the projects may utilise touch - digital or otherwise. However, human touch is complex, and the field of haptics has expended copious resources and time attempting to replicate the multitude of touch sensations. For this reason, the following subsections will cover social and mediated touch.

2.7 Touch

...the relationship between the skin and the flesh can be intuitively grasped as a folding, the implication of cutaneous sensation (through skin) and interoception (through flesh). In everyday experience we rarely differentiate between skin and flesh, since - as Aristotle suggested - our embodied experience of touch occurs through the medium of flesh. As either precise cutaneous sensations on the skin surface, or less distinct sensations of contact and manipulation arising from muscular pressure and proprioception for example, tactility arises from a combination of these. (Paterson, 2007, p. 113)

Mark Paterson's background in philosophy and human geography provides a unique perspective and constructive framework compared alongside Sheet-Johnstone's thoughts on sensation. As Paterson emphasises, there is a difference between pure sensation and tactility, with humans recognising continuity here explained through the example of hearing a melody rather than the discrete notes lying within it. Rather than only being distinct and abrupt points, sensations can be a collage of experience. Paterson continues to state how emotions, affect, and symbolisation are involved in the reception of touch (Paterson, 2007, p. 3).

Social touch has an important communicative role, with a handshake or a hug expressing something unique through the tactile and kinaesthetic senses. Research suggests affective touch can be responsible for promoting health and wellbeing, bonding, and behavioural change (Huisman, 2018, pp. 3-4). Despite this, we require further research to understand the type of touch and the neural connections between different skin receptors, providing evidence for how and what type of contact is received by the brain and its impact. Studies by Hertenstein *et al.* (2006) indicate that

we can recognise selected emotions through touch. Experiments in the USA and Spain looked at certain areas of the arm to remove contextual bias and emotion identification across different cultural settings. Of relevance to this research are the remarkably similar responses to the human form of touch and the digitally-created 'mediated' form discussed in Huisman and Frederik's experiments (2013).

The programming of digital touch technologies raises questions about interaction and how participatory objects can generate touch sensation. For example, some digital clothing or devices vibrate to provide the wearer with physical feedback in specific contexts. "Responsive objects" are an element of Cranny-Francis's work on technology and touch (2013), in which she suggests that meanings are "potentially activated when we touch [objects or others], although the nature of the particular interaction determines which meanings are deployed and to what ends" (*ibid*, 2013, p.465). She further elaborates the point, "by exploring those meanings we are able to map the potentials that are available in every tactile encounter and how they might be mobilized to create the most effective and/or rich interaction" (*ibid*, 2013, p.465). This connects with Carey Jewitt's argument, whereby "the object itself is not seen as agentive, but rather full of meaning potentials that can be activated via interaction" (Jewitt, 2017, p. 112). Recently, Jewitt and her colleagues at the University College London developed a project specifically considering digital touch (Jewitt *et al.*, 2020), more generally referring to the socio-cultural element of touch through digital means:

...we use the term 'digital touch' to emphasize our attention to the social orientation of touch and to refer to the digital-mediation of touch by a broad range of technologies, beyond the hand. We prefer 'digital touch' rather than 'haptic' which references a technological or physiological orientation and are strongly linked to the hand via its etymological roots 'grasping'. Digital touch communication can be co-located or remote, and might involve human-object, human-human, human to robot or robot to human touch. (Jewitt *et al.*, 2020, p. 24)

Within digital touch literature, there is an existing tension between the physicality of the touch and subjective experience and the socio-cultural theories explaining the

wider perspective. Laura Marks eloquently explains how the process of digital touch can bring about a change on the micro-level:

In a haptic relationship our self rushes up to the surface to interact with another surface. When this happens there is a concomitant loss of depth— we become amoeba like, lacking a center, changing as the surface to which we cling changes. We cannot help but be changed in the process of interacting. (Marks, 2001, p. xvi)

This explanation provides a visual image of an ongoing, mutually influenced process, serving a useful reminder of the interaction's physicality even in what appears as passive touch. Furthermore, this stance recognises the socio-cultural factors shaping a dancers'/choreographers' response to the prototypes and the sensation produced through the skin. However, in this body of work, the focus will inevitably fall on the micro - what is felt and experienced and subsequently, how this relates to what is recorded and observed. This considers the perceptions of the participants in terms of their relation to each other and the wider world through the trends and themes compiled. How participants use and interpret emotion through the making of dance is of paramount importance, but equally, so is the abstract interpretation of patterns and sensations and openness as to *how* the prototypes may be used creatively.

2.8 Body Worn Technology/Wearable Technology and Haptics

In the 1990s, the Massachusetts Institute of Technology (Cambridge, USA) fostered new developments as to how people could wear personal computers and use new interfaces (Rhodes, 2016). Its subsequent research would pave the way over the following two decades for later commercial products such as *Google Glass* (2013) and *Apple Watches* (2015). The 'bodily turn' in cultural studies, sociology, and phenomenology in philosophy undoubtedly influenced the innovation of technology, an example of which can be seen in Paul Dourish's book 'Where the Action Is: Foundations of Embodied Interaction' (2001) which promoted the moving body as the starting point of interaction design. As a result, designers and engineers began engaging with the concept of embodiment, looking to areas like phenomenology to

record the type and quality of movement, or to assist in moving between first, second, and third-person perspectives in data capture and documentation (Schiphorst, 2007 cited in Alaoui *et al.*, 2015). It is notable that military and healthcare research powered much commercial development of wearable technology, with new materials, sensors, and computers designed to monitor individuals and administer drugs. Innovation in these industries and sectors continues to be vitally influential, but while it is beyond the remit of this work to produce a historical chapter on wearable technology, it is significant that the rise of personal computing coincided with new ways for considering the moving body and cognitive processes.

This research does not seek to emulate realistic versions of touch through digital means but instead seeks to explore how digital touch might be used as a stimulus for movement creation, and so accordingly, the discussion of literature and practice will not delve too deeply into the field of haptics. However, it is contextually useful to comprehend the development of the field of haptics and its implicated factors. David Parisi's examination of mediated touch posits multiple factors in its evolution, including the commercial development of technology (both cost and manufacturing requirements), the codification of hand and finger touch and its influence on further development, and the limiting of possible types of touch due to consumer tastes (Parisi, 2018, p. 261). This context is beneficial to the reflective process within this research, with Parisi's discussion of how external influences and designer biases are reflected in the design, prototyping, and development of technology useful for identifying similarities in the eventual prototypes produced.

2.9 Assimilation of tools for creativity

The relationship and ease of assimilation to the tool is fundamental to how it works with the body, but questions about the latter's boundaries and how we receive and process this information - and subsequently, interpret stimuli for creative output - is a complex matter. Despite the difficulty of investigating what is an ephemeral art form, the work of philosophers and neuroscientists on thought process, and by extension, the creative thought process, could provide a means for considering the experiences and products of working with body-worn technology.

Maurice Merleau Ponty's 'Phenomenology of Perception' (1962) and Martin Heidegger's theories from 'Being and Time' (1927) both discuss the assimilation of tools or artefacts into corporality by essentially becoming part of the body and explaining how the body adapts to material objects in use. To quote Merleau Ponty:

Once the stick has become a familiar instrument, the world of feelable things recedes and now begins, not at the outer skin of the hand, but at the end of the stick... The pressures on the hand and the stick are no longer given; the stick is no longer an object perceived by the blind man, but an instrument with which he perceives. It is a bodily auxiliary, an extension of the bodily synthesis.

(Merleau-Ponty, 1962, p. 152)

With the use of wearable technology, we must address several considerations: firstly, the interactive processes between the technology and the user, and secondly, prolonged exposure and the developed use of working with a tool. As a result, it is logical to consider phenomenological discussions of tool assimilation alongside that of interaction design. Larsen *et al.* (2006) discuss how future designers should approach the process accordingly: "To design technology interactions that address the feel dimension, as well as the other human senses, we suggest that technology designers consider how their design might impact on the body- thing dialogue, potential for action, within –reach, out-of-reach and movement expression, as well as thinking in terms of ease of use" (Larsen *et al.*, 2006, p. 331). Emphasised within these considerations is the fact that beyond familiarisation or skilful tool use, there lies a complexity of issues including material sensation, environment, bodily potential, and cognition.

Although previously described as the amalgamation of object and body, Gallese's (2020) more recent work views tool use and assimilation as a means of extending thinking processes:

The performative character of the body and the reuse of its underpinning neural mechanisms constitute the backbone of the evolution of human

cognitive technologies. Indeed, the performative character of the body enables the 'discovery' that the world affords the extension and externalization of cognition... (Gallese, 2020, p. 12)

To further comprehend how this extension of thinking may occur, the following subsection will introduce and discuss the term 'embodied cognition'.

2.10 Embodied Cognition

The focus of this research is digital touch stimuli and its influence on creative response through movement, and so subsequently, it is worth considering that creative thinking emerges through environmental affordances in addition to the influence of an individual's physiological make-up and the social-cultural impact on the body. I did not select embodied cognition as part of the theoretical framework for investigating the area due to having adopted an inductive methodological approach, but its related literature has provided a valuable for discussing the findings produced by coding and analysis. Specifically, this was relevant when participants' responses to creating with digital touch stimulus connected with attention, perception, sensation, and consciousness. Consequently, I will present a brief context of embodied cognition to assist the discussion of its literature and the findings in subsequent chapters.

Many scholars now consider the process of thinking to be embodied, with the constituents of this school of thought now termed the 4E's of cognition - Enacted, Embodied, Extended, and Embedded. Their main proponents and points are summarised below.

In the book 'Embodied Mind' (1991, 2017), Varela, Thompson, and Rosch present their theory opposing a tradition of cognitivism whereby the brain is solely responsible for all cognition. They propose an enactive means for combining the body, brain, and environment in thought and action, "...the neuronal network does not function as a one-way street from perception to action. Perception and action, sensorium and motorium, are linked together as successfully emergent and mutually selecting pattern" (Varela, Thompson, and Rosch, 2017, p. 163).

Shaun Gallagher (2017) further developed this conception of enactive cognition using a holistic approach envisaging the environment, brain, and body in a complex dynamic system. This approach supports the idea that we think through doing and can use the tools that the immediate space affords. Of particular significance to this work is his inclusion of intersubjectivity and the social-cultural factors influencing how we think and act. His argument dismisses higher-order cognitive function - imagination, reflection, memory - as purely cognitive, instead using abstraction and active pretence of imagination to continue accessing the 'thinking through the doing' of enaction. Even in our abstract thoughts and imaginative creations, we are considering the performance of our plans and their active possibilities (Gallagher, 2017, pp. 193-194). Nöe (2004), who subscribes to an enactive view of cognition including using the entire body in the process, expresses that "[f]or mere sensory stimulation to constitute perceptual experience... for it to have genuine world-presenting content – the perceiver must possess and make use of sensorimotor knowledge" (Nöe, 2004, p. 10). Conversely, Clark (2008) and Clark and Chalmers (1998) present a case for extended cognition, proposing that it expands beyond the boundaries of the body to artefacts and objects which change our thinking processes. Meanwhile, embedded cognition concerns the situatedness of cognition and the subsequent constraints on the physiological body and that afforded by the environment.

For the most part, dance scholars and academics who branch into movement and dance cognition have considered embodied cognition for explaining the way that dancers process information and create movement. David Kirsch, a professor of Cognitive Science, studied the choreographer Wayne McGregor and dancers from the dance company *Random*, exploring the elements of extended cognition when considering the body as a tool. His definition of embodied cognition suggests:

...the mechanisms by which creative subjects think non-propositionally, using parts of their own sensory systems as simulation systems, and in the case of dancers, using their own (and other's) bodies as active tools for physical sketching. (Kirsch, 2011, p. 1)

Subscribing to Kirsch's argument, Edward Warburton (2011) suggests the use of the term 'dance enaction' in place of 'embodiment'. Warburton's example of what occurs when a dancer marks ⁶ a 'turn' clearly analyses the methods of learning and rehearsing dance, but also how the brain and body work together in the thought process:

At the perceptuo-motor level, movement coordination requires continuous reciprocal influence between perceptual flow and motor commands; the dancer is undeniably situated in relationship to self (and instructor) and thinking "in real time." At the same time, the dancer is manipulating her environment, for instance using movement reductions such as a small hand gesture to indicate a turning movement on count eight, to exploit predictability in the task situation and automatize what was a formerly effortful process of skill acquisition. In short, she can use her implicit memory to prime in correct sequence a "turning" motor program by taking it off-line. (Warburton, 2011, p. 70)

Bresnahan considers Clark's extended cognition and argues that improvisation in live performance is evidence of agency. She explains this through the creation of body schema through training and experience, teamed with the ability to use this as the situation allows. This cultivation of *artistic body schema* enables dancers "...to engage in "online" agency, which is just the sort of on-one's-feet, thinking-while-doing" (Bresnahan, 2014, p. 92).

Despite the usefulness of embodied cognition for explaining how a body thinks through movement, in certain circumstances, a perspective remains that considers the body itself to be a 'tool'. By using this term, we may be limiting our understanding of the possibilities of the body conjoined with its external environment and by laying claim to this perspective of the dancing body we may perpetuate its objectification. It is not the purpose of this research to delve into the identity of the dancing body but instead to highlight a consideration of the language used, and a recognition that some

⁶ 'Marks' or 'marking' is the process of thinking through movement without performing the actions at full capacity. i.e., using a hand gesture or smaller movement to articulate the movement.

perspectives of the body may bring associative tensions to the debate of tool assimilation.

2.11 Summary

This research studies the dance making process, and in this context, this refers to the making of dance with wearable technology and the human body. The workshops are based on dance making in a Western theatrical dance setting, but also align to the 'Choreographic Lab' situation whereby practice creates meaning and new forms of knowledge. The participants in these projects hold dual roles of dancer and choreographer and will be asked to create movement based on digital touch stimuli. Throughout, improvisation featured heavily as a means for creating movement, defined in dance as the spontaneous creation and execution of movement, and in this circumstance used for its generation rather than for use in a performance setting.

This chapter purposefully outlined what is academically considered somatosense, explaining that the afferent system sends signals from receptors in the body to the brain, including information received from the skin, muscles, tendons, and organs. This information can encompass the senses of touch, proprioception, heat, and pain. Field related definitions of kinaesthesia differ, but this work includes proprioception under the umbrella of kinaesthesia/kinaesthetic awareness/kinaesthesia and therefore it is used relating to the sense of one's own body's position and movement. This is followed by an outline of the concept of the body used within this thesis.

In recognition of the influence of different somatic practices in dance, this chapter emphasised that one can gain a greater awareness of the body achieved through movement techniques, guided touch, and facilitated movement exploration. This information relates to later chapters in the thesis, as it highlights how dancers/choreographers may consider or be aware of their moving bodies, and already use internal- external body connections to make creative decisions in making dance.

Different forms of touch were found to elicit emotional responses with evidence suggesting that touch created through digital means could match that of human touch.

However, this body of work does not focus on emulating or reproducing the feeling of human touch through computers and so briefly outlines the development of haptics and the factors layering meaning to mediated touch. As this work involves wearable technology/body-worn technology, I offered a brief explanation of the advancement of this technology to explain the influence of its commercial development.

Although this work is reluctant to describe the prototypes as tools, there is of course an object attached to the body that can be utilised for a task. Therefore, I have presented the phenomenological argument for tool assimilation as pertains to the absorption of the object into the body schema, subsequently explained as an extension of the body. This chapter concludes with an outline of embodied cognition and proposes that the environment, body, and brain form parts of a dynamic system whereby thinking occurs through interactions with our bodies in the world.

3. Literature and Practice Review

Borne of the burgeoning creative potential of innovative technologies, the recent history of technological arts encompasses cyborg identities, prosthetics, and new ways to view and experience art. In this collective pool of interest, the pathways of music, fashion, design, theatre, and dance have often converged in the creation of artistic products. Despite my interest in how each area mutually influenced the other - at points following parallel lines of evolution – we must acknowledge the breadth of interdisciplinary research to carefully navigate it. For this reason and the sake of clarity, I have narrowed the presented subsections to those related to dance/movement and technology; specifically, the topic of kinaesthesia relating to dance technology and digital touch. However, the process of mapping practitioners and institutions has been integral to my research design, which I will further elaborate on in the following chapter.

To enable a contextual reference point, this chapter will include the emergence of digital dance and the primary texts discussing theories of technology concerning dance. This will include a brief historic overview including how practitioners have developed this area within dance studies. By providing a clearer picture of the emergence of choreography and dance work involving software and digital interaction, it will become apparent that wearable technology is a part of this history but underrepresented in the literature. By reviewing the debates concerning the influence of technology on performance and during the choreographic process, this chapter aims to outline previous claims and perspectives on creative practice with computers. Furthermore, this chapter situates this research within the existing literature on wearable technology used in dance performance and choreography, centring kinaesthesia and technology within dance and design interaction.

As the main purpose of most projects and artistic ventures is the creation of artefacts and products, most literature covers performance and the performers/audience interaction with technology. However, over the last ten years, there has been further research documenting this process, and subsequently, I have utilised a mixture of

sources and references in this section to illustrate how information is gathered and disseminated within technology development, projects, and labs.

3.1 The influence of technology on choreography and the performer

To begin with, I will detail the texts discussing the influence of technology on the choreographic process and its products. Chris Salter's compendium of digital performance emphasises the different "range of techniques (electro-mechanical, optical, acoustic, and computational) that have elicited radically different kinds of perceptual practices" (Salter, 2010, p. xvi), resulting in events that create a new means for audiences to experience space and time (*ibid*, 2010, p. xxii). Presenting case studies across different disciplines, the book provides a compelling case for the dramaturgical role of technology, describing its potential to change how the sensate experience is received or brought to the audiences' attention.

Offering a different historical perspective, Steve Dixon (2007) highlights the development of technology and the evolution of the tool/body relationship within interactive environments, from a starting point of crude communication to a more sophisticated manner: "The two can converse intelligently, "listening" and responding sensitively to one another, expressing themselves articulately and building a complex dialogue of ideas" (Dixon, 2007, p. 205). Refining technology and its use seems almost common sense, but Dixon's statement reminds us of the impact a performer's skill and technological understanding may have on the overall artistic product. He also raises, albeit subtly, the idea of co-creation, whereby the software sustains a role in bringing forth the artistic vision.

Maike Bleeker's introduction to the edited book 'Transmission in Motion' (2016) considers how technological involvement in movement/dance creation entwines with the act of perception, cognition, and making sense (Bleeker, 2016, Para 9.5) and therefore, we should assume the inclusion of these areas when considering choreographic practice with the assistance of technology.

Francisco Sagasti uses the term “computer choreography” to describe “the use of digital and analogic electronic means to assist in the creation and performance of dance” (Sagasti, 2019, p. 4). His extensive historical review details the development of computers from initially assisting choreographers in their practice to their wider use facilitated by motion capture, their interactive capabilities through sensor systems, algorithm use, and the use of AI and neural networks over the last 50 years. With precision, the article charts the influence of projects, conferences, and choreographers in the Western world while emphasising the polarity of opinion across the dance field - from technophobes to technophiles - and therefore, contextually reminding the reader of the divided attitudes to technology within dance practice.

Kent De Spain further considers the tensions provoked by technology use in dance through the framework of the philosopher Heidegger’s essay ‘The Question Concerning Technology’ (1954). Underscoring issues of bodily interaction and assimilation, he digests the possible reasons for these frictions, concluding that “we are tethered, so much so that we can no longer find the border between us. If we want to move, we must move forward together” (De Spain, 2012, p. 29).

Susan Broadhurst expands the debate on performer engagement and the adoption of tool use in the embodiment process. Here, the extension of the body through technological tools in performance inclines towards concepts of evolving body image and multiple identities (Broadhurst, 2006, pp. 148-149). Despite Broadhurst’s logical argument for adapted movements and possibly, the kinesphere, the question as to how this occurs and the complexity of this process remains unanswered. Blades and Whatley pick up this point, stressing that academics have yet to fully explore a representation of proprioception/kinaesthesia:

the dancer can tune into different senses, downplaying the visual sense by tapping into proprioception to sense the whole body in relation to others and the environment. Thus far, however, tracking proprioception remains largely elusive in digital dance projects that explore the convergence of human and machine knowledge. (Blades and Whatley, 2019, p. 28)

Consequently, a dancer's feeling of their own body moving in space and their subsequent recalibration of this sense with technology has, as yet remained vague, revealing the difficulty of tracking and comprehending this element of bodily experience.

There have been a few attempts to explain the body/technology interaction concerning wider influences, including research by the WholoDance Project. Cisneros *et al.*, (2019) consider VR and its use through Hahn and Jordan's theory of intercorporeality, whereby our interaction is extended with each other and via sensible objects:

'sensible objects' are particular things that extend the body/self to serve as a vehicle for expanded sensory means, to also enable a kind of informative sensory loop, and to creatively express one's self in that reality (e.g., through text, drawings, music, movement). (Hahn and Jordan, 2017 cited in Cisneros *et al.*, 2019, p. 20)

Using Hahn and Jordan's theory, they suggest that the experience of moving through the virtual body enables a loop of multisensory feedback. Consequently, the work promotes a concept of the expansion of the senses manifesting through the integration of these sensory objects.

Focusing on improvisation in technological composition, Sher Doruff (2009) utilises Deleuze's theories of the "fold" (Deleuze, 2006) to explain forces influencing the individual during a performance. Her suggestion of a biogram (see Figure 2.) references the dynamic relations of the "fold", pertaining to a continual process. The example given describes the playing of an electronic musical instrument, but the eloquently articulated porosity of this creative act struggles to be represented in the diagrammatic form, raising the question of how we can fully illustrate and discuss an ongoing activity potentially transcending physical boundaries to encompass layers of socio-cultural and political influence.

Waisvisz [electronic artist] drew the content of his expression from a vast database of soundings processed through software and wetware and the milieu that surrounded him. This quiet, intense drawing off, filtered through the whole of his body. He was resistor, capacitor, transistor, potentiometer, transducing outside and inside, content and expression. The outstretch of his arms, the porous membrane of his skin, the intermediary callous, the touch of fingertips on the small keypads, were of the biagrammatic, poetically, ardently, tangibly. (Doruff, 2009, p. 30)

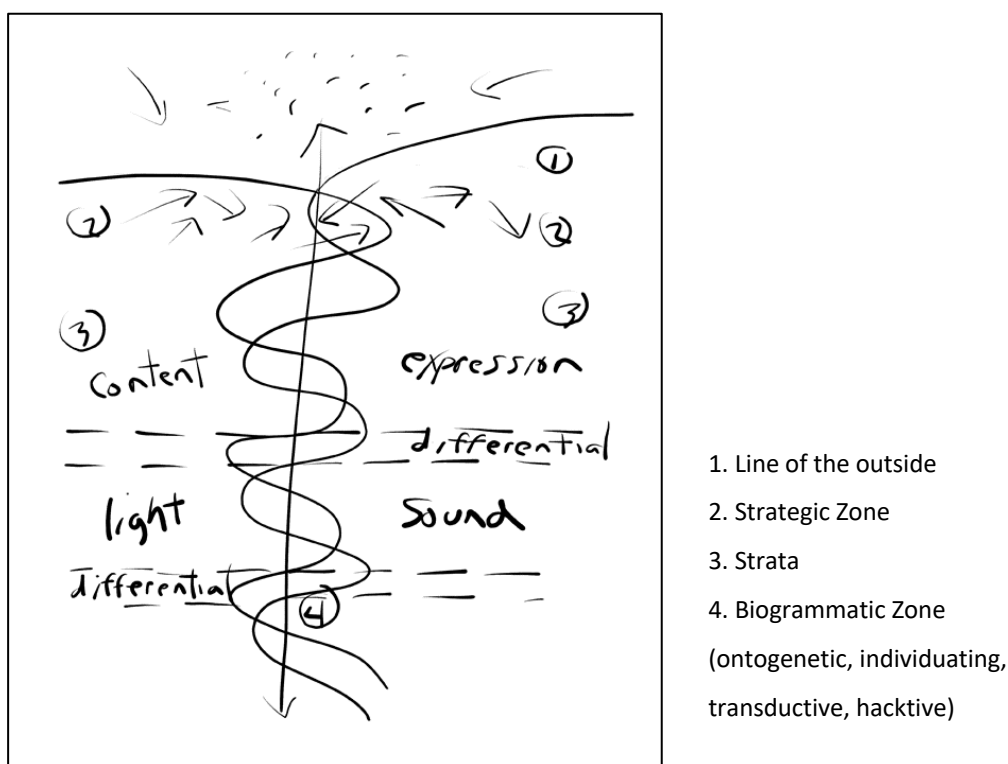


Figure 2. Diagram of the Biogram (Doruff, 2009)

Furthering the discussion of how technology, environment, and the performer inter-relate and its impact on movement is Birringer's work on the "post-choreographic" (Birringer, 2008; Birringer and Danjoux, 2009). Writing both alone and in his collaborative work with Danjoux, he questions the interactive interface of technology and scenography, arguing the necessity of a different performative approaches due to the multiple changing elements and added dimension of available data and feedback. This is suggestive of the body becoming part of the system, because "[t]hese [emergent] states evolve from the system behavior as a whole" (Birringer and Danjoux,

2009, p. 24). In more recent research, Birringer (2017) reconsiders the experience of interactive installations through AR technologies, terming these *metakinospheres*. Here, he identifies the different relationships possible from a philosophical perspective and through active reflection/experience of objects, movements, corporeality, and the kinetic atmosphere.

Thus far, the theory produced from historical reviews and critiques of projects/pieces identifies several points requiring deliberation. Firstly, we must discover how an extension of the senses manifests through technological tools or objects. Secondly, we must examine how layers of influence are represented in an ongoing process and how this is communicated or interpreted, particularly when the technology functions as a co-creator. Thirdly, we must observe how the complexity of the process can be respectfully explained where there are porous boundaries, and time and space can be perceptually altered. The ramifications of technology in the creative process and the use of senses invites many questions, but before we grapple with the bigger picture of technologically-assisted creativity, let us consider what tools have previously been utilised, by whom, and in what manner.

3.2 The development of Digital Dance

The use of wearable technology within dance can be traced back to emerging digital dance practices in the 1990s. Sporadic in nature and led by collaborative projects of choreographers with digital artists and programmers, the development of motion tracking systems, software for composition, and exploration of choreographic objects has enabled dance artists to explore the creative potential of virtual, mixed reality, and interactive environments (Dixon, 2007; Birringer, 2008; Whatley and Sabiescu, 2016; Sagasti, 2019).

Certain individuals in Western dance practices can be credited with both actively seeking collaboration with technologists and experimenting with software and hardware to find new means for creating and presenting their work. Most notable is the work of American choreographer Merce Cunningham (1919-2009), widely recognised for his contribution and commitment to the development of digital dance

and through his use of technologies enabling new pathways to choreograph. The *Lifeforms* software created by Credo Interactive enabled a generation of new movement potential through a graphic interface. In addition, his collaborations with media artists Paul Kaiser and Shelley Eshkar (*Hand-drawn Spaces*, 1998) led to the creation of illustrated figures through the process of motion capture, programming, and projection. This work's legacy has been the development of more responsive and interactive environments and the technological collaboration that expanded Cunningham's practice, opening both new possibilities for moving the body and of what the body and computer can produce together. In the USA, other established choreographers such as Bill T. Jones and Trisha Brown worked with The OpenEndedGroup ⁷ to create choreographic experimentations with both recorded and live dancers. Motion capture technologies evolved, and AI programmes enabled new relationships and choreographies in real-time (TheOpenEndedGroup, no date).

Several other collaborative partnerships pioneered the development of dance within interactive environments and with the creation of new software and tools. One of the most influential was *Troika Ranch* (composer and software engineer, Mark Coniglio; choreographer and artistic director, Dawn Stoppiello), who created works using technology to further support the storytelling and content of the work (Stoppiello, 2009). Coniglio's technology and software helped realise *Troika Ranch*'s creative ideas, and in turn, they shared this with other dance artists and choreographers. Most notable are *MidiDancer* and *Isadora*, with the former – a wearable hardware movement sensing system - using flex sensors attached to joints and allowing data to be relayed to microcomputers, with MIDI signals then interpreted by the main computer to enable interaction between the body's movement with projections and sounds (Dixon, 2007, p. 197). The latter creation was a software package with a user-friendly interface, furthering the potentials of interactive performance environments and allowing a greater number of performers/choreographers to experiment and create without requiring coding or technical knowledge.

⁷ Riverbed with Paul Kaiser and Shelley Eshka became The OpenEndedGroup following the addition of Marc Downie.

In Australia, *Company in Space* (1992-2004) founded by duo John McCormick and Hellen Sky used motion tracking and sensor environments in projects including "telematic performance, interactive Web TV and VRML world" (Company In Space, no date). Assisting the development of the Motion Lab at Deakin University, the pair worked across research within this institution and their own company. McCormick's development of neural networks (2014) furthers the premise of the computer becoming a co-creator, mutual learning tool, and influence in the choreographic process.

Importantly, the crossover collaboration between academia and the performing arts in the UK provided fertile ground for technological integration. Universities and organisations encouraging interdisciplinary work generated experimentation within "sensor controlled interactive environment[s]" (Birringer, 2008, p. 204). Birringer determines that the relationship between dancer and digitalised environment evolved from that of "disassociation with the computer systems... to a more integrative "we do this together" relationship" (Birringer, 2008, p. 205). He suggests that this underscored the creative process, with technological additions undergoing a process of synthesis and further sophisticated application enabling a more collaborative approach. Further to Birringer's publications relating to theatre/dance and technology, his work as an artist and facilitator⁸ has explored the creative potentials of technology both in Europe and the USA. Most importantly, he has questioned what occurs in the interactions between technology, environments, and dancers, promoting the necessity for academic practitioners to consider new ways to recognise, analyse, and discuss digital dance.

Artist scholars including Carol Brown and Sarah Rubidge responded to Birringer's call for criticality, providing explanations for their creations across the messy terrain of interactive and digitalised dance. Brown's reflections on the creation and performance process express a fluid negotiation of identity through the virtual other (Brown, 2004),

⁸ His Professorship at Brunel University, co-directorship with Michelle Danjoux of the *Design and Performance Lab*, and the formation of annual workshops such as *Interaktionslabor Goettelborn* continue to develop the debate and artistic practices with technology.

while Rubidge's work as an artist and academic proposes a reconsideration of choreographic space through digital installations.

In the USA, the pioneer of dance and body-worn technologies Yacov Sharir developed several transdisciplinary projects focusing on different elements of dancing with virtual dancers. Over the years his work has included VR, wearable, and interactive technologies, and most notably the incorporation of smart fabrics - electronics embedded into materials - during his collaboration with Professor Barbara Layne and the Textiles Lab of Hexagram at Concordia University in Montreal. His collaborations with Diane Gromala for *Dancing with the Virtual Dervish: Virtual Bodies* (Canada, USA, 1994) produced one of the first artistic uses of VR headsets and haptic gloves. Projecting the dancer into a view inside the body, this work was one of many documented in his PhD thesis, with his scholarship striving to unpick the impact of technology on the performer.

I am still engaged in the process of assessing how the physical human dancer/performer is creatively influenced. When interacting with a cyber-partner, my physical ability is definitely augmented in a way that exceeds the physical boundaries of what is defined as physical 'dance.' I am noticing that my movements become more varied and grossly physical in ways that are new to me as a long time performer. I am also directly affected by the liquidity and fluent movement that my partner possesses; my touch and partnering activities therefore become more sensitive in order to be fully effective, and my observation intensifies and sharpens. (Sharir, 2013, p. 36)

With the benefit of other artists and academics referencing projects, productions, and pieces within their PhD research, the last 5-10 years has presented a more coherent picture of the evolution of dance and technology. The support network of artists, the sharing of technical knowledge, and a willingness to learn from and with each other is evident. Scott de Lahunta's role in galvanising projects and research is apparent within his extensive publications and their subsequent compilation into his PhD thesis (2010). This body of work provides a useful context for the development of dance and technology in Europe, with the chapter 'Dance Becoming Data Version 2' recounting

how a group of choreographers - Siobhan Davies, Shobana Jeyasingh, Wayne McGregor, and Ashley Page - worked with digital artists from the UK and Germany – Guy Hilton, Jo Hyde, Bruno Martelli, Adrian Ward, and Christian Ziegleand - on the project *Software for Dancers* (2001); this eventually led to several long term projects, including Wayne McGregor's research into *Choreographic Language Agent* and the development of *Becoming* (2013). Created by Marc Downie and Paul Kaiser, the first technology was a 3D improvisational graphic promoting different choreographic ideas, while the second, created by Downie and Nick Rothwell, involved a larger, screened interface of another body in the physical choreographic space.

Several other choreographers worked with coders and designers to further document and create pedagogical resources, including B Emio Greco | PC (Pieter C. Scholten). Led by Bertha Bermudez, a former dancer with the company, they created a system to collate, interact, and capture choreographic intent, culminating in the production of the book and DVD *Capturing Intention* (2007) and the interactive screen installation *Double Skin / Double Mind* (2008) using sensors and motion capture. Prior to *Capturing Intention*, Christian Ziegler and Nik Haffner had worked together with William Forsythe and his company on *Improvisational Technologies*. The use of a graphic overlay for Forsythe's movement concepts illustrated choreographic thinking in a DVD format (1999). Its origin came from its role as an educational resource for new dancers of the Forsythe company, however, the DVD's release became a catalyst for technological use to reveal and document choreographic ideas and work, disclosing the richness of concepts related to space, formations, and relationships within both the process and product of the choreographer's work. *Improvisational Technologies* became the precursor for William Forsythe's collaboration with Ohio University for *Synchronous Objects* (2009), an online interactive animation digitalising the space, shape, and interaction of dancers during a specific piece of repertoire titled *One Flat Thing, reproduced*. This project was a continuation of Forsythe's work revealing choreographic thought and objects. As de Lahunta predicted in 2002, the beginnings of these collaborations would enable "...the process where thinking, coding and form

intertwine" (de Lahunta, 2002, p. 102), which we can see later in the form of the *Choreographic Coding Labs*.⁹

Further attention to the process of choreography and the discoveries of technology can be seen in projects focused on the development of digitally-archived material, including British choreographer Siobhan Davies and the documentation and digitalisation of her dance work by Sarah Whatley in *Siobhan Davies RePlay* (Whatley, Varney, and Bennett, 2008). We can find another example in Anne Teresa De Keersmaeker and her collaboration with Bojana Cvejić revealing the choreographers' process, supplemented by animated annotation (*A Choreographer's Score*, Cvejić and De Keersmaeker, 2012-14). Furthermore, the use of digital technology and interventions within intangible forms of culture and heritage has remained the concern of the *Digital Echoes Symposium* and its subsequent project *WhoLoDance*, funded under the European Union's Horizon 2020 Programme. The book documenting this work considered "the intervention of digital technologies in all aspects related to the recovery, creation, transmission, curation and preservation of ICH" (Cisneros, Whatley, and Sabiescu, 2018, loc 335) including the recording of different dance genres through motion capture and the use of digital archives. Contextually this is important, as new ways to reveal or communicate choreographic intentions through graphic overlay or annotations and digital processes demonstrate a desire to harness the ephemerality of dance, making clear the 'workings' of the creative process. The appetite for revealing creativity or perhaps the means to do so - including funding and institutional support - has increased, however, there remain issues as to the wider dissemination of research findings.

Sarah Watley and Amalia Sabiescu (2016) identify a lack of documentation within interdisciplinary projects, and the consequent epistemological concerns surrounding

⁹ The *Choreographic Coding Labs* were collaborative intensives of digital media artists and dancers/choreographers looking specifically at choreographic thinking and the translation of dance into digital forms. The *Choreographic Coding Labs* started through *Motion Bank*, a 4-year funded project (2013-2017) instigated by William Forsythe, which took on a life of its own in different forms across the globe. During its funded period, several choreographers contributed to the project articulating choreographic process and creating digital scores. (<https://choreographiccoding.org/#/>, 2022)

how we create and share knowledge more widely following project experimentation. Particularly as choreography, engineering, and computing invariably develop through the creative and practical process of working together in situ and as such are rarely documented and distributed (Whatley and Sabiescu, 2016, p. 33). Driven by the increased number of PhD studies and partnerships between artists and academia, there has been significant development towards addressing the knowledge gap in digital dance. As a result, there is increasing evidence of documentation, conference papers, journal articles, and book chapters regarding the role of technology, but generally, this remains driven by outcomes and products and the work of specific choreographers and their existing practices. It is worth noting that the documentation of body-worn technology is still comparatively small compared to literature discussing interactive environments and AR/VR performance-related technology. Interest in the choreographic process as a topic for scholarship has evolved as a result of lab formations, the development of support networks for choreographers interested in technology, and the emergent “knowledge economy” visibly signifying the worth of the dance process, choreographic thinking, and artistic value (Leach, 2016, Para 25.49). The aforementioned projects and those of *Inside Movement Knowledge*¹⁰ (The Netherlands, 2008-2010), *Capturing Dance*¹¹ (Australia, 2009-2012), and *METABODY* (Europe, 2013-2019) have been pivotal for developing the previously outlined software

¹⁰ The *Inside Movement Knowledge* (IMK) project was a consortium of institutions working over four intensive periods to investigate the documentation, transmission, and preservation of choreographic and dance knowledge. These organisations included the Art Practice and Development Research Group; Amsterdam School of the Arts; ICK Amsterdam – Emio Greco | PC; Netherlands Media Art Institute; Department of Media and Cultural Studies; Theatre Studies at the University of Utrecht; and the Dance Department/Theaterschool at the Amsterdam School of the Arts (<http://insidemovementknowledge.net/project/organisation/>, 2019)

¹¹ *Capturing Dance* was a three-year project supported by the Australian Research Council. Dr Kim Vincs (Deakin Lab) collaborated with mathematician Dr Vicky Mak and biomechanist Associate Professor Richard Smith from the University of Sydney, looking at the statistical analysis of motion capture data to view the choreographic process in a new light. (<https://www.deakin.edu.au/about-deakin/news-and-media-releases/articles/2009/dance-project-captures-expert-attention>, 2022)

and interactive installations. More recently, projects such as *Quest Lab Network*¹² (2018-2021), and *Danseathon*¹³ (2018) have continued to develop the skills and interests of choreographers and digital artists/technologists, encouraging opportunities for new generations to collaborate.

3.3 Wearable technology (WT) used in dance performance and choreography

Primarily, collaborative interdisciplinary projects have dominated the production of published sources available on wearable or body-worn technology widely distributed across several categories of music, performance art, design, and fashion. Consequently, the literature cited below involves academic practitioners who utilise movement/dance within their projects but not as the sole feature of their output. Approaching the literature from this perspective, we must acknowledge that the amount of attention accorded to movement may vary and the literature may lack detailed accounts of the moving body. However, this omission further supports the argument that research investigating the micro perspective of technology use is currently underrepresented. For the sake of simplicity, this chapter focuses on projects holding direct relevance to wearables and the involvement of kinaesthesia in the creative process.

Designer Michèle Danjoux's (2014, 2019) research considers the impact of design on movement choice, particularly its possible restrictions, alongside that which she terms *choreosonics* or the interaction of the performer with their instrument/costume to simultaneously create sound and movement. Direct quotations from dancers within the project support the concept that integrating wearables into performance combines the sensorial and kinaesthetic abilities of the body. There is also a valid argument that the costume or wearable may influence or develop the ability of the performer to

¹² *Quest Lab Network* is a three-year Arts Council Funded programme run by Studio Wayne McGregor, gathering choreographers and technologists to support collaborations for regional work in dance and technology. (<https://waynemcgregor.com/>, 2022)

¹³ Initiated by BNP Paribas Foundation and Maison de la Danse Lyon, *Dansathon* was the first European dance hackathon. (<https://dansathon.eu/>, 2022)

project character or narrative into the context of their performance piece. Danjoux's work with Birringer (2009) had previously interrogated how sensor-based interactive technology may influence how we acquire information through our senses and the evolving behaviour reflective of a unified system. They see the performer-technology relationship as a multifaceted means to connect to the environment, "how the functions and aesthetics of body-worn technologies enhance the bodies' capabilities to interface with the environment as transmitters, receivers, and enablers of sensory information" (*ibid*, 2009, p. 1).

In the same arena of sonic interactive wearables, Tim Murray-Browne's PhD thesis discusses the project *Serendipitchord* (2009), recounting its unfolding of narrative through movement and sound. In both cases, Danjoux and Murray-Browne characterise the performer's skill and reflexive awareness as to how their senses and kinesphere interact with the wearable when communicating the story.

Artist and scholar Susan Kozel provided one of the first books on technology within the dance creative process (Kozel, 2008). Her exploration of technology and its relationship to the body was pursued through phenomenological approaches, broadly using different technologies. Wearable technology was the particular focus of the *whisper[s]* project (Kozel, 2008, p. 280) allowing participants to access their physiological data through sensors and using haptic and sonic outputs to interact with other bodies, data, and the environment. The work discusses the complexities arising from interacting with technology, and the political and psychological tensions with abjection and affect¹⁴. Despite this book's ground-breaking work, it contains issues surrounding the use of "second-person phenomenologist, or heterophenomenologist" (*ibid*, 2008, p. 58) and in generating evidence using a methodological approach prioritising the subjective lived experience. Arguably, viewing experience from a second-person perspective is indicative of the varied perceptual affordances of technology; however, the book does not reveal the complexities of this discussion for the reader. Furthermore, a cursory summary of movement vocabulary emerging from the

¹⁴ In this context, 'abjection' and 'affect' refer to the work of Julia Kristeva (1982) and feminist psychoanalytical theories in 'Powers of Horror: An Essay on Abjection'.

participants' improvisations and interaction with the wearable technology gave little in the way of explanation or analysis of what this may reveal.

Thecla Schiphorst (2007) provides a clearer and more detailed picture of *whisper[s]* project, largely due to the inclusion of the design process relating to human-computer interaction (HCI). Schiphorst - whose role involved direction, concept, performance, and interaction design - scrutinises several case studies of interactive performance works using embodied methodologies within her PhD thesis. Providing a systematic and thorough account of how users have previously applied wearables, the work details from each perspective – participant, artist, and designer - how this impacted the choreographic and performance elements. Schiphorst's interest in touch and technology influenced several projects, and when amalgamated with her previous experience of somatic practice provides a rich area for exploration. Within her PhD research, she used Shusterman's concept of *somaesthetics*¹⁵ as a means to consider touch within interactive installations and objects; "interdisciplinary practice-based explorations combine a bodily somaesthetic concept (the tactile nature of perception through our sensory organs at the site of our skin) applied to an experimental technological solution (the concept of tactile impressions that are both proximally and contact sensitive)" (*ibid*, 2007, p. 213). The contributions from this body of work are numerable, but notably, Schiphorst argues for a greater ethical dimension to design and interaction gained through self-awareness, linking between subjective and shared experience and knowledge within interdisciplinary projects using somatic practice.

Camille Baker and Kate Sicchio's work has logical lineage from that of Schiphorst and Kozel, with their exploration of biometric data with sensor devices in 'Blended Participatory Performance/Choreographic Hacking' (Baker and Sicchio, n.d, p. 3). Their artwork appropriates commercial mobile technology - in addition to DIY wearable technology - and deviates from its intended use, exposing the internal body data to render it externally. Their work generates possibilities for exploring the body by giving

¹⁵ Shusterman terms *somaesthetics* is the "study of the experience and use of one's body as a locus of sensory- aesthetic appreciation (aisthesis) and creative self-fashioning". (Shusterman, 1999, p. 302)

agency to the participants/hackers; however, the proceedings lack specific descriptions of the dance/artworks and their impression on the audience which would have assisted in further supporting the intentions of either the artwork or reception. The article 'Hacking the Body 2.0: Flutter/Stutter' (Sicchio *et al.*, 2016) includes a more detailed description of the design process, materials, and dancer interactions with wearable technology and returns to the themes of body data, personal information, security, and disclosure. Despite the greater detail provided in this instance, further information about the performance, the experience of wearing the technology, and the overall reception of the audience would have been advantageous. More recently, the introductory chapter to their edited book 'Intersecting Art and Technology in Practice Techne/Technique/Technology' (Baker and Sicchio, 2017) addresses this point and platforms the process of creative practice with technology, promoting its role from tool to co-creator (Baker and Sicchio, 2017, p. 313).

Valerie Lamontagne further dissects the role of technology in her article 'Wearable Technologies: From Performativity to Materiality' (Lamontagne, 2012), considering agency from an interdisciplinary perspective and the performativity of wearables. She analyses structures of knowledge production and the environment, resulting in a dismissal of textual artefacts in favour of the 'performative turn'. Lamontagne's background studying wearable technology at the V2_¹⁶ considers the performative acts of the body, its interactivity with the technology, and its communicative and artistic potential. The distinctions between wearable technology in performance and the issue of performativity are paramount across this academic field, with questions surrounding who is performing - the body or the wearable? - and in what context (V2_, 2011) defining the parameters for such analysis. For example, Susan Elizabeth Ryan's book 'Garments of Paradise' (2014) focuses on every day, social-cultural aspects of wearable technology outside of the conventional performance context. The strengths of this text include its attempt to address the lack of criticality in wearable literature while documenting its historical development; despite this, there remains a gap in scrutinising wearables on a micro-level or what movement is produced. A vast range was covered within the book, providing an extensive picture of the evolution of

¹⁶ V2_, Lab for the Unstable Media, is an interdisciplinary centre for art and media technology in Rotterdam.

wearable technology, confining its inquiry to philosophical and sociological theoretical arguments and predominantly, the linguistic structures based upon 'conversation' were used to explain wearables to our lived experience. Ryan's closing discussion highlights the need to consider the body within this paradigm, addressing its disappearance in the production and communication of wearable technology and recognising the theoretical 'messiness' of this situation.

Theodora Kyrgia and Marina Toeters offer a proposal for movement typology and the use of wearables as an extra dimension of expression in performance in their article 'Expressive Social Wearables' (Kyrgia and Toeters, 2014). Their exploration of "embodied movement-based interaction" through three prototypes of wearables/costumes communicates how dancers have used sensors and wearable costumes to broaden choreographic practices. Unfortunately, no substantiated evidence from qualitative data or any analysis of this interaction is provided for supporting observer/audience interaction with the creative product. Despite these omissions, the work includes useful discussion as to how movement is impacted by the form of wearable, influencing the relationship between two dancers and their wearables.

The garment's ability to change in response to the wearer's movement (transformability) creates affordances of expression through the qualities of the wearables (form, tactility, interactive capabilities), triggering the curiosity of the mover to discover all the possible affordances. All of these things, facilitated by the interaction between bodily movement, interface and the effects of technology create an ongoing, embodied, narrative experience. (Kyrgia and Toeters, 2014, p. 3)

Kristi Kuusk provides another consideration within the literature regarding the scenographic capacity of the wearable in conjunction with the body. Detailing two projects within her PhD thesis, she describes how dancers interact with thermosensitive conductive yarns (Kuusk, 2016, pp. 84-87) and the scenographic element, illustrating how movement and the use of tools create landscapes on the dancers. As Kuusk's thesis focuses on sustainability and smart textiles, the descriptive

depth of the artistic elements is understandably brief. Margarita Benitez and Marcus Vogl (2014) also address the use of wearable technology as both a soundscape and landscape in their conference proceedings 'S.A.R.A.: synaesthetic augmented reality application', describing how the "human-computer interaction between the dancers and the technology as an extension of their bodies creates an altered/mediated/mitigated performance environment" (Benitez and Vogl, 2014, p. 13). Inspired by synaesthesia and the relationship between sound and colour, this project examines how this might artistically be utilised through technology. Interestingly, the proceedings comment on dance's facility to explore the senses through choreography (*ibid*, 2014, p. 10) but they fail to explain the interpretation of sensory appreciation and movement creation, instead, inviting others to explore the tool's potential through open-source means.

Maria Kapsali's work within different museum and festival settings further explores the sonification of movement via mobile phones and software applications. Within her journal paper (2017), Kapsali considers the benefits of movement sonification on somatic practices and the means for developing kinaesthesia through developed listening to the body. Morland's related discussion (2019) of wearable sensors for capturing body data focuses on both training and the ongoing process of listening, attunement, and conscious awareness of technology use by dancers. The project *Emovere* studied the formation of sound, physiological data, and movement, being "focused on configuring artistic material by exploring the biology of emotion, through experimenting with the induction of emotional states based on corporeal patterns, using the Alba Emoting method" (Morland, 2019, p. 1). The use of electrocardiogram – the measuring of cardiac rhythm - and electromyogram - or muscle tension sensors enabled performers to interact with the soundscape through the use of patterns of breath and body tension associated with emotional states.

To summarise, the literature within this field has presented sparse evidence of the movement produced within these projects, creating a significant absence of movement analysis within current research. The use of microanalysis would provide data for exploring common concepts across participants, linking their perceptions of events with their physical reactions. Despite this, the literature generally indicates the

potential for technology to provide new perspectives on movement creation - particularly active listening - transmitting character/emotion/narrative both through the qualities afforded by the technology's shape and materials and the potential information communicated to the performer. It questions the agency of the technology during the creative process – for example, who is performing - but also clarifies the revealed socio-political dimensions of the body (biodata) and the tensions associated with its intersection with the object. Creating an added element to the body or affording different scenographic opportunities only conveys the pro-technological argument and consequently, fails to consider either the disadvantages or critically acknowledge the messiness of the multiple outcomes of working with technology.

3.4 Kinaesthetic awareness and proprioception in dance with technology

As introduced earlier, the term kinaesthetic awareness includes many definitions. Due to these differing opinions, I will also reference the term kinesphere - related to the space directly around the body - in the literature review below. I will cover the most relevant texts, specifically those involving dance and technology to contextually situate this research.

Birringer (2003) considers the relationship with space as somewhat different in interactive media-based performances:

Addressing "interaction" as a spatial and architectural concept for performance, therefore, means shifting the emphasis away from the creation of steps, phrases, "combinations" or points on the body that initiate movement, away from the dancer's internal bodily awareness... into her environment, to a not-given space but a constructed, shifting relational architecture that influences her and that she shapes or that in turn shapes her. (Birringer, 2003, p. 90)

The research produced by the *METABODY* project considered AR and the interactive space to be “immersive kimospheres” (Birringer, 2018, p. 5), being evident of Birringer’s thoughts moving beyond architecture to a more fluid concept; “This

sensorial interconnection and social ambience of atmospheres (cf. Böhme 2013) offers new, vibrant potentials to examine how a space enters us, and how we enter an elemental material perception-space” (*ibid*, 2018, p. 6). Within a performance using image projection, sonification, and interactive set design/installations, we can expect a shifting relationship between the body and the external environment, but despite this type of performance often working with improvisation there is a lack of evidence to support the movement relationship.

'Neural Narratives - Dance with Virtual Body Extensions' (Bisig and Palcaio, 2016) discusses the sonic and visual amplification of kinesphere in greater depth. By using *Kinect* for motion capture, the dancer is aware of their position to the camera causing these parameters to restrain their use of physical space, and as such, their kinesphere. Despite the restrictions mentioned, the authors stress its valuable learning and development potential:

By creating systems that strongly connect to and modify the dancer's awareness of their bodily capabilities... The output of the system can alter a dancer's bodily awareness and thereby evoke new kinaesthetic images via cross-modal transfer¹⁷ (Kirsch, 2011). And the output of the system which can be perceived by multiple performers at the same time can act as mediator for and transformer of kinaesthetic communication. (Bisig and Palcaio, 2016, p. 5)

Echoing the findings of Bisig and Palcaio on cross-modal transfer, Francoise *et al.* (2017) addresses the influence of imagined sources within the perceptual and kinaesthetic process. This work looks at the feedback loop of movement and sound and its impact on kinaesthetic awareness, acknowledging its participants' amalgamation of the physical with imagined sensory modalities contained within their

¹⁷ Working through ideas with one or more sensory modalities, Kirsch discusses the choreographic strategies of Wayne McGregor with his dancers “that require them to imagine what something feels like kinesthetically, or to imagine what something would look like, or smells like, or feel like in an emotional sense, then to translate this to movement” (Kirsch, 2011, p5).

response to movement/sound feedback. Compiling the use of *Myo* armbands¹⁸ with participant responses within explicitation interviews, they found that participants tended to experience issues understanding both their movement and the sound produced. During the second iteration of the research, the team addressed this further by facilitating micro-movements. The closing commentary of the article discusses the nature of working with wearable technology, advising supplementary time in workshops to ease its transitional integration.

One element of Laura Karreman's (2017) PhD thesis on motion capture concerns the kinaesthetic dimensions to a dancer's movement choice when using technology: "Dancers' experiences demonstrate that performers learn to move in accordance with the anatomical and 'outward-in' logic of the motion capture setting... the marked bodies of dancers in the motion capture volume also have a profound impact on the dancers' physicality and proprioception" (Karreman, 2017, pp. 166-167). She discusses two case studies, with the description of the actions and overall movement preferences indicating

...an extreme sense of unfolding of the body, a maximum exposure of the body's surface. This movement vocabulary directly points to the dancer's awareness of the optical markers on her body's surface. Her experience with the system has endowed her with an acute embodied awareness of the system's threshold. (*ibid*, 2017, pp. 172 -173)

Whether this adaption to the systems' needs or its synthesis exists on a conscious level, the relationship of sensors to the skeleton promotes a unique way of moving. Conceptually, this phenomenon is linked to traces of the body, with Karreman concluding that our Western historical preferences for both kinaesthetic imagery and marking space through the drawing body represent our cultural disposition for record-making and use of the "conceptual metaphor" (*ibid*, 2017, p. 183). This example

¹⁸ *Myo* armbands measure muscle activity through EMG sensors by detecting electrical impulses in the arm's muscles and therefore, create data from the participant improvisation.

provides a useful pathway for considering what is happening within the interaction and the socio-cultural influence of technology use.

Parviainen *et al.* (2013) address this at length, suggesting that Laban's definition of kinesphere¹⁹ cannot comprehensively cover the complexity of the "spatiotemporal condition of the environments within its physical space, architecture, socio-cultural events or political tensions" (Parviainen *et al.*, 2013, p. 3). Within their exploration of gestural interaction in the related technological design, they explain a proposed framework encompassing the "micro, local and macro": the micro, considering the body's actions; the local, the relationship with the body in the environment; and the macro, the wider impact of those actions, including consumption and influence in a larger sense on the population. The suggested framework certainly contributes an alternative, addressing the multifarious conditions of bodies in space and serving as a reminder of the dominance of Westernised notions of technology and interaction.

Providing evidence for a changing relationship between kinesphere and technology, Gretchen Schiller's PhD thesis (2003)– alongside her technologically-interactive installation works between 1998- 2003 - argues for a dynamic relationship between the body and its surroundings, proposing a divergent theory of 'kinesfield'. Schiller's artworks and subsequent analyses suggest that "bodily awareness and kinesthesia are not fixed. They are dynamically cultivated" (*ibid*, 2003, p. 437). It seems logical to conceptualise the body adapting to consider its trajectories, energy, and imagined elements in a changing multimodal environment, but due to the nature of the installations and members of the public playing/improvising, it is difficult to link the installations' impact on the physical choices of the participants to the wider socio-cultural influences.

Ruth Gibson (2019) proposes further developed notions of 'kinesphere' and 'kinesfield', using the Skinner Releasing Technique, motion capture, and VR to

¹⁹ 'Kinesphere' is a term used by Rudolf Laban to describe "the sphere around the body whose periphery can be reached by easily extended limbs without stepping away from that place which is the point of support when standing on one foot" (Laban, 1966, p. 10).

negotiate new ways of imagining. She cites the influence of Laban and Schiller in her conception of 'kinosphir' with the term built upon the latter's research, suggesting that through extended use of the technology, embodiment moves beyond that of the "networked and distributed to a fractal sense of embodiment" (Gibson, 2019, p. 70). Her long-term collaboration with Bruno Martelli has enabled an in-depth understanding of how one may incorporate the somatic technique into the creation and use of VR while employing principles within the interactive design (*ibid*, 2019, p. 97).

Dynamic 'feeling states' in virtual environments highlight sensorial shifts in our bodily make-up shaking up our preconceived ideas... the Kinosphir plants seeds of awareness opening somatic registers, somatic layers in different dimensions making us 'available' to impart vitally essential bodily knowledge. Allowing us to make choices and go deeper into experience (*ibid*, 2019, p. 256).

Similarly, Rachel Sweeny's work (2017) considers using technology to engage with the senses when dancing, questioning the role of proximity, perception, and proprioception within integrated digital dance and the live choreographic process of Butoh²⁰. Promoting these strategies in Butoh and the digital image, she suggests new ways to consider the dancing body where "[p]hysical synaesthesia presupposes a re-ordering through the senses of the body as an organised or self-organising structure" (Sweeny, 2017, p. 12).

In continuation of this position, Giomi's work theorizes the reorganisation of the sensory experience - and subsequently, kinaesthesia - regarding technology and movement through sonification.

From a phenomenological perspective, the transformation of mainly interoceptive or proprioceptive sensations into exteroceptive stimuli (i.e. augmented "auditory" feedback), allows the user not only to become aware of

²⁰ Butoh is a Japanese dance form created in 1959, distinguished by its slowness and ability of the performer to create "a state of 'hyper-presence', aware of everything going on around them and within their own body" (Sadlers Wells, 2017).

his own body but, due to this new sensorial feedback, he/her also becomes capable of experimenting new modalities of movement execution (Giomi, 2020, p. 4)

Andrea Davidson (2013) discusses at length the idea of restructuring and reordering the body through somatic practices and technology. She provides examples from somatic practices - and choreographic work by Brown, Choinière, and de Lima - highlighting how presence and sensorial awareness enable an engagement with and through technology. Specifically, she draws parallels between these artists and their discussions on how the physical/technological interface enables multiple states of presence during the creative process (Davidson, 2013). She presents further ruminations in her 2016 article emphasising the lack of examples discussing the ontology of digital dance and attempts to readdress this imbalance with a thorough historic review of influences and by outlining the transition into what she designates a 'third wave' of dance and technology. Davidson outlines a position of how the body develops from interactive and wearable technology:

...this article returns to a more pointed understanding of *sōma* as interoceptive, kinaesthetic and proprioceptive bodily experience with respect to exteroception (perception of the external environment). It also takes into account a distinction of aesthesis as sensory appreciation. It suggests that under the influence of digital technology – a powerful new exteroceptive agency – the individual's interoceptive, proprioceptive experience is modified in the encounter with technology. A mediated body emerges as a hybrid, multi-levelled response to interoceptive and exteroceptive stimuli. (Davidson, 2016, p. 23)

Davidson's book 'Through the Prism of the Senses' co-written with Isabelle Choinière and Enrico Pitozzi (2019) continues to address the senses and multimodal reception in performance and practice-based research methodology. According to the ideas of Davidson, Choinière, and Pitozzi, the internal and external reception of information in the body/technology interaction can change the manner with which we perceive and

create dance works and in so doing, suggests that our whole system for sensing modifies, and by extension, our understanding of the experience.

Pitozzi's chapter further clarifies the meaning of the 'prism' and the different realities revealed through artworks and specifically biofeedback from sensors. He discusses the reorganisation of the body through the sensory system, explained by defining technology and body collectively as the "environment" for perception (Pitozzi, 2019, p. 91). He suggests this reformation is structured into three stages:

1. The configuration of movement hypotheses based on *proprioception* through an articulation of the senses with respect to the environment;
2. The extension of proprioception in a digital network; what we have called *mediated exteroceptive*;
3. Feedback from movement in the form of digital data, *biofeedback* which induces a reorganisation of neural networks that overlap with proprioception in the formulation of movement hypotheses, and thus, of the formulations of actions to come (Pitozzi, 2019, Para 8.103).

Pitozzi suggests that listening, playing with, and responding to feedback within the exterior environment can influence movement choice at possibly a deeper neurological level. Isabelle Choinière in chapter 2 discusses her "practice as research", promoting an alternative framework for considering technology in creativity, "towards an analysis developed around sensory perception and the evocation of complex relations of a multisensory, multimodal (as in different ways of learning) and integrative order" (Choinière, 2019, para 9.14). She promotes the influence of somatic practices and the consideration of bodily awareness internally and externally to suspend the binaries of body/object. Choinière explains her research through the dynamic, ongoing process of the perception and destabilisation of the senses, which at the closing of the chapter, she relates to as intercorporeal communication with the spectator/audience member. The conducted research used specific strategies but of significance was the daily use of the technology for prolonged periods, with Choinière describing the "integration" as successful after the dancers began breaking habitual movement and behaviours.

Andrea Davidson's chapter takes a slightly different angle, outlining the main philosophical and post-humanist discussions regarding the body and technology and how this concerns the narrative of creative creation and difference of approach. In concurrence with her fellow writers, Davidson promotes the idea of the dancer's ability to attune to the environment inclusive of their internal perception. She considers how interactive performance environments add complexity to the performers' awareness and presence. For both performers and for the experience as mediated by the audience, there are opportunities for an altered time and space created through the performance. Certainly, her work promotes the need to investigate the aesthetics and behaviours produced in this realm, with very little literature "explaining precisely *how* the body interacts with technology" (Davidson, 2019, para 10.5).

Jaana Parviainen's (2011) research addresses questions surrounding the integration/adoption of technology in the choreographic process. She scrutinises the work of two choreographers and analyses possible stages of the choreographic process - testing, exploring, and working on a performance. Parviainen connects the thinking occurring during this interaction to that of Merleau Ponty's explanation for the simultaneous feeling of touching and being touched (Merleau Ponty, 1962, p. 93). In the paper, she claims that this process moves beyond tool acquisition, whereby during sonic and kinaesthetic interaction, dancers "become conscious of the new multisensorial experiences, especially aural, kinaesthetic, and haptic sensations that the interface evokes in the moving bodies" (Parviainen, 2011, p. 640). This further supports the suggestion that new behaviours may be borne from the new lived existence with technology.

A growing area of research surrounds technology and psychophysics, particularly the consideration of how we can utilise findings in psychology and neuroscience in the creative and performative environment. This area holds relevance as it explores the possible effects of technology on the kinesphere and kinaesthetic awareness. Emerging from a theatre background, Liam Jarvis (2019) discusses *theatres of mislocalized sensation*, considering technology and brain plasticity for amalgamating

additional prosthetics or for tricking the body's senses. This argument primarily centres on the potential ability to disrupt proprioception and body ownership, following the Rubber Hand experiment (Botvinick and Cohen, 1998, p. 756). Jarvis considers the empathetic value of theatre and community projects, enabling its participants to “*feel with the body of the other*” (Jarvis, 2019, p. 7) through technology, both VR and wearable technology. Creating illusions or tricking the senses can impact how we see our body, but this interrogation lacks understanding as to how this happens with/through technology. Experiments and installations pursuing this research area tend to employ a stationary set-up - participant in one stationary position sat down or standing - and consequently, cannot fully examine the proprioceptive or kinaesthetic element within the exchange of bodily ownership, particularly when restricting full bodily movement.

‘Intersecting Art and Technology in Practice Techne/Technique/Technology’ (Baker and Sicchio, 2017) debates explanations of what materialises from technological and bodily unification through the process of working in media art and virtual reality installations. One proponent for extending body ownership is Moore; her chapter explains the relationship between the installation and the audience similar to Merleau Ponty’s use of “chiasm”²¹, with the addition of the term “bleed” for explaining the connection and crossover between the corporeal and the digital (Moore, 2017, p. 38). Using an example from her work, she recounts the relationship between the viewer and the visualised internal body of another by using Head-Mounted Displays. Moore attributes the ownership of experience to intercorporeal communication and synchronicity via digital means, explaining that this enables an expansion of the boundaries of the body; “we are caught between self/other positions through a disruption in our proprioception” (*ibid*, 2017, p. 39)

Echoing a similar message of relationality, Ania Malinowska (2021) considers wearable robotics in several dance works, referencing the performances of *Inferno*²². According

²¹ Merleau Ponty used the term “chiasm” to explain that divisions or distinctions exist but possess overlapping points.

²² “*Inferno* developed by Louis-Philippe Demers and Bill Vorn (Demers and Vorn, 2018). The performance consists of a set of twenty-four upper body exoskeletons (the actual

to Malinowska, adopting and enacting movement through exoskeletal robotics allows for the examination of the body rather than its disappearance.

Moving with the machine makes them [audience-participants] paradoxically more aware of their own movements and mobility... This kind of movement neither dehumanizes, nor mechanizes their motions, but opens up spaces for performing anew the human qualia of kinesis. (Malinowska, 2021, p. 119)

This is affirmed by research conducted in parallel to the *Inferno* performances, whereby the body-worn technology defamiliarises the body and its movements; “Exoskeletons paradoxically both impede and facilitate spontaneous movement, creating heightened kinesthetic awareness while simultaneously rendering the body and even basic movements unfamiliar” (Jochum, *et al.*, 2018, p. 4).

We can group the literature reviewed within this subsection into several areas. Firstly, one for the recognition of the dynamic body promoting an evolving kinaesthesia through a different physical understanding of space within interactive and VR environments and motion capture (Birringer, 2003; Schiller, 2003; Gibson, 2019). This includes the outward-in logic promoted by Karreman (2017), and the restrictions and subsequent new ways of moving by Bisig and Palcao (2016). Secondly, a group for the sensory reorganisation invited by technology use (Davidson, 2013; Sweeny, 2017; Choinière, 2019, Pitozzi, 2019, Giomi, 2020), and lastly, one discussing the destabilisation or disruption to kinaesthetic awareness resulting from technologies (Jochum *et al.*, 2018; Moore, 2019; Malinowska, 2021). This research supposes that

number varies according to the venue) that actively manipulate and control the participants’ motions.)... The performance lasts 60 minutes, during which the participants (audience members) are guided through a series of choreographic motions that are synchronized with special effects such as music and lighting cues”. (Jochum, *et al.*, 2018, pp. 2-3)

recent technologies need to be fully explored in practice, undertaking further comparisons for understanding the body, its boundaries, and shared space - including objects sharing that space. The value of such is evident in Davidson's (2013) article considering different practitioners and gathering conclusions based upon their overlapping themes. Moreover, evidence-based micro-analysis is lacking from the literature and would be valuable for enabling further appreciation beyond Western practices, concepts, and biases regarding technology and the moving body.

3.5 Embodied Design

By comparison, several scholars have used embodied processes to study the design and interaction of movement with technology/clothing. Claudia Nunez–Pacheco and Lian Loke have further developed body-centred design to suggest that "[b]eyond mere amplification of sensation, wearable technology can potentially assist in the ongoing human process of meaning-generation" (Nunez–Pacheco and Loke, 2017, p. 223). Their research looks at how we can use bodily knowledge within the design process, using wearable technology and "focusing technique" to allow designers to engage in meaning-making. This research proposes that the multimodality of experience is entwined with the participants' imagination/memory in the creative process. Through embodied experience and other somatic techniques allowing an internal focus, we can connect to how 'we' make meaning through sense experience.

Similarly, in her PhD research, Danielle Wilde questions the poetics of body-worn technology,

reflect[ing] on the importance of action, narrative and meaning-making in experience; and on the qualities of attention brought to the body as a result of wearing or viewing a physically engaging body-worn system or device... the nature or quality of physically interacting with the effects of technology – whether or how this might extend the way we see, imagine or experience the world through our bodies, and how this might shift our relationships to our bodies, as well as to body-worn technology. (Wilde, 2011, pp. 40-41)

This research involved several projects, one such in collaboration with Alvaro Cassinelli and Alexis Zerroug entitled *Light Arrays*, used lasers to project the body movement in space. The responses of participants indicated what Wilde refers to as "augmented proprioception". However, due to the available screens and the participant's desire to see their movement projected visually, there remained a tendency for prioritising visual modality over the kinaesthetic experience.

In general, design and research have moved beyond usability to examine the interactions possible via the body and technology, enabling a "shift in focus from what can be done with technology to the inherently expressive processes of how humans move while interacting with technology" (Pirhonen, Tuuri, & Erkut, 2017, p. 6). Smelik, Toussaint, and van Dongens' (2016) journal article uses two designs of Pauline van Dogen's as case studies in working through an embodied approach to the design process. By interviewing those who have physically interacted with/worn the garments the paper explicates a need to bring together the functionality, aesthetic concerns and the interaction of the 'user' and highlights the necessity to consider the moving body further in the technological development of garments.

From a performance perspective, and similarly promoting the collaboration between costume and performer, is the work of Jessica Bugg (2014). She considers the "potential for developing design methodologies that draw on the embodied strategies to inform both design and communication in contemporary dance" (Bugg, 2014, p. 68). Bugg refers to the dancer's interaction with the feeling of the garment and the visual aspects of the material and form in action (*ibid*, 2014, p. 74). Evidently, from the qualitative data captured and presented, evidence supports further academic research recording and analysing the garment/costume with the moving body. In her chapter contribution to 'Performance Costume: New Perspectives and Methods' (Pantouvaki, & McNeil (eds.), 2021), Bugg further considers the embodied process through a series of research case studies and methodological developments and contribution to practice-led research. Bugg's concludes that "the wearer's engagement activated the materiality and form of the garments and their relationship to the body, triggering cognitive processes and physical responses..." (*ibid*, 2021, p. 223), illustrating the experiential process of creative interaction in the lived moment. She highlights the

complex levels of influence from materials to senses, emotions, creative thought processes and bodily action.

Donatella Barbieri's (2021) use of phenomenological theory underpins her consideration of the costumed body and, subsequently, a moving/perceiving body. Through an embodied means to consider costume design, she "applies the principles of material performativity" (Barbieri, 2021, p. 202), whereby the senses use the body's materiality in interaction with the environment and objects. However, Barbieri sees this mutual influence not as actions reinstating the body's boundaries but instead as dissolving this and, as a result, providing agency to the costume.

Sally E. Dean's (2021) research into Somatic Costume Design uses the somatic body to further how costume and movement relationships operate. Through her examples of workshops and costumes which focus on bodily connections, she concludes that touch and contact enabled through the movement of costumed bodies could uncover new knowledge of "kinesthetic, psychophysical and visual effects of costume." (Dean, 2021, p. 241)

3.6 Summary

The lineage of dance and technology research presented contextualises the development of software, equipment, and computing alongside the collaboration of choreographers, multimedia artists, and HCI specialists. This indicates how wearable technology has featured as a part of this evolution, despite remaining peripheral within dance scholarship and in use during choreographic practice. In considering how technology might influence the creative process, scholars have focused on documenting and collating technological performance with work raising questions regarding altered perception, while also interrogating the role of technology in the creation of interactive performance and the porosity of the body and technology. Part of this area's complexity hinges on how we reveal or analyse the subjective experience of the dancer in conjunction with differing influences in states of constant flux. Those practitioners who have documented their work with body-worn technology highlight its potential for promoting narrative/character/diverse perspectives, the material

affordances and new physicality brought to the creation of movement, and the agency of technology as a co-creator. Those involved in embodied design processes also express the agency of what is worn and the material interactions of both the body and the clothing/technology. Research considering technology's impact on a performer's kinaesthesia emphasises how motion capture, VR, and interactive environments create a dynamic and changing feeling/understanding of the body moving through space, pointing to an external influence or extended proprioception. Nevertheless, some artist scholars consider technology use to influence an internal reorganisation of the senses within the creation process.

I have identified a need from this literature review for further discussion of the choreographic processes and knowledge production involved with body-worn technology. The ephemerality of movement-based research necessitates a greater emphasis on movement analysis (microanalysis) in tandem with first-person accounts as evidence of how kinaesthetic awareness may adapt or change with the use of wearable technology. Combining this detailed information with an interdisciplinary perspective discussion could provide us with fertile ground for reconsidering how we perceive our bodies moving in space with technological assistance.

4. Methods and Methodology

This chapter will outline the research design with detailed subsections concerning the components of review and audit, mapping, and prototyping. I will explain the mixed methods of the embodied researcher, workshops, semi-structured interviews, field notes, and movement analysis; followed by my rationale for an inductive approach influenced by embodied methods, dance anthropology, and sensory ethnography.

4.1 Methods Overview

As the purpose of this research is the study of digital touch in dance making, I organised two projects for using body-worn technology in a practical setting. I invited professional and student dancers/choreographers to participate in workshops in which they used the prototypes to create, structure, and edit creative movement. My role moved between participant and observer in Project 1 - including facilitation of prompts for improvised exploration - and then learning and dancing structured phrases of movement created by the participants. Project 2 involved activities of improvisation, structuring, and editing with the prototypes and as the researcher I participated alongside or in collaboration with the participants depending on their existing practice. I used semi-structured interviews to gain the participants' perceptions of the experience, conducting this at the end of each condition in Project 1, and with Project 2, more frequently following different episodes of exploration (see interview questions Appendix A). All interviews were transcribed verbatim and were then coded. Using field and analytic notes I was able to consider the dialogue between the data and coding, noting occurrences, my own biases, and thoughts about the events. Finally, I employed movement analysis to acquire data about the movement; using video recordings to analyse the movement in tandem with my embodied knowledge. Figure 3. depicts these different methods and how I collated and analysed the data for both projects.

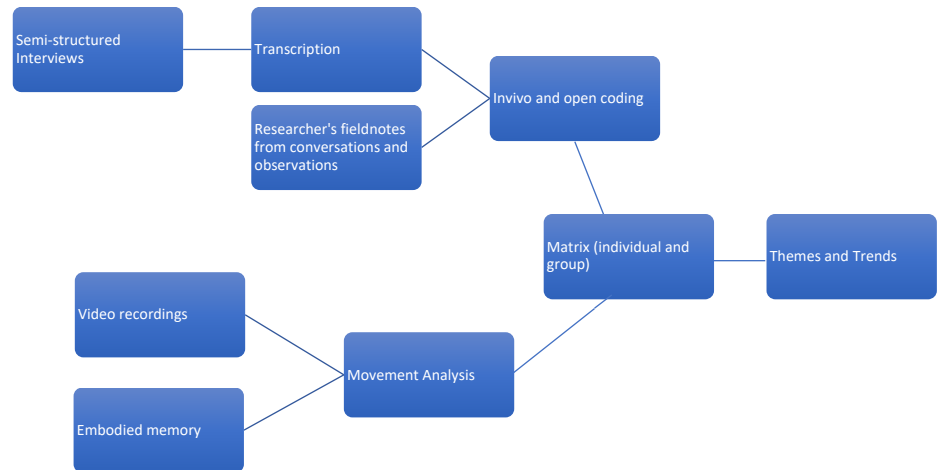


Figure 3. Chart of methods for collecting and analysing data

4.2 Research Design

As illustrated in Figure 4., the cyclical process of reading, auditing, mapping (tools/artefacts/clothing), prototyping, pilots, workshops, and evaluation, collectively enabled the development of the prototypes. The subsequent evaluation and analysis of the data facilitated decision making for the following project and influenced the research trajectory. In writing this thesis, I preserved my original thoughts and the development of certain concepts, presenting these with collective findings from both projects in the final discussion found in Chapter 7.

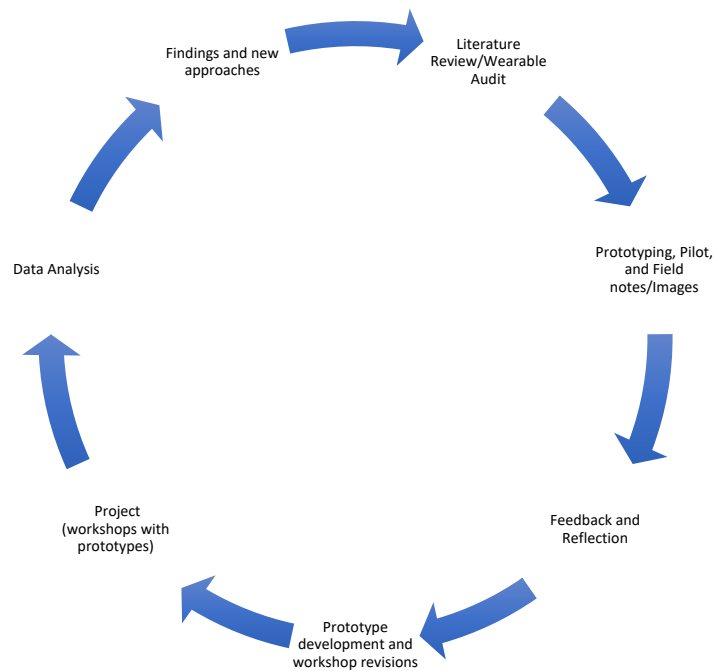


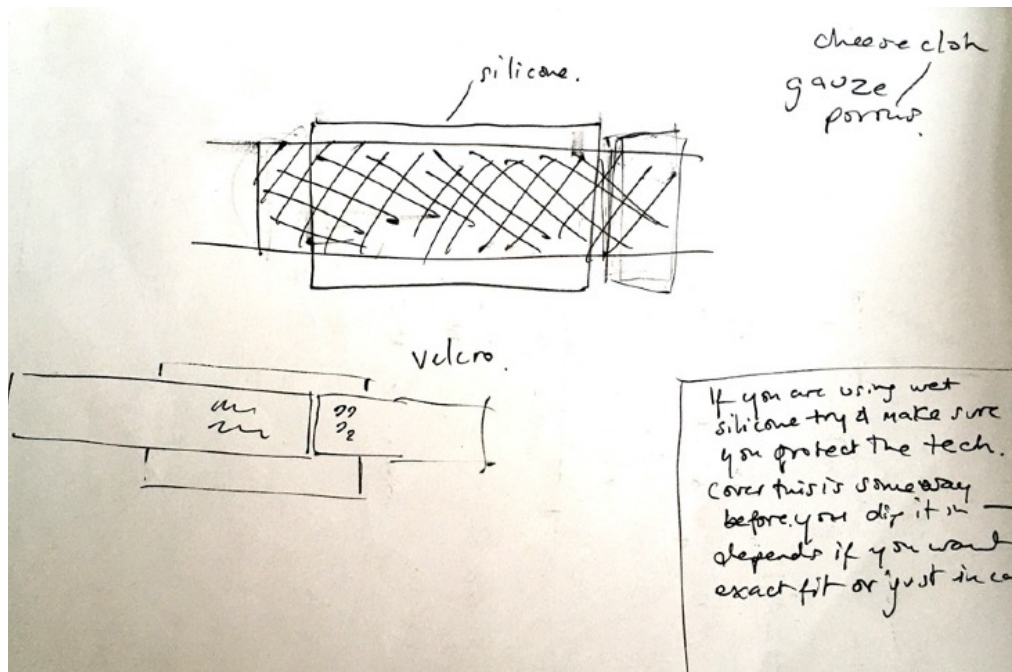
Figure 4. Cycle for Research with Prototypes

4.3 Review, Audit, and Mapping

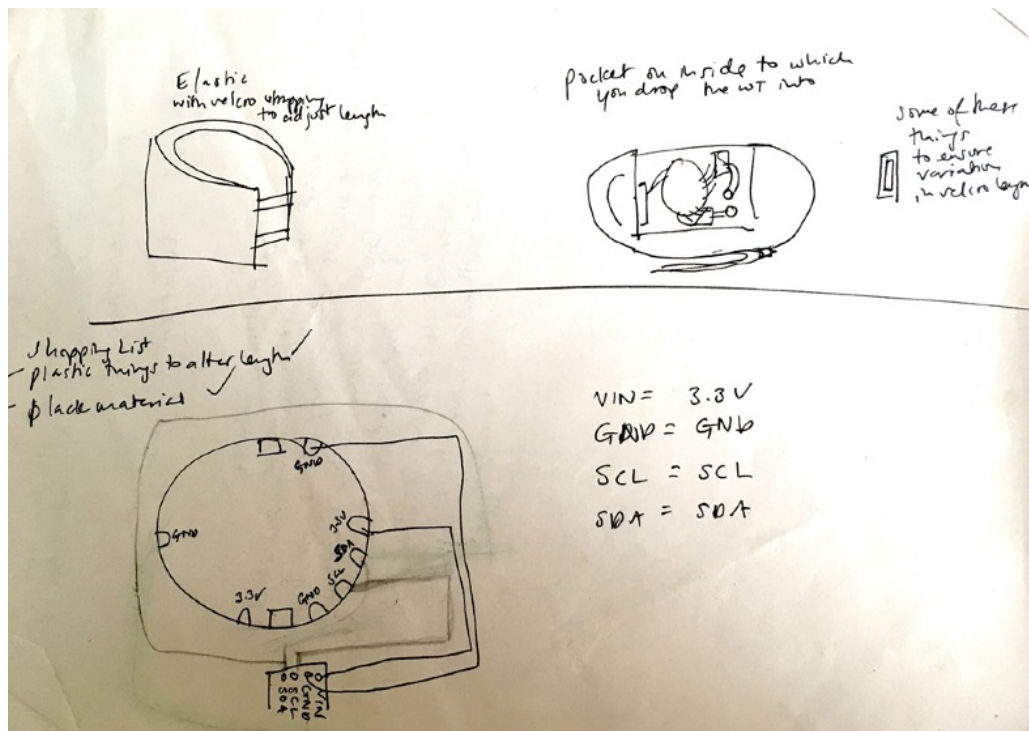
To visualise, digest, and understand the interdisciplinary area of movement and body-worn technology, the mapping of institutions, designers, and projects became a necessary task. Mapping possessed a dual purpose; it functioned as an aid for considering what type of wearable may be of use in the creative dance process and how this might be produced. Moreover, it assisted in gaining knowledge of who was designing and making wearables, and where and what materials they were utilising. Auditing existing technologies enabled the discovery of materials and their uses, leading to accessing and collecting free open-source resources and gaining knowledge from the Do-It-Yourself movement for wearable technology. Eventually, this progressed to a mapping of projects, designers, institutions, and universities involved in wearable technology (see appendix B and C for maps) and a more in-depth discussion of praxis.

4.4 Prototyping

The next stage began with sketches and discussions of materials with the Digital Anthropology Lab staff, leading to a narrower selection of ideas presenting practical options to prototype. A series of experiments with electrical circuits, parts, and materials then ensued, enabling me to eventually conduct pilots for testing rough prototypes on volunteer participants and for checking the feasibility of my workshop plans. I then used feedback via participants and observers for prototype and workshop development before using the final prototypes in the workshop setting.



Figures 5: Images of sketches from prototyping and discussions (Project 1)



Figures 6: Images of sketches from prototyping and discussions (Project 1)

As expressed by Wensveen and Matthews (2014), prototyping within the research process can be “driven by or conducted through the prototype, and cases where the *process* of prototyping is the vehicle for inquiry” (Wensveen and Matthews, 2014, p. 263). In this instance, the prototypes assisted conducting the research and formed a means for considering the digital stimulus in the process of making dance.

The benefits of working in this manner included the ability to physicalise ideas and identify practical ways of housing the technology on the body. I will cover details of each prototyping journey and the development of the technology and workshop content in each corresponding chapter - with chapter 5 covering Project 1 and chapter 6 covering project 2 - however, I will first address the techniques employed to gather the data below.

4.5 Workshops

I devised the format of the workshops in Project 1 around three prompts, asking participants to explore digital touch sensation and the imagined experience of touch.

Improvisation tasks lasted 20 minutes, with each structuring section 10 minutes long. With Project 1, the motivation for participants to experience the improvisations tasks (both conditions) as individuals was largely due to the simplicity of movement analysis and parity between participants' experiences. I facilitated tasks and therefore was required to communicate to participants on several occasions to move onto the next task, requiring attention to the workshop plan and the entire timeframe. At the end of each condition, the participant taught me their devised movement phrase.

By learning the movement phrases in Project 1, I was able to further understand the participants' experiences and to gain greater knowledge of their structured movements. Enacting can allow for a wider understanding of the possible influences of the prototypes, as explained by Poutanen, Ylirisku, and Hoppu:

...the enactment generated insight into the kinesthetic experience and usability of technologies ... as well as into generic considerations of how particular technology artifacts constrain, guide, and support movement, positioning, posture, orientation, and sensuous foci. (Poutanen, Ylirisku, & Hoppu, 2017, p. 21)

In Project 2, the boundaries of participant-observer fluctuated, but I held less responsibility for facilitating the workshops as the participant/artists and their practice most often took the lead. I joined the participant where possible in the experience, improvising or structuring with the same prototype and for the most part independently working in the same space. The length of the workshops varied according to each participant and the time spent with each prototype. I discuss this in greater detail in chapter 6, but concerning its benefits, it enabled me to shift between perspectives during the research process, particularly destabilising the authoritative 'I' in the recording and analysing of data and providing greater scope for reflexivity over the process.

Undeniably, by asking participants to work in diverse ways and under new conditions with an additional tool, there was an element of experimental construction, however, the workshopping of ideas is standard practice during both choreographic workshops

at vocational dance school and in the professional setting and therefore in keeping with normal expectations of making dance. I selected the venues for the projects because they were existing dance studios or spaces that participants had used previously for creating dance works. I positioned three video cameras - an SLR camera, GoPro, and iPad - in the dance studio to record the participants working with the prototypes from different angles and used the audio and video recordings to record the workshops and the following interviews.

4.6 Interviews and Field Notes

The use of semi-structured interviews involved a set of questions (Appendix A) asking the participants to consider the experience of working with the prototypes and enabling the participants the freedom to use their own words to explain the phenomena of digital touch as a stimulus for creating dance. In Project 1, I conducted the interviews at the end of each condition, while in Project 2 this occurred more frequently, after each episode of trying a different prototype/combination of the prototypes or choreographic approach. Gathering qualitative data in this manner assisted me in explaining and evaluating the participants' experiences (Matthews, 2010, pp. 223 -224), and enabled me to consider both the perceived advantages and disadvantages of using the prototypes and to greater understand the choices, influence, and attitudes to working with these tools/aids.

I compiled field notes to record the environment, the structure, my role, and conversations in the lead up to and during the project. The benefits were two-fold; firstly, they enabled me to recognise bias and secondly, allowed for a second stage reflection on elements that might influence the research through the developed analytic notes. This element of mixed methods enabled reflexivity and supported me in acknowledging the presence of the researcher within the data. As Karen O'Reilly claims,

Reflexivity in contemporary fieldwork studies is the requirement to think critically about the context and the acts of research and writing and involves thinking about what we read (and an awareness that ethnography is

constructed); thinking about what we write and how; and acknowledging we are part of the world we study. (O'Reilly, 2012, p. 189)

4.7 Coding

To negotiate the data sets I needed there to be forms of categorisation, and so I selected open and invivo coding to allow for patterns and similarities to arise from the data collected from the interviews and the field notes. Johnny Saldana explains that this process of coding “attributes interpreted meaning to each individual datum for later purpose of pattern detection, categorization, assertion or proposition development, theory building and other analytic processes” (Saldana, 2008, p. 3). The use of a matrix in Project 1 and 2 enabled the comparison of each participant’s experience through improvisation and the developed work, alongside their explanations. Inputting the data into a group matrix gave me an overview of whether there were any shared experiences of creating movement with the prototype, therefore enabling me to identify any theme that “captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set” (Clarke and Braun, 2006, p. 10)

4.8 Movement Analysis

In Project 1, I used the collated videos to transcribe the movement into words, and through this process, translated the data and separated it into three categories - Body, Space, and Effort - through an adapted version of Laban Movement Analysis. My choice of using Laban Movement Analysis in a descriptive fashion rather than a notation system was largely determined by my personal speed and skillset. My rationale for using Laban’s categories for movement analysis was due to this system being sympathetic to the complexities of dance presented in the project and it being generally understood and accepted within the fields of Human Computer Interaction and Dance.

I examined the movement analysis for patterns and in particular, the frequency, sequence, and similarities/differences of the individual participant within both

conditions, comparing the data across the whole participant group. Next, I transferred the information into the qualitative data summary matrix Individual Participant (Table 1), and into the Data summary matrix Group (Table 2), to correlate the data. The figures below represent the matrix and the data categorisation across Projects 1 and 2 and how I compiled them.

Participant	General themes/ elements of significance	Differences	Similarities	Habitual movement preferences
Laban Movement Analysis				
Condition with technology 16 count phrase				
Condition without technology 16 count movement phrase				
Improvisation with technology				
Improvisation without technology				
Interview Data				
Comparison between interview data and movement analysis				
Researcher's reflections on movement				
Analytic memo notes				

Table 1. Project 1: Data summary matrix – individual participant (blank)

Participant	IMPROVISATION WITH TECH Summary/significant points	Analytic memo notes	Notes from individual participant matrix
P1 etc			
Similarities and differences			

	IMPROVISATION WITHOUT TECH: Summary and significant points	Analytic memo notes	Notes from individual participant matrix
P1 etc			
Similarities /differences			
	16 count phrase WITH TECH Summary and significant points	Analytic memo notes	Notes from individual participant matrix
P1 etc			
Similarities /differences			
	16 count phrase WITHOUT TECH	Analytic memo notes	Notes from individual participant matrix
P1 etc			
Similarities /differences			

Table 2. Project 1: Data Summary matrix – Group (blank)

With the development of Project 2, I implemented a version of the matrix but described in greater detail the improvisation with the prototypes for the individual participants (Table 3 and Table 4) and adapted categories for the group matrix (Table 5). My decision to adapt the tables was in response to the fact that participants chose to spend more time working on movement generation through improvisational practices.

Movement	Qualities	Physical Relationships - body to space and prototype/external environment/other people

Table 3. Project 2: Video analysis categories for each participant and the different use of each prototype (blank)

Participant	Extracts of Movement analysis	Interview Data
Existing practice		
Improvisation with pump prototype		
Improvisation with vibration prototype		
Combination of both prototypes together		
Structuring phrase		
Editing		
Internal and External experiences		
Influences from social-cultural backgrounds		

Table 4. Project 2 Participant Matrix- compiled (blank)

Participant	Summary	Existing practice	General themes/elements of significance
Movement Analysis			
Improvisation with pump prototype			
Improvisation with vibration prototype			
Combination of both prototypes together			
Structuring phrase			
Editing			
Interview Data			
Comparison between interview data and movement analysis			
Researcher's reflections			
Analytic memo notes			

Table 5. Project 2: Group Matrix (blank)

4.9 Rationale

In this subsequent section I will address methodological decisions and their rationale, tackling why interdisciplinary research necessitates an inductive approach for engaging within a landscape of physical computing and dance. This part of the chapter will further detail the journey of prototyping - making, dancing, talking - and how it enabled greater criticality, prompting a personal interrogation of my existing practices and assumptions. Following this, I will present a justification for adopting/transferring methods from different fields, further outlining the connection point of several embodied approaches to gathering data and their influence on the methods used in this research. The chapter closes with a discussion on the ethical considerations and concerns of this research and more generally around digital touch and the challenges presented by the mix-methods selected.

4.9.1 Inductive approach

Interdisciplinary practices inevitably produce new and emergent methodologies and methods as respective fields share and develop these further. In the formulation of this PhD research, I selected an inductive approach due to the complexity of creative experience. This area of research necessitated an openness to the interplay of numerous factors rather than attempting to limit these variables or hypothesise, subsequently allowing opportunities for the theory to emerge. As illustrated in the diagram below, this involved a constant re-examination of terms and concepts due to the unfolding nature of the research, but also because of the communication required with different communities of researchers/technicians across disciplines.

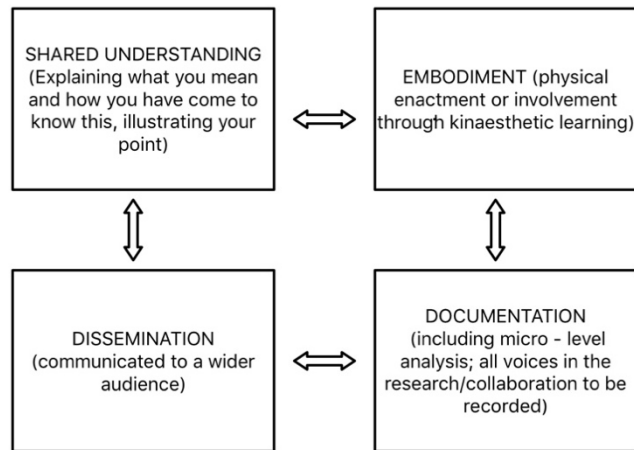


Figure 7: Diagram for Interdisciplinary Research in movement and computing (presented at the 2017 Research Network of the University of the Arts London)

The process of this research was advanced through shared meaning, although its original conception was communicated as “shared understanding” (presented at the Research Network of the University of the Arts London). As conveyed in Figure 7., this process of explaining through verbal language and the embodiment of concepts generated an expanded understanding of all those involved and formed the background of the research, directly influencing my discussions on methodology and research design.

Identified as a consequence of this type of research, is the additional time to create shared meaning. Communicating with technicians and supervisors to clarify terminology and concepts relating to dance/choreography and physical computing/ design remained an ongoing process but clarifying the meaning built an essential frame of reference. As explained by Jewitt *et al.* (2020) the use of prototyping may assist in providing communication between parties within interdisciplinary projects, and making, using, and observing allows for conversations bridging ontological and epistemological divides (Jewitt *et al.*, 2020, pp. 79-80).

4.9.2 Making Somatosensory Wearable Technology

Beyond its active manner for collaboration and aid to interdisciplinary communication, the usefulness of prototyping has been more recently used for exploring the potentials of future scenarios.

The methodological migration of prototyping to social research has partly been fuelled by a desire to research 'emerging and uncertain worlds'. (Jewitt *et al.*, 2020, p. 73)

In this use, the creation and investigation of prototypes of all manners and purposes allow researchers to propose and dip their proverbial toes into any area which may not currently exist or be standard practice. Digital touch is irregularly used in the creation of dance; however, dancers have used vibration in interactive environments/installations for performance. In this case, my use of prototyping allowed for the examination of digital touch phenomena in the creative process, which has been infrequently documented.

Personally, the process of prototyping allowed me a deeper appreciation of the materials and subsequently, an awareness of how the prototype worked. Beyond the practical usefulness of understanding the materials, coding, and electronics, there also lay a second layer of insight into the prototype use in practice.

4.9.3 Gathering qualitative data from a process

Looking at body-worn technology and creative movement choice required me to work with dancers/choreographers in an applied manner. Without this element of practical research, it would have remained a historical review or audit of the practices currently adopted within the field. As digital touch is an emergent area, the opportunity to study the creative process of working with the technology required both the making of the said prototypes discussed above and creating opportunities for involving and observing participants.

Understandably, I was unable to gain research data at the moment of dancing - either through verbal or written accounts of participants in real-time - without drastically interrupting the creative process. Consequently, I chose to ask questions about the experience retrospectively. This provided challenges in that this required participants to recall and use their memories of the experience to answer my questions, and subsequently, the acquired information reflected their perceived experience but not necessarily their 'present' one. However, scholars in dance studies have debated the temporal aspects of experience and resolved tensions involved with recollection and memory. Memory and its possible difference to the body remembering is raised by Theresa Buckland (2006) regarding phenomenology in 'Dancing from Past to Present: Nation, Culture, Identities'. She cites philosopher Edward Casey's (1987) work on "body memory", discussing how sense and feelings remembered through the body differ from the visual recollection of events (Buckland, 2006, pp. 98-99) and subsequently can provide a vivid link to the prior experience. In addition, this PhD research relies upon the collation of many types of data potentially aided by the triangulation of its sources, whereby my observations of movement can be considered alongside a participant's perception of the experience.

Unsurprisingly, there are ontological tensions concerning the nature of reality within a creative experience, as briefly discussed in chapter 2, in which I outlined the terms and definitions of the research. There is also debate about the socio-cultural influences of sense appreciation. Without entering into an extended discussion on culture and its methods of analysis, Ian Heywood's work emphasises that the distinction between the two can be blurry and therefore, we must consider sense appreciation alongside the construction of culture:

Bringing together research interest in the senses with the concept of culture requires a familiar, unavoidable distinction between two meanings of 'culture': the anthropological and ethnographic view of culture as customs, outlooks and ways of behaviour characteristic of human groups, and a more limited focus on the skills and outcomes of intellectual, artistic and constructive making in general to which artefacts with presence, functions and meanings are central. This second notion typically attaches qualitative, normative or value

dimensions to cultural activities and artefacts, be they aesthetic, ethical or political... in practice the two cannot be neatly and definitively separated. (Heywood, 2017, p. 2)

Consequently, this research's analysis of what participants feel and produce should also acknowledge cultural influences and Western aesthetics. We should avoid perceiving this through over-generalisations about the entirety of dance-making when paired with technology, recognising that the prototypes creating three different loops of code may be representative of specific types of digital touch in the contemporary dance setting in this country. Despite this, there is purpose in considering the wider ramifications of technology and its role in dance practice alongside the shared meaning created by participating and observing in the projects.

4.9.4 Embodied Research

Countless disciplines have used embodiment and the sensory experience to further understand both the socio-cultural experience and the body's role within intangible culture; with "scholars working at the juncture of sensory anthropology, performance studies, and dance ethnography have queried the relationship between the sensual and the ideological in the organization of cultural knowledge and memory" (Sklar, 2006, p. 98). From those in dance ethnography using analytical frameworks of movement analysis in tandem with their physical knowledge of learning dances (Kaeppeler, 1972), there exists a lineage of scholars attempting to understand movement and the expression of culture. Anne David explains how practical engagement in dance ethnography can create a means to gain a more in-depth understanding:

...focusing on the centrality of bodily experience as a key tool for understanding dance practice and dance knowledge. I explore how the emplaced body and lived experience (of the researcher) can yield deeper levels of understanding and insight through engaged practice on different levels of immersion. (David, 2013, p. 1)

From a sociological perspective, Helen Thomas and Jamilah Ahmed present a convincing argument for the necessity of research through "the body as a lived reality" (Thomas and Ahmed, 2004, p. 285). Their edited book, 'Cultural Bodies: Ethnography and Theory', connects each chapter through the corporeality of the researcher in the field. Andree Grau (2007) provides an anthropological perspective, commenting on the pedigree of work from scholars including Blacking, Baily, Keil, and Turner, acknowledging the importance of physicality in the epistemological framework and how this data gaining process exposes the researcher's biases, frames of reference, and "bodily knowledge" (Grau, 2007, p. 4).

Despite the differences between ethnography, anthropology, and sociology, they share recognition of the need for the researcher's presence to actively participate in the field and within the data analysis. They speculate over how this impacts the research and how as a participant-researcher it is essential to recognise one's voice amongst those present in the data. My role as the researcher inherently impacts the design and gathering of data, but through a process of analytic notation and an active discourse considering my position in the research, I hope to maintain some reflexivity. By closely watching and analysing movement, reliving the embodied experience, and transcribing participant experiences, it remains my intention to acknowledge the different voices present alongside the emergent commonalities and themes.

As embodied research involves the researcher overtly acknowledging their presence within it, Susanne Ravn & Helle Ploug Hansen (2013) consider their encounters within this methodological territory in their research on dancers' sense experience. They address dilemmas surrounding a researcher's involvement in the interactions and the particularities of each field studied. They suggest that exploring the senses presents opportunities for understanding the experience of others but that this must be accompanied by an acknowledgement of the construction of meaning produced by the researcher and participant dialogue, both through verbal and non-verbal thoughts throughout.

While it is important to emphasise shared constructions of meaning, we should also reflect upon the complexities involved in the dialogue between the participant and

researcher during their movement experience. As Sklar (2000) identifies, the element of thinking through/with the moving body in kinaesthesia or kinaesthetic awareness is rooted in a dance scholarship that has largely omitted kinaesthesia due to the historical preference for only recognising five senses, and so, the difficulties of communicating these experiences could be the reason as to its lack of adoption (Sklar, 2000, p. 70). Her thoughts on the doubled experience of kinaesthesia - the recognition and reflection in situ and then later during the data analysis - explain the complexity of its use. In essence, the analysis of one's own moving body can be utilised by the researcher if they are open to the multisensory experience and the considerations of translating this into words.

4.9.5 Participation and Sharing

As introduced by Sklar (2000), there are different thoughts associated with the importance of embodied research and how physical learning, copying, or sharing in a task may enable an understanding often difficult to articulate in words. Firstly, I have employed two different practices within this body of work: participation and sharing. This section will illustrate the benefits of experiencing the same situations as participants by task and sharing the intentions of others through learning the physical movements of choreographed work.

Susanne Ravn & Helle Ploug Hansen (2013) explain how the participatory role of the researcher permits several levels of information that can be gathered and analysed:

...through the active participation in workshops and training, I gained access to the dancers' process of verbalisation and conceptualisation in direct relation to their praxis of movement and ways of handling their body. Furthermore, in both the informal and formal interviews, I used descriptions of my second-person perspective of the dancer's practices in combination with my own first-person perspective of participating in the same practice to create a creative tension for generating still further descriptions of how they use their embodied awareness, sense of movement and interaction in their practice. (Ravn and Hansen, 2013, p. 63)

The ability to observe and participate presents opportunities to reflect on the experience in situ, considering those in front of you, their movement and expressions, and your own simultaneously. There also exists the possibility of intercorporeal or intersubjective sharing through the process of dancing at the same time.

As Pink states, the involvement of the participant-researcher in gathering data opens further methodological questions about how we recognise, document, and communicate the research, namely,

...the role of sensory perception in how we interpret and interact with others; the implications of sensory intersubjectivity for understanding the research encounter; and the ethnographer's quest to share sensory experiences with research participants, attempting to apprehend their experiences and seeking to communicate about them and with them through this sharing. (Pink, 2013, p. 54)

Promoted by sensory ethnography, discovery through participation has in part supported my methodological decision to include researcher involvement. Sarah Pink's book 'Doing Sensory Ethnography' (2013) outlines how data collected in various forms can assist the researcher in making links between the experience and analytical processes; "[r]esearch materials can be used as prompts that helps to evoke the memories and imaginations of the research, thus enabling us to re-encounter the sensorial and emotional reality of research situations" (Pink, 2013, p. 121). This method also creates opportunities for understanding subjective experience through sharing; reviewing the experience in the interview, physically revisiting aspects of improvisation, and teaching the researcher the developed movement phrase.

As discussed by Jewitt *et al.* (2016), the purpose of these more defined sensory ethnography episodes and sharing experiences with participants is for encouraging empathetic ways to uncover knowledge, feelings, and action, particularly when challenged with sensation and tacit elements not necessarily explainable by language

(Jewitt *et al.*, 2016, p. 72). Despite the opportunities enabled by sensory ethnography, this PhD research required greater structure to observe and analyse movement.

4.9.6 Movement Analysis

I must acknowledge that there are tensions associated with recording the temporal flow of movement into segments or separate actions and the interpretations occurring during the recording of movement on paper in movement analysis. In addition, there exists a danger of oversimplifying movement responses and attributing cause to the prototypes and code when multiple elements can contribute. However, following Drid Williams's (1982) description of human movement through an anthropologist lens, the study of movement favours complexity reaching beyond simplistic cause and effect responses or blanket explanations for the entirety of human experience:

[this approach rejects] ...a positivistic, behaviouralist universe where human actions are seen simply as necessary responses to external stimuli. Nor do we see semantically dense spaces solely as the results of "social forces" that are external to individual decisions. (Williams, 1982/2019, p. 22)

Finding a balance between the perspectives Williams describes is of course challenging, it requires an amalgamation of the micro-level of movement analysis with its relationship to the external world. However, by using embodied methods there is an appreciation for the complexity of human actions, their relationship to objects, and the production of knowledge through participation, recognising the factors involved in the influence of digital touch stimuli. I adopted the subsequent measures to assist in the collection of and my approach to handling the data. Firstly, I included a reflexive approach to gathering and analysing data including field and analytic notes, and secondly, I related the micro of lived experience to the interdisciplinary perspectives of research across fields of knowledge.

4.9.7 Transfer of methods

As outlined earlier in this chapter, the combination of mixed methods enabled the examination of both the creative process and the product with technology. Next, I will consider the justification for the 'transfer' and merger of established methods and discuss interdisciplinary practices using technology. In their study of different institutions and the use of digital tools and practices, Carey Jewitt, Anna Xambo, and Sara Price (2016) consider the potential of adopting methods from other fields. They argue the necessity of "inter-spaces" created by technology and the need for integration and adoption of different methods for studying new experiences:

...[it] can provide a new lens on a phenomena; re-framing it through new questions, and bring a new descriptive language and different analytical concepts to bear on phenomenon.) ...Transfer brings different epistemological concerns and historical groundings to the study of phenomena that can unsettle methods in productive ways. Methodological transfer involves the loss of a method's 'disciplinary history' when it is moved to a new disciplinary context; it is inserted into different research practices and dispositions that can lead to a method being taken up in fundamentally different ways. The transfer of methods enabled the groups to engage with the spaces, challenges and questions that the use (and limitations) of technology created for them. (Jewitt, Xambo, and Price, 2016, p. 9)

Consequently, the transfer and merger of methods can provide techniques for interrogating both the means and the data itself. Beyond this practice functioning as another level of criticality, there is also support for this approach from the fact that digital bodily practices are emergent and therefore constantly evolving, requiring different approaches for capturing the available data. I must address here the additional point that kinaesthesia or kinaesthetic awareness usually relates to one's own body, and therefore, is not necessarily about an external object/body relation (omitting the body-as-an-object stance). However, in this instance, the participant wears the object on their body, existing in a double dimension; the possibility of being part of the body (tool assimilation) and also regularly felt on the skin via touch stimuli.

As a result, we must adopt new means for considering an artistic process/product alongside technology, acknowledging that being both part of a body and in contact with it provides a complexity of sensation and response.

In conclusion, it seems logical to include an explanation as to why I dismissed certain approaches or omitted them. Before beginning Project 2, I considered combining 'Thing' ethnography (Giaccardi *et al.*, 2016) within mixed methods, to decentre the research away from the dominant perspective of the body towards one considering greater equality between the perspective of technology and the body. I recognise that this research might appear body-centric and that the materiality of the technology may seem secondary, which could be rectified by providing more data from the perspective of the tool/aid. Data capture from the technology for analysing movement would have addressed this issue, but despite its relevancy and the benefits of using sensors/data in this manner, the practical aspect of creating small and light technology was of paramount importance to the research. I felt that adding more technology to the existing prototypes may potentially inhibit movement responses during the workshop scenario.

The context of creating prototypes and the practical application of using the technology holds some associations with 'focused ethnography', as this project-led structure would be considered short-term field work and my dance background would suggest an insider status. Generally, this form of ethnography would have a specific research question and therefore would not align with an inductive approach. By contrast, 'grounded theory' does follow inductive procedures for moving from qualitative data collection to theory, through a series of steps with coding and analysis. However, the movement selected by participants remained a key component for understanding their choices and subsequent creative influences, and therefore, the inclusion of participant-observer and movement analysis deepened the interpretation of the coded process into one not necessarily associated with focused ethnography or grounded theory.

Despite its synergies with sensory ethnography, the rejection of recorded material analysis resulted in my assemblage of the mixed method hybrid illustrated below

(Figure 8). Elements of dance ethnography and sensory ethnography influenced the embodied methods approach to documentation and data collection, and this was merged with design approach of prototyping and piloting. This does not completely resolve the complexities of presenting findings or theorising an ephemeral process but does critically provide a conduit between the immateriality and materiality required for investigating creative movement assisted by digital touch stimuli.

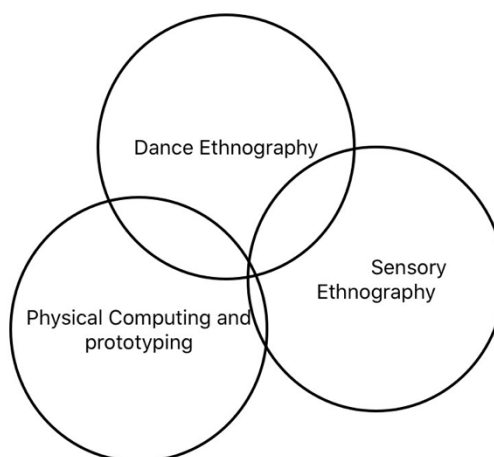


Figure 8: Diagram of the influences within the PhD research

4.10 Ethics of wearable technology

The ethics of prototype development and its use were at the forefront of this research, and as mentioned earlier in the discussion on haptics, Parisi (2018) raises the question of how technology development reveals the biases and preferences of those who design/ fund the advancement. This point will be elaborated further in the following chapters and project prototyping, outlining why I made certain decisions. From a broader perspective of movement with technology, Tuuri, Parviainen, and Pirhonen (2017) consider the 'choreographies among devices... and define three different dimensions of embodied control: instrumental, experiential and infrastructural.' (*ibid*, 2017, p. 1). They conclude that the technology design process must use embodied approaches to reveal how tools and behaviour are co-evolving. In this research, embodied prototyping and writing fieldwork notes throughout the design and making of the prototypes assisted in recognising the instrumental embodied control and the

following use of data and discussion to consider the experiential dimensions. Of course, the infrastructural element is more challenging to reveal in project-based research; however, it is helpful to highlight how embedding technological tools in making dance might enhance some aspects, with extensive use, and possibly adapt creative movement processes. This notion will be further reviewed in the final chapter; however, the consideration of user choice was a factor in the design. As the researcher, I was interested in studying the creative use of stimuli and understanding participant response to passive touch stimuli attached to the body.

Furthermore, the researcher had several opportunities to consider the ethical ramifications from the user perspective and to ensure the protocols (providing participant information sheets prior to the workshops, and information on how participant data is captured, stored and presented) established by the University of the Arts London were adhered to. The ethical approval process started with the registration of the research proposal, and forms were submitted and completed on three occasions to the ethics committee at the London College of Fashion. This procedure ensured that the changes to the workshops or prototypes were considered with due diligence. In addition, the participants of both projects had information regarding the technology and the workshops and permission forms (see Appendix D for an example of the permission forms for the workshop participants). Participants signed the papers before participating, and the completed transcriptions of the interviews were sent to the participants for amendments/approval.

4.11 Challenges and Limitations of the methods

I navigated stability issues in the first project by ensuring the participants had parity of experience via the same introduction, information sheet and permissions, prototype fitting, prompts in the improvisation and structuring task and questions within the interviews. The second project had consistency in those procedural aspects such as information sheets, permissions, and fitting of prototypes. However, participants existing practices and interests led to the varied settings and use of the prototypes. The data sets underwent the same coding and analysis process in each project which enabled consistency in the approach. The thematic analysis in the final chapter

compared learning from each project. The findings were discussed in the broader sense of working with technology, its impact on dance-making, and the experience of working with body-worn somatosensory technology.

The rationale for moving from improvisation to the task of a structured movement phase within Project 1 was to examine whether the vibration prototype might steer or navigate the process of structuring movement material into a phrase. As the researcher, it also allowed me to explore the movement from an open task of improvising to a more confined and comparable short excerpt. The decision to adapt the Laban Movement Analysis categories in the second project was because the analysis in its original form did not necessarily lend itself to identifying and comparing multiple layers of influence and interaction in the use of technology. By widening the analysis categories, the second project analysis tried to link the microanalysis of the movement to the perceptions, the body-worn technology, the environment, and the broader associations.

This research accepts the multisensory and multimodal nature of the communication and interpretation of the stimuli and, because of the inductive research approach, was able to recognise and appreciate that the sound emitted from the wearables could add or distract from the sensory focus of touch. By attempting to dampen the sound of the motors in the prototyping process, there is a recognition of the limitations of working with equipment that provides additional or corresponding stimuli in a research setting. However, the findings revealed valuable information about entrainment, and part of this adds to knowledge on multisensory reception and has brought about prospective areas for further research beyond this thesis.

This research appreciates the influence of the participants' lived experiences in their creative responses. As discussed in the introduction and contextual chapter, with regards to Csordas (1993) and Ravn (2017) and how many factors can filter into improvisation; therefore, pinpointing what input stimuli resulted in an exact output would be very difficult. However, by coding responses, looking for perception themes and considering this alongside the movement analysis, the research can recognise similarities or shared experiences across participant groups.

The nature of how information is received, combined, and interpreted by the dancer/choreographer in the moment of movement is a complex matter. In addition, the dancers' training can inform the style of movement and creative decisions in the making of the dance. Subsequently, there are limitations in considering creativity in relation to stimuli. By broadening the participant group in the second project, the research was able to gather perceptions of a wider sample and account for a range of dance experiences and training institutions.

By embodying the movement of the participants and performing together, I gained through this shared experience an understanding of how the wearables could impact the movement. In the second project, dancing with the prototypes within the same working space allowed greater insight into the stimuli and the participants' frame of reference. As the researcher/participant, there are issues of positionality within the projects. The limitations and strengths of this position are discussed at length by scholars in sensory ethnography, dance studies and anthropology, and they have been outlined within this chapter. As a reflexive researcher, recognising your presence in the research provides a way to understand and account for personal bias or influence.

The issue of agency was apparent in the use of the prototypes, in that the participants, particularly in the second project and their working practices, felt that they could not consistently achieve their aesthetic preference for the improvisation. As further detailed in Chapter 6, this shifted or influenced their working relationship to change with the wearables. Therefore, elements of control entwine with affordances and how the participant chooses to use the technology.

4.12 Summary

In summary, this chapter presents an overview of the mixed methods used to gather qualitative data. I followed this with an explanation of the research design, whereby auditing and mapping the existing technologies and institutions involved in body-worn technology fed into prototyping and the subsequent pilot tests of the technology and workshop plans. The review and development proceeded to the final prototype stage used within the project workshops, with the latter stages involving gathering data and

evaluating any further considerations I would need to implement in the following project. In this chapter, I further detailed my explanations for using semi-structured interviews, field notes, re-enactment, movement analysis, and coding of the data. I followed this with a presentation of the complexities and opportunities emerging from interdisciplinary research, my justification for using embodiment, and the transfer and mixing of methods. The chapter closed with an explanation as to why I did not adopt alternative methods for investigating digital touch in the making of dance, further sections outlining ethical procedures and implications of the prototypes/projects, and the limitations and challenges of the methods employed.

5. Digital Intervention Project

April - December 2017

This chapter will detail the planning and making process, contextualising the development of the somatosensory wearable technology (SWT) and explaining my role within each stage of the project. I will follow the initial steps of development with a summary of the project workshops, supported by a reflexive account constructed from my field notes. Lastly, I will discuss the findings and emergent themes found in the data relating to theory and research spanning the fields of philosophy, cognitive science, dance studies, and anthropology.

During the early development of the research question, I was inspired by Mark Coniglio's provocative argument for focusing on the potential for "digital tool[s]... to force and divert new ways of creating movement, rather than complementing or mirroring the dance; physically creating new conditions to innovate" (Coniglio, 2017). Consequently, the ideas for the preliminary prototype were largely based upon disrupting movement and embedding materials into the technology to make this happen. Through a process of reading, discussing ideas, and refining the approach, my aim evolved and narrowed to prototypes creating possible forms of digital touch.

5.1 Prototyping and Planning

My successful development of the prototypes began following an audit of the existing technologies and then mapping those projects using wearable technologies in dance. I quickly came to realise that I would not be able to source suitable wearables for creating digital touch within the timeframe and budget parameters of a PhD research project and so instead, the research's aims changed to incorporate the making and development of body-worn devices. Despite the challenges of having limited experience with digital making, I was encouraged to learn new skills including electronics, physical computing, design, and sewing to create the prototypes for Project 1.

By approaching the Digital Anthropology Lab (DALab) with my initial areas of interest, the creative process evolved from rough sketches to discussions about materials and parts. As a dancer, I intuitively possessed an awareness of the usefulness of disrupting the body's centre of gravity through adding to the skeletal structure, however, the senses came to influence my early designs, for example, by impairing or restricting the vision. Subsequently, the consideration of touch and the use of vibration and communication through a tactile means arose.

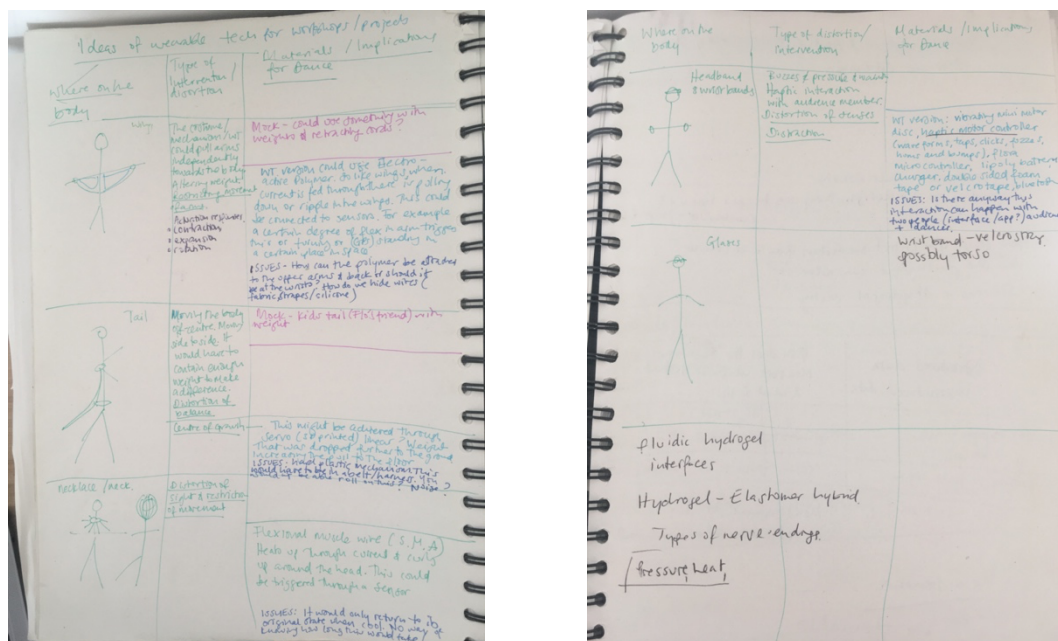


Figure 9 and 10: Initial sketches and ideas for prototypes

From a practical perspective, vibration motors provided a readily available and cheap option with existing libraries of vibration patterns and intensities accessible to code with relative ease. Immediately, the apparent positives of using these small motors and my research into their communicative potential opened a range of ideas.

5.1.1 Materials

Through access to spare electronic parts at the DALab and tuition from its technicians in circuits and soldering, I mastered the basic on-off operation of motors. This led to testing how several motors may be used in parallel with conductive thread and fabric, experimenting with different fabrics (felt and cotton) and patterns. Despite the

advantages in terms of flexibility of fabric and thread, the joins/junctions between soft and hard materials (the motors and the microprocessor) created weak spots, which in this instance, were often too delicate for the rigours of dance exploration. In general, the use of wires in the circuit provided a stronger and more reliable electrical current for the Adafruit Flora microprocessor and the vibration motor, however, this left less flexible connections requiring encasing.

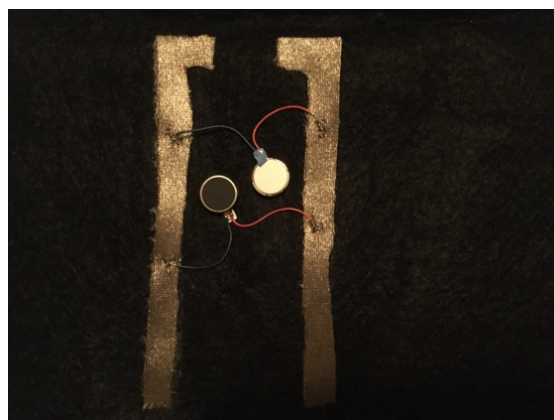


Figure 11: Photo of test with conductive fabric and thread and small motors

5.1.2 Placement

Optimum movement range became of paramount concern during the prototyping, largely for ensuring that the user could easily move their hands and feet during supporting and travelling actions. Additionally, the technology's placement needed to be in an area already proven sensitive to vibration (Gtat *et al.*, 2019) but also relatively discreet; therefore, I selected the inside of the lower arm for placing a prototype in the form of a bracelet.

During the pilot, the encasement of the technology evolved from a small thin cotton bag to a silicone and muslin band. Through a series of experiments with different porous materials, I considered the different thicknesses of silicone and the material's absorbency throughout the curing process. A material like silicone enabled a flexible structure for holding the technology, while the material cured with silicone allowed me to sew Velcro fastenings to accommodate different participants' wrist sizes. Material

testing included a range of commercial silicones cured in muslin and bandages and different fastenings, as can be observed in Figures 12 and 13.



Figures 12 and 13: Conducting tests - curing silicone and materials for attaching the technology to the body

Juggling the functionality of the prototypes with my aspirations meant the designs required constant re-examination and modification throughout the prototyping process. Factors including the location of the electronics (worn close to the body, but on a location where it would not hinder movement) and the robustness of materials (wires versus conductive thread and material, silicone versus cotton materials) ultimately steered the development of the prototypes.

5.2 Pilot and Development

I tested the initial versions of the technology during the June 2017 pilot. One participant received a very simplified version - one vibration pattern every two minutes through an Adafruit Gemma with a vibration motor - the other participant wore a more complex loop - the entire library of vibration patterns totalling 123 effects played in the same order controlled by an Adafruit Flora, haptic motor controller, and vibration motor.

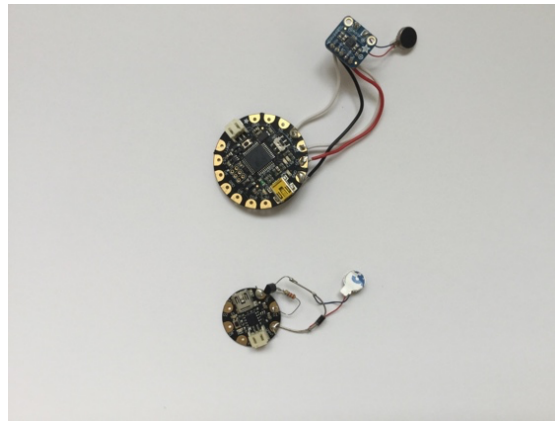
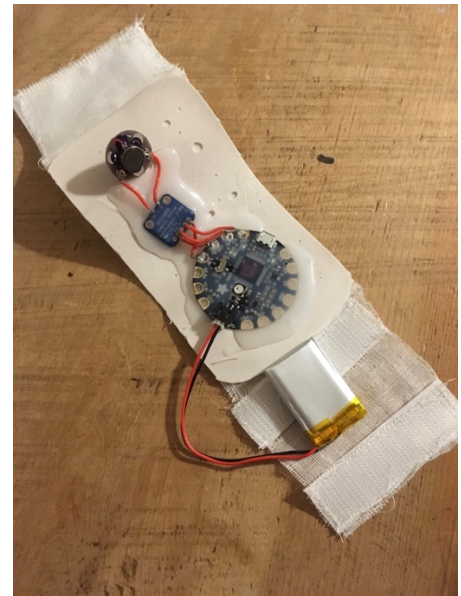


Figure 14: Circuits used in the pilot

Verbal feedback (see Appendix E) received during the pilot indicated that some of the vibration effects were too subtle, leading me to investigate and devise a code including stronger, more prominent effects. In response to the feedback and from my own concern that one armband alone may not provide enough stimulation for the workshops, I developed a second version of the prototype programmed with a different coded loop. Used in conjunction with the simplified version, the two bracelets would be worn collectively: one for each arm of the participant.

The June 2017 pilot of the workshop structure and its subsequent evaluation provided me with valuable insights into language, approach, and the environment. Two participants physically completed the workshop, with one participant observing. The informed observer's feedback suggested minimising instructions to that of prompts, advising that this would further assist participants to explore aspects within a defined structure, but also allow participants the necessary freedom to explore movement during the improvisational section. My analysis of the pilot's initial tasks led to my refinement of the tasks and prompts, and consequently, my role as the researcher. I developed the workshops so that participants could respond to a series of choreographic tasks performed under two different conditions; one requiring the wearing of two wrist bands with different programmed vibration loops and the other performed without wearable technology. Aligning the tasks to imagined touch and digital touch stimuli, I designed three prompts asking the participant to respond to either the imagined sensation of touch or the physical sensation on their wrists.



Figures 15 and 16: Final Prototype used in Project 1 – Digital Intervention Project

5.3 Workshops



Figure 17: Photo of the Balcony Space – Studio Wayne McGregor, London

The project culminated in choreographic workshops held over two weeks at the Balcony Space at Studio Wayne McGregor, Stratford, London. With audio-visual equipment support from three members of the DALab staff, I facilitated the workshops, conducted interviews, and oversaw the technology construction for the duration of the project. Each day was split into two - morning and afternoon - with each session involving a different participant spending approximately 2 hours 30 minutes completing the tasks and talking about the experience. Nine participants out

of a possible ten completed the workshops, eight of whom were female and one male. Recruited from a London-based conservatoire for contemporary dance, the participants were in their second year of professional training on a Bachelor of Arts (Hons) course. The group came from a range of European countries - including British nationals - and were all aged between eighteen years and twenty-five. Here, it is worth considering that the participants all came from the same institution, having gained specific dance training following a particular education ethos. While overall, contemporary dance training respects the unique individuality of each dancer and how they move, I was conscious of this factor during the movement analysis and semi-structured interview and therefore, this formed part of my reflexive treatment of the data and the subsequent analysis.

Each dancer completed the choreographic tasks wearing the two bracelets, the right-side bracelet containing a loop of the ten most prominent vibrations and the left-side with a loop of 123 different vibration effects. The tasks were also completed without the technology; this order was randomly changed to vary the experience for the participants. During each condition, they completed a 20-minute structured solo improvisation, later refined and structured by the participants into a 16-count movement phrase. Next, I asked the participants to teach me their movement phrases to enable my further embodied understanding of the movement and the motivations behind their choices (see Appendix F – Workshop Plan).

The conditions differed in that I asked the participants to respond to the *physical sensation* of touch created by the technology and *the imagined sensation* of touch. I offered three main prompts and then sub-elements for considering through each prompt.

Prompts	Elements within each prompt
1. Close your eyes, I want you to concentrate on the touch and the physical sensation of this. Where is it happening on the body, the type of touch, and the frequency? How does this make you want to move?	- shape - level - space - time - dynamic qualities
2. Concentrate on the source of touch, the materiality of it. How would you move in relation to this?	
3. Shift your perspective and attention away from the sensation of touch, how does this impact your movement?	

Table 6: Prompts from the workshop plan

All participants were videoed during their movement response and interviewed after the workshops to record their perception of the creative process.



Figures 18 and 19. Participants in the workshops using the prototypes

5.4 Findings

Collated data went through a process of transcription which I then merged into tables examining the individual, including a movement analysis during their improvisation and movement phrase and their perceptions of the experience (see Tables 1 and 2). I also devised tables for considering the collective results, looking across the participant group (see Appendix G). The discussion below is based on the themes arising from the coded data from the interviews and fieldnotes and the trends across movement analysis.

5.4.1 Improvisation

5.4.1.1 *Internalised sensation*

The main difference noted between the perceived experience of the two conditions was that despite being produced by an external object on the skin, the vibration promoted a more internalised sensation. Participants felt it vibrate through their body and internally in bones and tissues; as Participant 2 described, “[I] felt it in my veins” (*ibid*, 2017, Interview). Participant 5’s response reiterated this sensation of vibration and transduction:

...with the technology, it was all very internal, especially at the beginning... it was in me [laughs]. Because in touch, you can only touch the top of your skin, there’s imagery of it going deeper but it doesn’t really go in - it’s quite superficial. Whereas with the vibration, I felt like it was in me. (Participant 5, 2017, Interview)

Confirming her peers’ perception of the experience, Participant 6 comments on how “it made me more aware of... it was like a different sense. Like the pulse felt internal. So, I almost felt - this might be more related to the idea of touch I was using. I felt wearing the technology, the movement came from a more internal place. Whereas, without the technology, I was using my mental image of the external touch” (Participant 6, 2017, Interview).

As Participant 6 explains, she summoned the *imagined touch* as something external to the body and coming from different angles, promoting different body parts to move. As further clarified by Participant 3, “[I] found it easier to think about being pushed or pulled. As a force, as opposed to a touch” (Participant 3, 2017, Interview). Additionally, the participants discussed the movement produced by the SWT in more abstract terms, with the imagined touch condition more often related to a memory of human touch such as being touched by a specific person or touch as a force, as recounted by Participant 4: “I imagined someone else was moving me” (Participant 4, 2017, Interview).

5.4.1.2 Influence on rhythm and quality

The constant physical stimulus provided by the loop could evoke a direct response in rhythm and quality. When wearing the SWT, most of the performed movement during improvisation reflected the rhythm - from moving to moments of stillness -embodying the ten looping vibrations on the right arm. This was also observable during dynamic changes between bound and free movement and as noted; “juddery movement and then smooth” (Participant 3, movement analysis) and in the case of Participant 7 where “the arm extends in moments which give a sudden burst to break the slowness of the other movement” (Participant 7, movement analysis). Commenting on the rhythmical influence, Participant 6 stated that “it didn’t feel superficial because it’s on quite a pressure point, it was kinda deep. And I feel, as I went on, I was able to incorporate the pulse of it a bit more and I felt that it came... I realised my patterning of it was dependent on the pulse” (Participant 6, 2017, Interview).

The table below summarises the participants’ improvised responses to prompt 1, asking them to consider the sensation from the prototype and move following this input. This movement analysis discusses the participants' initial responses, as prompts 2 and 3 ask the participant to further consider the materiality of the prototype, and then to try and ignore the sensation.

P1	First Prompt: Jagged movement. Isolations - gestures of the arms and then coming into the torso. Bound and then moments of free. Started as a small kinesphere reach but progressed to large.
P2	First Prompt: Shifting weight (stepping, turning, sitting), there is a rhythm of move and stillness. Smooth quality, but this is still quite bound and controlled. The focus of space is indirect. Medium to small kinesphere reach. Distal Initiated - lead and then fold the body back in on itself or shift to another point in space.
P3	First Prompt: Distal limb initiation (predominantly the right arm). The movement almost shifted around the arm in space- in relation to the body. The movements produced were fragmented, juddery and moments of pause. Bound, sudden. As the improv progressed there was more sequential initiation - the judder through the body, but then smoothness. Small to medium kinesphere reach.
P4	First Prompt: Distal initiated - but both wrists leading the movement, the dialogue between the two wrist bands. Melting inwards towards the core/torso and then the extension with the arms. There is a sense of the body being caught in the middle between two points. Rocking, swinging, pulsing, turning. As the improv progresses the movement becomes more angular, but still the body relates to the wrists in space and how they lead the movement. There are moments of moving then contemplation. Use of middle and low level. The flow goes between bound and free. The dynamic quality becomes a bit quicker and erratic as the improv progresses, with more jumps (little).
P5	First Prompt: Bending back in, stepping out. Coming back to the centre, the arms lead the movement. There are pauses, then more accented movement. Spiral in the body and a bit more swing in the movement. The dynamics are free, indirect, light - sometimes with a little weight in the swing. The movement is mainly on the middle level, with some low. Medium kinaesthetic reach.
P6	First Prompt: The movement is led by the wrists, distal initiation. The arms pulse and fold the body over and then lead the movement to extend. The legs are just shifting in response to the upper body and it's mainly stepping and standing actions (lunges, crouching). Dynamics go between a weighted, bound element and then free, a bit like a rebound, but more complex because it seems to be a dialogue between the arms, although it's mainly right arm dominant. The movement is mainly on medium level and the reach ranges from small to large kinesphere.
P7	First Prompt: Slowly moving into the floor and adjusting the weight into different places of weight-bearing. The arms extend in moments that give sudden bursts to break the slowness of the other movement. Large reach of the kinesphere. Spinning and spiralling to the floor. The initiation of the movement comes from the distal, mid limb and core. The movement works through all levels, the most dominant is the floor work. Its quality is smooth and free flow. The speed picks up and the movement covers more space in the room - more expansive.

P8	First Prompt: There is an element of moving and then resting. The movement is predominantly on a low level/middle level. The arms (distal) initiate the movement and cross in front of one another or rotate around the body, wrapping around. Slow and sustained, the movement is medium weight (neither strong nor light), there are elements of bound.
P9	First Prompt: Scooping the space with arms and framing the body. Slow and sustained quality. Fluid and free, the body dips and twists from the distal initiated movement. Middle-level movement using a medium to large kinesphere reach. The movements do not shift much in the space and tend to stay in centre stage for the most part.

Table 7: Summary of Prompt 1 - Participant improvisation with the vibration prototype

The participants cited anticipating the rhythm of the code or the relationship between the two bracelets and the looping of vibrations - the interjection of the left arm SWT - as a factor in their movement response. As Participant 2 described:

So obviously, it wasn't constant, but you always felt like it was there, you were always expecting it. It was irritating, it wouldn't leave you in a sense. That's why that sort of movement and repetitive things - slightly twitchy, twitch effect to it. It obviously felt a lot more right-side dominant, and the left side was a little bit more weary. You were not sure exactly when it was going to come. You were expecting and got used to the pattern on the right. But for the left, it came and then went slightly down, and you were like, "oh when is it going to come back?" And in some ways, the left side would just react to what the right side was doing, but that's why I was more inclined to use the right side of the body, but then obviously the left side was still affected. (Participant 2, 2017, Interview 2)

Participant 4 similarly considered the right-side dominance and how the interaction of the two bracelets influenced the movement:

Yeah, the right one. Or it felt more dense. I think kind of at some points, later on, because it's a constant happening. It could almost be kind of comforting in a way, a layer of something, that's just constantly there, and that affected bits of my movement, but I didn't last long in that inspiration for my movement. It

often came from something, like the space between the tapping. Which because that was kind of - the rhythms were off each other, they weren't happening at the same time. (Participant 4, 2017, Interview 4)

In the same way, the occurrence of bound and weighted movement was more frequent during the SWT improvisation, suggesting the coded vibrations provided a qualitative impact on the movement, influencing the manner an action is performed. In the categories used to analyse the movement following Laban, "this factor refers to the muscular tension used to let the movement flow (free flow) or to restrain it (bound flow)" (Fernandes, 2015, p. 3227).

As can be seen in Table 7, the responses to Prompt 1 possessed a stop-start quality reflecting the relationship between the two different vibration patterns on each bracelet and the looping dialogue. We can view an example of this within the video footage of two participants found in Appendix H.

5.4.1.3 Movement initiation

My movement analysis of the improvisation tasks disclosed that without the SWT, movement was initiated across the full range of areas. By contrast, the focus on the arms where the bracelet was located dominated the condition using the technology. Although we could expect the distal initiation of movement resulting from the physical presence of the vibration on the wrists, of interest was how the arms were then brought back about the body. For example, wrapping, scooping, folding movements framing and highlighting the body were frequently included in the participants' movement choices (see Appendix G, Data Summary Table – Group, and Appendix I – video footage).

Similarly, this is supported by Participant 7's account:

Because of the way it vibrates, it made me turn - to think about turning to follow the vibration... I don't know why I associate the rotation to the vibration? Maybe because it was wrapping my wrists. The idea of something -

not blocking you - but limiting my movement. Obviously, after a while, you start to translate that feeling into the other parts of the body, so it's not the arm anymore. Even though I was giving importance to the arms, I was trying to recreate that feeling to the rest of the body. Something physically wrapping around the body. (Participant 7, 2017, Interview 7)

This experience was highlighted in the pilot when using the more simplified version of the bracelet, where Participant B described the technology as enabling an unusual engagement with the rest of the body: "I thought more about what the rest of my body was doing in relation to it... I don't think I was conscious of the opposite of what was happening until I had the wearable tech" (Participant B, 2017, Pilot Transcript, Appendix E).

5.4.1.4 Foci and Awareness

The SWT enabled the participants a greater awareness by assisting their focus. Describing the experience, Participant 2 expressed how "[f]ocus and ability to primarily respond to the touch was easier with the technology. It gave you like... an input to what you are doing. Instead of you having to think, about how it would make you feel, or imagine it, it was just happening to you" (Participant 2, 2017, Interview). Participant 4 explained how "[i]t brings your focus in" (Participant 4, 2017, Interview) while Participant 5 similarly described how the experience of the prototype was "more of a focus rather than it just affecting the movement. It was more driving the movement. Rather than just something to think about" (Participant 5, 2017, Interview). Participant 9's experiences echo that of her peers, whereby "I started going to think about dancing and responding to it at the same time, rather than just thinking how responding to it can initiate dancing"(Participant 9, 2017, Interview). The connection between the SWT and dancer is two-fold; firstly, it can diminish the tendency for consciously premeditating movement and secondly, it can act as foci for movement generation. However, some participants perhaps found the repetitive nature of the loop to be limiting, and in some instances, difficult to initially understand:

In the first task, because of moving with the vibration and the different feelings of the movement. How I would feel in the movement with the vibratory response in my body. I was thinking and doing, sometimes which was quite difficult, quite challenging. (Participant 8, 2017, Interview)

Despite this, participants also described the more positive aspects, stating that the SWT enabled a more “honest” response to the stimulus,

[the] vibration... sharpened my senses a bit more, it made me more aware. There was definitely sort of an awareness happening. For the next task, it was like an after effect of the vibration. In some ways it was like warming up of the senses, sensing my senses through the task of improvising (Participant 8, 2017, Interview).

5.4.2 Structured Movement Phrase

After the participants’ improvised response to the prompts, I asked them to structure a 16-count movement phrase. When using the *technology*, the findings from the movement phrase section reveal similarities between participants, namely, their use of rotation and frequent spirals and turns. The movement analysis also revealed the use of flicks and extensions in the space. Less than half of the participants moved into the general space of the room, so its prevalence or relevancy is questionable. The movement mainly occurred on the middle level with some low level, but this did not affect their kinesphere reach with a range being used. The movement contained a mixture of distal and core initiation.

By comparison, during the 16-count phrase *without the technology*, the participants’ responses were divided with some creating accented phrases and others using very slow and sustained qualities throughout. The initiation of movement mainly originated from the core and distal, and so was therefore comparable to the phrase created with the SWT. Similarly, in the phrase completed wearing the prototypes, movement occurred over medium and low levels but with a greater frequency towards the latter

and utilising a complete range of kinesphere reach. There did not seem to be any occurrence of patterns in the actions created across the whole participant group.

The effort categories of the 16-count movement phrases across the participant group differ completely, as does their dynamic quality. Consequently, I observed a greater diversity of dynamics, use of different body parts, and some aspects of space during the structured phrase than in the movement generated during the improvisation. We can attribute this to a more direct response in the improvisation section, whereby participants reacted to the stimulus present on the skin and its interpretation. During the devised 16-count phrase of movement, there were different interactions potentially resulting from the additional time - for deciphering the loops between the arms – and their reflectivity when deciding movement structure.

5.4.3 Field notes and the reflexive researcher

5.4.3.1 Emplacement

Studio Wayne McGregor is an extraordinary space and so consequently, we must acknowledge the influence the environment may have had on the participants. On one scale, the open top of the room allows for both people outside to see in from above and for the participants to view and hear external events, for example, the phone ringing in the office. As the field notes illustrate:

The Balcony space or workshop space is wooden and open-topped (no ceiling), so it's quite a unique space. There are usually pieces of art within the space, but these have been moved for safety. There is a sense of warmth from the wood and it's a box shape, so it is enclosed and open simultaneously. Without a doubt there will be some influence of this space on the movement, not just for the fact that you can hear noise from all around, from the office, from the other rehearsal studios, but the unusual setting. (Field notes, 6th Dec, 2017)

All these environmental influences may also become possible parts of the improvisation and therefore, we must appreciate its 'presence' in the results when

considering any movement analysis and the subsequent discussion. Equally, we cannot ignore my own influence, with simply the active presence of another person in the space impacting the response of the participants. However, the participants were students at a conservatoire of dance accustomed to external observation by way of their education, and so, this situation can be perceived as a component of the conventional experience of a dance student.

5.4.3.1 Order

Undeniably, the order of the conditions may prove influential, particularly when the participant initially completed the workshop wearing the technology. This work recognises that prior experience can influence thinking to potentially leave traces, which in turn may continue to influence the second condition.

Despite the possible influences shaping participant responses, there are also positive aspects to my reflexive position when collecting and analysing the data, detailed in Chapter 4. In the following section, I will consider in further depth the themes identified from the coding, with an appreciation for the previously discussed factors.

5.5 Discussion

I gathered the following themes from the coding of the qualitative data: *Internalised sensation; Influence on rhythm and quality; Movement initiation – reference of a body part to the whole body; and Awareness/Foci*. I will use a broad range of theories and research from cognitive science, philosophy, anthropology, cognitive archaeology, and dance studies to explain and unpick the use of digital touch stimuli in the process of making dance. As a result, this chapter will consider how we may explain sensation, consciousness, and perception with the SWT and subsequently, its use by participants in the creative choice of movement.

5.5.1 Internalised sensation

Firstly, let us contextually consider vibration touch stimuli. Vibration as touch is commonplace due to the use of small motors within mobile phones, smartwatches,

and fitness trackers. Everyday activities involve people wearing these devices or at least holding them close to the body, for the purpose in this context of such vibration effects alerting or communicating specific meaning. However, only one of the participants related their experience in the workshops to the vibrations from the commercial products they might own and use. We can explain this through the location of the vibrating sensation and the closeness of the motor to the skin. Interviewee descriptions located the sensation travelling internally, such as "I felt [it] in my veins" (Participant 2, 2017, Interview), indicating a relationship between that felt externally but also viscerally while involving an imagined response. The sound and the rhythm of the vibration loop were also influential, as explained in the findings regarding the dialogue between the two bracelets and their loops, discernible within the 'stop-start' tendency of the movement, and the associated bound and free dynamics.

The 'multimodality in body awareness' theory (de Vignemont, 2014; Wong, 2014, 2015, 2017) maintains that our body uses senses collectively to create a working body schema. The argument is that motor control requires an up-to-date plan of the body for effectively dealing with everyday activity and therefore, uses information from different sources including sight, touch, and proprioception to integrate and manage how we perceive our body during action: "that proprioception feeds into the construction and maintenance of a multimodal body schema – suggests one way in which proprioception could figure in action control" (Wong, 2017, p. 32). Responses from participants suggest that the process of utilising all the combined senses and subsequent information became entwined and inclusive of *internal awareness*:

...that image held quite strongly, the buzzing- travelling an imagined current going through my bloodstream and nervous system. And the left [bracelet] was very subtle and sometimes I found it very hard not to want to play with that more, and I wanted to stay honest to the intervals that it went off. (Participant 3, 2017, Interview)

The experience combined the association of real - vibration waves travelling through the body - and imagined stimuli - images linked to the vibration and sound - with the

interpretation of coded vibration supporting a multimodal perspective of body awareness. In this instance, the vibration bracelets prototypes encouraged greater attention to an internal perspective of the body.

As suggested by Clark and Ando (2014), the dancer utilises a broader encapsulation of imaginative propositions in their kinaesthesia. For example, this involves a dancer creating images relating to how they move in real-time with their imagined intention, coupled with the projected feel and look of movements (Clark and Ando, 2014, p. 12). They continue by discussing the use of digital resources for promoting diverse ways for considering the body's kinesphere and use of space. They suggest that using digital imagery - in this case, mappings from motion capture - combined with choreographic instructions will allow a recognition of internal aspects of the body and can inform new ways of improvising. Moreover, Clark and Ando state that this method exceeds external trajectories and geometric forms of visualising and occupying space, to a new connection of the tactile body to the external environment through sensation and projection (*ibid*, 2014, p. 14).

The findings of this research support a similar experience adhering to an internal reference of sensation and how it travels through the body influencing the dancers' use of kinaesthetic awareness. However, the visual aspect of multimodality becomes less important to the dancer/choreographer as they utilise imaginary sources inspired by the prototype's sound and sensation. To summarise, digital touch through improvisation promoted a heightened awareness brought to the body from the vibration and a greater awareness of the body internally. As the SWT is an attached object to the body and used for the purpose of choreography, it is necessary to also consider a discussion of tool use relating to these findings.

5.5.2 Tool assimilation

Despite the lack of reference to tool assimilation by the project participants, the theme of *internalised sensation* warrants investigating the relationship between the prototype and the body itself. While the participant wears the object on the body it does not necessarily induce a lengthening or expansion of its material boundaries, and

due to the contact with the participant's skin creates greater introversion. Vibration and sound created by the prototype add another dimension to interoception and proprioception than perhaps normally utilised by a dancer. This extra element of our kinaesthesia results from the constant physical presence of sensation and sound from the vibration prototype. It enables a richer relationship of different body parts to the whole and to the physical space explained by the relational element discussed in the movement initiation section of the findings, particularly as the movement, shape, and quality maintain a point of reference. This new relational understanding of the body through digital touch is certainly sympathetic to that envisioned by Clark and Ando in their use of digital imagery (*ibid*, 2014, p. 14).

As briefly discussed in Chapter 2, tool assimilation and its adoption within the proprioceptive frame is associated with both frequent use and skilled control of the tool. In this project, as they were not required to master handling the tool, participants were permitted a maximum of 45 minutes with the vibration prototype, but of course merely interpreting the digital touch presents different parameters. Regardless, we still need to understand the level of consciousness involved when using the prototypes, particularly during improvisation.

Anthropologist Tim Ingold (2011) dismisses the notion that automatic movement is associated with expert tool use, arguing we can perceive through sensory participation of using the tool by relying upon an active awareness of the ever-changing environment and affordances of the material. Accordingly, the movement may seem to be automatic, but it is operating through a less defined attention to the task through the senses and therefore, suggests a type of awareness in keeping with Wong's multimodal updating of the representative body (2017). By subscribing to both Ingold's theory of sensory participation (2011) and Wong's multimodal body schema (2017), we could propose that the constant presence of vibration patterns heightens this process through tactile means. Therefore, heightened awareness occurs through the expanded sensory participation of both internal and external sensations and sounds. However, the complexity of ongoing sensory information in the *looped* vibration and sound makes this process both a predictable and anticipatory act when complicated by using two bracelets on two different loops.

The question of automatic movement when using a tool requires further deliberation, with academics mostly discussing unconscious movement related to "job" orientated tasks such as driving a car, rather than a creative activity with divergent pathways.

Dorothee Legrand considers this further:

In dance, goal and means collapse to some extent, and the experience of the body and its morphocinetic²³ actions come "at the front". Contrastively, most of everyday life actions are topocinetic²⁴ goal-directed actions. (Legrand, 2007, p. 502)

As highlighted by Legrand, the experience and the aesthetics of the movement are of greater concern in choreography, as supported by the findings of this project: participants articulated added emphasis on the 'how' of movement (Participant 1, 2017) when using SWT. More importantly, these findings suggest that the constant reminder provided by the SWT's somatosense stimulation allowed participants to access a heightened awareness and focus. This enabled another reference of the body part to the entire body, feeling vibration waves travelling internally through the body and more overtly, the qualitative dynamics associated with performing the movement.

5.5.3 Movement initiation and relationship of 'body part' to the 'whole body'

As the body wears the device, its location is unsurprisingly complicated within the data and findings. In the case of Project 1, participants wore the prototypes on the wrist and therefore peripersonal space could factor within the theme of movement initiation and the perspective of the body part to the whole. De Vignemont explains body part relationships and the theme of relational movement to the entire body by considering that "a defining characteristic of peripersonal space is that is encoded in a body part- centred frame of reference" (De Vignemont, 2018, p. 177). Subsequently, this can clarify the findings involving the intimacy of sensation whereby vibration

²³ Morphocinetic actions being the 'what'- the form, shape, structure.

²⁴ Topocinetic actions being the 'where' – the place.

travels through the body encouraging interoception, but also the body's disposition for orientating body parts based upon the location wearing the SWT.

Central to this discussion is how this specific form of passive digital touch may influence how the choreographer/dancer themselves feels moving in space and how this involves internalised sensation. Whilst discussing virtual reality, Royden Hunt (2000) considers the space on either side of the skin's boundary. Employing Rosmini's theory of "fundamental feeling" (FF), he contemplates experiencing space differently through technology:

The subjective FF contains a feeling of space which is in itself not shaped nor limited by the body surfaces, until the limits of the felt body are defined by touch sensations on its surface. Such a surface can only be located in the felt space of the FF because this space extends on both sides of the surface. Movement into spaces outside the body then generates a subjective sense of time, and the importance of movement in both dance and in and through installations (real and virtual) for the generation of subjective space-time is clear... Interactive VR techniques draw attention to this feeling/felt union in experience and particularly to the spatiality of the FF and the extrasubjective inputs which lead to a consciousness and an exploration of this space. (Hunt, 2000, p. 147)

Even though Hunt argues touch sensation reinstates the binary of inside/outside the body, his line of inquiry holds value by opening the debate to possibilities of the dancer's awareness of space being adapted by technological assistance. If we dispute the simplified notion of touch presented by Hunt and instead consider the complexities of vibration as a form of digital touch, one can conceive a different subjective sense of space engendered by internalised perspectives and somatoperception. Certainly, the relationship of the body part to the whole may be explained by the prototypes' location and the SWT's promotion of peri-personal space, but how the vibration travels through the body and in turn how the dancer/choreographer utilises and maps this through the body is suggestive of an internal perspective to space.

5.5.4 Habitual Movement and Presence

Changing perspectives, alternative methods, using rules to divert tendencies and patterns: these strategies are commonly employed by a dancer/choreographer to move beyond their habitual preferences or existing behaviours. In choreography, we see retreating from convention towards novel ways of moving to be both favourable and positive (Nöe, 2016, Para 31.34), and so we must identify how participants ordinarily move so that their habits can assist in ascertaining technological influence. The results of The Digital Intervention Project - Project 1 indicate that although habitual movements remained present when moving with the technology, participants still cited the value of working with the technology, explaining that they “felt different” when moving with the SWT. Participant 1 identifies the differences alluded to, suggesting, “it makes people think less about what they are doing and more about how they are doing it” (Participant 1, 2017, Interview 1). This response highlights the prototype’s role in providing a focal point not necessarily for action choice but the dynamics of the movement.

If the prototype enables greater awareness of *how* the body moves, then it provides reference or foci for what Maxine Sheet-Johnstone terms “qualitative dynamics²⁵”. She contends “the more attention we properly focus on the sensory modality of kinesthesia the more insight we gain into its experiential realities, that is, into its inherent qualitative dynamics, and the more insight we gain into those experienced qualitative dynamics, the more insight we gain into the foundational, integral and pervasive significance of thinking in movement” (Sheets-Johnstone, 2019, p. 9). For Sheets-Johnstone, the *how* is important to both the thinking process behind movement and identifies the habitual movement that is your kinetic signature. As previously discussed in Chapter 2, this notion relates to the individual characteristics of

²⁵ Qualitative dynamics, as termed by Maxine Sheets-Johnstone, includes: “the felt tensional quality has to do with our sense of effort; the linear quality with both the felt contour of our moving body and the linear paths we sense ourselves describing in the process of moving; the amplitudinal quality with both the felt expansiveness or contractiveness of our moving body and the spatial expansiveness or constrictedness of our movement; the felt projectional quality with the way we release force or energy” (Sheets-Johnstone, 2011, p. 123).

how you move, rather than the actions per se and Sheets- Johnstone explains this developmentally through a combined process of moving and learning from childhood.

During improvisation using the vibration prototype, there was an explicit looping mechanism placing participants on a continuum. Consequently, the body becomes bound by a repeating loop to the consideration of what just occurred, what is happening at that moment, and what is about to happen. Through this process, the vibration patterns draw the participant in, ultimately influencing their body awareness and focus during the temporal experience.

5.5.5 Time and consciousness

To further understand coded loops combined with the participants' creative digestions and interpretations of this stimulus, we must consider how phenomenology explains the pre-reflective experience. The work of Husserl is a useful starting point:

...consciousness is engaged in continuous alteration. The actual [leibhafte] tonal now is constantly changed into something that has been; constantly, an ever fresh tonal now, which passes over into modification, peels off. However, when the tonal now, the primal impression, passes over into retention, this retention is itself again a now, an actual existent. And every retention is already a continuum. (Husserl, 1964, §11, pp. 50 -51)

These concepts of primal impression, protention, and retention²⁶ detail why this process of awareness occurs, holding even greater significance to the participants using a device on a digital loop. As Dan Zahavi (2003) comments, if this process of pre-reflection works as an unfolding of the temporal event - enabling recognition of past, present, and future moments of consciousness - then certainly, this may appear to

²⁶“Primal impression - that intends the now-phase of experience in subjective or phenomenal time and, by virtue of that, the presently intended object” (Drummond, 2007 p. 170). “Protention is that phase within the momentary phase of consciousness or living present that intends yet-to-come phases of absolute consciousness (*ibid*, 2007, p. 171)”. “Retention is that phase within the momentary phase of consciousness—the living present—that intends just elapsed phases of absolute consciousness” (*ibid*, 2007, p. 182).

influence the level of awareness operating during improvisation. Looping the digital touch sensation demonstrates an explicit marker of the continuum of consciousness during improvisation, potentially explaining the "don't think, just do" element of participant responses to the vibration patterns. For example, if the participant recognised the vibration pattern, then during the repetition they may actualise their movement intentions even when not fully conscious of this happening. However, questions remain as to whether a heightened awareness of the body influences decision making during the improvisation process and so, I will explore further theory concerning consciousness.

To pursue this line of inquiry, we shall return to Dorothee Legrand's (2007) discussion concerning the various levels of awareness of consciousness during a dance. She promotes four distinct categories specifying how we may operate under differing levels of attention to body control. These include the "opaque body" for when an objective stance is required to learn new movement; the "invisible body (absent from the experience)"; the "performative body" - lying between these polarities – allowing for full control of movement alongside a less overtly conscious direction of the body via pre-reflective consciousness; and the "transparent body (the pre-reflective bodily experience of the world)" (Legrand, 2007, p. 514). By considering the expert dancer's "in the moment attention to the body/environment", Legrand proposes a consciousness formed through the integration of sensorimotor information (Legrand, 2007a) whereby awareness of this remains in the foreground but is not necessarily intentional. Legrand describes this changing pre-reflecting consciousness as being of the body itself, taking account of the environment and its role within it. She considers this an active process, but not necessarily one of which we are overtly aware. Certainly, the concept of the "performative body" resonates with the following description of the experience by Participant 2:

...focus and ability to primarily respond to the touch was easier with the technology. It gave you a like an input to what you are doing. Instead of you having to think about how it would make you feel, or imagine it, it was just happening to you. (Participant 2, 2017, Interview)

Of course, one could misinterpret Participant 2's perception of using the SWT as merely a reaction to the stimuli presented on the body, yet if this were the case, there would be no digression in the movement response of the participant. The movement analysis and interviews serve as evidence that the participants developed their responses to the sensation during the 20-minute improvisation. In isolation, the looped code of digital touch shifts beyond a stand-alone sensation to uncover the complexities in the participants' responses. Used in tandem with digital touch serving as a marker within the pre-reflective experience, the expanded sensory perception of the SWT explains the "performative body" in operation; however, we should give further consideration to what occurs during improvisation as a practice to identify how a digital tool may change or adapt this process.

From the discussion, it is apparent that the body during improvisation operates according to degrees of awareness, with varying levels of intention and possible automaticity. For example, let us examine artists'/dancers' experiences of improvisation in the context of existing practices. Ehrenberg's (2015) research with contemporary dancers highlights the participant's use of a "predominant mode of attention toward "internal" and pre-reflective bodily experiences, although there is an element of attention and awareness of the environment too (e.g., the studio space, another dancer's touch, the choreography, the music)" (Ehrenberg, 2015, p. 46). Buckwalter's collection of approximately 20 practitioners' experiences with and frameworks for improvisation (2010) provides valuable insights into this field, with one contributor, Penny Campbell, emphasising that improvisation originates from "the basic underpinning: paying attention" (Campbell, 2010 quoted in Buckwalter, 2010, p. 17). This supports the concept that during the moment of creation, efferent and afferent information influences movement. Similarly, Nina Martin's work using fast reactions as a strategy for improvisation - called "Neuro state practices" - "...gear[s] the dancer to enter an improvisation with no plan and fewer preconceived attitudes toward existing material... you react to what you find" (Martin, 2010 quoted in Buckwalter, 2010, p. 20). Therefore, within improvisation, there exist varying levels of consciousness, which we can also link to the speed of the action.

Wong's (2015) work stresses the importance of speed in movement improvisation because of the absence of body awareness during fast speed motor actions, arguing that "proprioceptive information is delayed because of the time it takes for neural signals to propagate from the limbs to the brain" (Wong, 2015, p. 797), and using evidence from neuroscience to contend that "the output of an emulator²⁷ does not have to be conscious for it to facilitate motor control. It can merely be providing predicted proprioceptive information for motor control" (*ibid*, 2015, p. 797). This theory of predicted movement is sited within a movement associated with a task, but it remains unclear whether this explains creative movement choice. Katia Savrami resolves this tension, arguing that conscious perception requires longer timeframes and so during the condition of improvisation, automatic movement or social/emotional predetermined responses may guide the dance (Savrami, 2017, p. 5).

As such, the speed at which the improvisation occurs impacts both an individual's awareness of their moving body and the level of consciousness required during decision making. Individuals work at different paces within improvisation and so both predicted model/automatic and slower/reflective processes may occur. However, the difference in SWT use has been its theme of digital touch enabling a *focus*. This work suggests that the vibration effects created through coded loops enhance the pre-reflective continuum and the manner with which "primal impression, protention and retention" unfold in temporal events, consequently enabling an impression of the dancer/choreographer 'reacting' to the stimuli.

5.5.6 The relationship between the participant and the SWT

Another contributing factor to the choreographic output was how the participant worked with the technology and therefore, we should consider the relationship between the SWT and the person. Interviewee descriptions of how they perceived the prototype vary, with some instances witnessing this relationship change over the 20-minute task. Additionally, the individual and their evolving rapport with the technology

²⁷ An internal forward model for motor control.

was further complicated by the active nature of the vibrational loop and its physical presence.

Within 'Material Engagement Theory' (MET), "doing" or what Lambros Malafouris likes to call "thingness" (Malafouris, 2013), substantiates the process of thinking. MET's appreciation of the interaction between the body, material, and tool in the way we think creatively is pertinent to this research:

...the term 'things' to signify energetic compounds of form and matter, and the term thinging to signify flow: the ongoing movement and transformation of mind-stuff. Thinging should not be understood as a psychological process of internalization or representation by which things become the object of consciousness. Rather thinging should be seen itself as an act of consciousness (Malafouris, 2013, p. 7)

When considering the use of a body-worn choreographic tool in this manner, it could be part of an ongoing *thinging* with the body, albeit one lacking a visible, enduring physicality or materiality beyond the dance's duration. The body's/mind's responsiveness to the tool/aid - the SWT - and the material – the body/passive digital touch - endorses the findings. For example, the use of the SWT further elaborated "the double act of moving and feeling oneself move" (Sklar, 2000, p.72), with the participant considering this in conjunction with the sensation felt through the prototype. As Participant 9 commented,

I started going to think about dancing and responding to it at the same time, rather than just thinking how responding to it can initiate dancing. Then everything became a lot more interesting. I think because I was performing to the feeling of it. (Participant 9, 2017, Interview)

Malafouris uses the term "metaplasticity" (Malafouris, 2010a, 2013, 2015, 2018) to refer to the evolving process of tool, motion, and cognition in a dynamic relationship (*ibid*, 2013, p. 47). In this process, there is no division of higher-order cognition, with imagination unreflective of and separated from "in the moment" creation. During

Project 1, the interview responses often mentioned the digital aid/choreographic tool afforded additional awareness/foci, which one cannot help but compare to the interconnected elements and mutual influence described by Malafouris.

5.6 Conclusion

By accentuating the pre-reflective experience caused by the SWT and the dynamic process of working with a tool - specifically, a material containing internal resonance or vibration - this thesis suggests that the use of a body-worn device influences the improvisation process in several ways. Firstly, the heightened focus allows the body a greater understanding of itself, both concerning the 'body part to the whole' and the internal sensation within the body. The vibration disrupted the perception of a boundary between the internal and external of the body, with participants often feeling the sensation travel internally. As to how this impacts the kinaesthetic awareness of the dancer/choreographer, it enables heightened sensory participation and interoceptive awareness; also allowing for wider consideration of the qualitative dynamics of 'how' the body moves from an internal perspective, and how vibration waveforms may travel through the body.

The SWT's location contributed to the movement initiation, but its attachment to the body enabled a relational stance connected to the peri-personal space. Subsequently, participants could consider what their arms were doing compared to the rest of the body or the upper to lower body. By promoting a different type of tool assimilation, the SWT failed to extend the body in space and instead facilitated a greater awareness of the body through movement.

The coded loop repetition produced by the vibration bracelets enabled a heightened multisensorial pre-reflective consciousness involving an unfolding of the present, past, and future. Within movement generation during improvisation, there were shifts between what one might perceive as intentional and automatic movement, explained by both the movement speed and the timescale of neural activity, or the manner with which body schemas used the predicted response. Despite the probable causes, the

coded loop provided a physical reminder of digital touch sensation to become an overt reminder of the body in action.

Participant responses to the somatosensory stimuli often became combined with their interpretation of the motor rhythm and the visualised imaginary. Consequently, we must recognise the use of the SWT in the dance making process as a multimodal creative response, with the relationship between the participants and the technology often changing throughout the workshop. However, the expanded sensory processing Ingold (2011) describes explaining tool use supports participant descriptions of improvising with the SWT as “not thinking, but doing”, whereby the selection and performance of movement appeared reactive. The similarities across participant awareness depicted by Legrand’s “performative body” (2007) are echoed within both Ingold’s and Malafouris’ (2013) theories of the dynamic nature of creating with a tool/aid, operating according to various active attention levels encompassing real and imaginative aspects of sensation and sound.

6. Digital Touch Project

June 2018 - October 2019

The second project of this PhD research continues the work of the Digital Intervention project, intending to use additional prototypes for producing diverse types of digital touch. This chapter outlines reflections from the previous research, charting the prototype process and development of the workshops. I then present the findings of the project, followed by a discussion of the identified themes.

As in Project 1, prototype creation took place at both The Digital Anthropology Lab and at my personal residence. Following the advice provided by the DALab technicians, I completed the planning and development of two new prototypes concurrently, culminating in my staging of workshops during the summer and autumn of 2019. I recruited six participants for The Digital Touch project: 5 females and 1 male of ages ranging between the early twenties to mid-forties. All of the participants were European or Canadian and of white and black ethnicities; they were all experienced in choreography and held a range of professional positions including a working choreographer, a higher education lecturer, and in one case, a digital artist with a background in dance. In what follows, I will further detail their backgrounds and influences.

6.1 Reflection and Developments from Digital Intervention Project 1

Through the data collation and analysis process, it became apparent that a system such as the Laban Movement Analysis – despite its usefulness for structuring the transcription of movement - did not allow for the complexities of recording objects relating to the body and space. As Schiller (2003) and Parviainen (2010) both argue, Laban's kinesphere would benefit from acknowledging the constant shifting dialogue between body, space, objects/adornment, and external influences within interactive environments and installations. Therefore, I redesigned Project 2's form of movement analysis to address these micro and local elements - namely the dynamic influence of

tool, environment, and body - and as a result, I simplified the template for movement analysis to adjust to the differing practices of the participant group as a whole. This developed matrix amalgamated the movement analysis and extracts from the interviews (see Chapter 4, Tables 4 and 5).

The focus of the new developments also centred on how I could develop the project to enable my further understanding of the participants' experience of their moving bodies with the new prototypes. Initially, I considered that a Go-Pro camera worn by the dancer/choreographer might help to gather data concerning the choreographic experience, potentially assisting to show the participant's perspective and capture the element of exteroception. After consideration and discussion with my supervisory team, we decided that the Go-Pro fixture would not necessarily help provide either an additional angle or further footage to analyse. For example, the restricted view would be unlikely to contribute usable data and subsequently, we deemed the existing set up of cameras - filming from three different angles in static positions – to be sufficient for viewing both movement and the external environment.

Operating from a viewpoint that the research would benefit from understanding the participants' use of interoception and exteroception, I considered employing phenomenological approaches to gather data by asking participants to verbally articulate their choices in real-time, resembling a stream of consciousness. Despite its potential usefulness, I felt concerned that this might deter the participant from the task at hand and interfere with their movement choice. The most significant development was the decision to incorporate the prototypes into the existing practices of the participants, creating a more naturalistic setting. The workshops were predominantly led by the participants, and I made suggestions when asked or if it looked like the participant had naturally followed the exploration to a conclusion. Therefore, while I created the workshop plans for each individual/pair, this functioned as a loose frame that remained open to adaption based on the participants' interests and preferences (see an example of a workshop plan in Appendix J).

It became evident from the project analysis that participants might benefit from longer periods of working with the technology to familiarise themselves fully with the

prototypes. I also implemented widening the participant sample to include more experienced dancers/choreographers possessing a mixture of training and styles. I wanted to observe the prototypes used across a range of choreographic practices, using participants more capable of explaining their choreographic work. Furthermore, I decided that varying the worn location of the technology and using different types of digital touch created by different pressure effects would assist when comparing both experiences and whether such internalised touch sensations were unique to vibration as a form of digital touch.

6.2 Prototyping and making

Inspired by explorations into soft robotics and DALab research into active matter²⁸, I began following two routes for designing the new prototypes. I investigated the alloy nitinol during prototype development because of its strength and lightness as a material. Consisting of nickel and titanium parts, it is often used in robotics “as an actuator where an electrical current (or heat) is applied to a stretched wire, and the wire will contract while the charge is applied and relax once the charge is removed” (Everything you need to know about nitinol, 2019). It often is referred to as retaining memory for its original shape, and so the contraction could be used for exerting different pressures and different possible types of touch.

In the case of soft robotics, I became interested in developing the movement potential of wearable technology to enable a variety of tactile sensations such as how the digital touch might create a grip or grasp. This also allowed for opportunities to further explore using silicone, utilising the knowledge gained from Project 1 to produce new SWT for Project 2.

As detailed in Chapter 4, my process of researching and auditing existing technologies and experimenting with materials, initiated Project 2’s making phase in the summer of 2018. This process then continued over the following year.

²⁸ “Active Matter is a newly emerging field focused on physical materials that can assemble themselves, transform autonomously, and sense, react, or compute based on internal and external information.” (Tibbits, 2017, p. 11)

6.2.1 Pump prototype

I initially started prototyping by experimenting with different types of pressure. The purpose was trying to develop a digital touch differing in its characteristics to vibration. Researchers have previously developed wearables and soft robotics using pressure to communicate virtual hugs (Cute Circuit, 2002, *Hug T-Shirt*) and kisses (Saadatian *et al.*, 2014, *Kissenger - Kiss Messenger*), and therefore I recognised the potential of its use in a creative environment. Originally, I explored manual methods of inflating and deflating with one early design example influenced by the armband used for measuring blood pressure, and this led to investigating DIY methods for making soft silicone structures powered by a manual pump.

With soft robotics, the silicone required shaping and curing in a mould to create chambers for air or fluid to travel through, inflating and deflating the object. I made the first moulds for the silicone out of cardboard, enabling me to quickly evaluate the flexibility, durability, and different potential grades of silicone. The initial shape contained chambers meaning that during inflation, there would be both a grasp and light touch sensation.



Figures 20 and 21: Testing of curing silicone in moulds

However, as the prototype needed to be wearable it became evident that the shape would require a change to be suitable for a dance workshop scenario. Maria Dada, the DALab Technician, designed four different shapes of mould which were then 3D printed. I then used these to cure the silicone and see which inflated shape was the most suitable. I selected the two shapes which provided the most effective inflation and deflation to use for the final prototype. I assessed this by wearing each prototype and considering which inflation shape could be felt more readily on the skin.



Figure 22: Testing different shape inflatables and attachments

When developing the vibration prototype during Project 1, it became clear that sourcing parts small enough to be wearable was paramount. The pump prototype also needed to be both suitably powerful and small-scale. The silicone inflatable needed pumps to inflate and deflate, and therefore, I selected a pump that could do both. The electronics for inflation and deflation underwent several stages of development to reduce the size of the circuit, while the inclusion of two different batteries, two pumps, and a circuit - breadboard and Adafruit feather micro-processor - necessitated encasement. I researched customised housing for the electronics, but the Adafruit enclosure for an Arduino processor was suitable and fitted the required equipment.

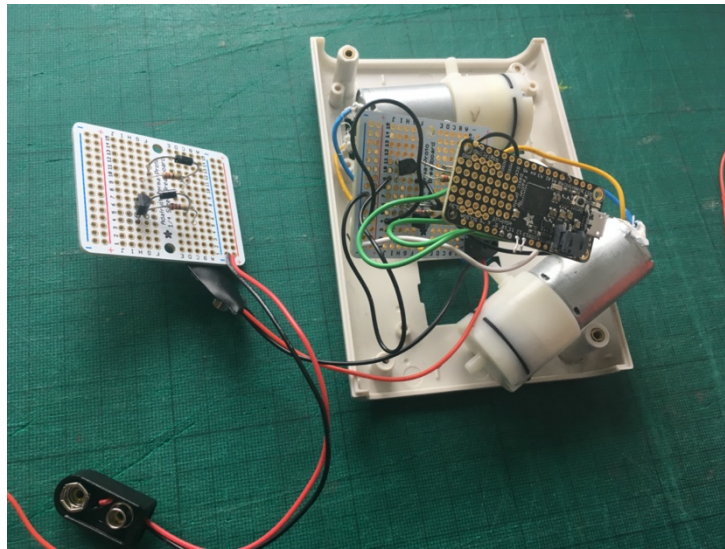


Figure 23: Circuit for the pump prototype

As the prototype needed to be body wearable, I made different bags for holding the electronics box, while sewing the inflatable silicone shape into muslin, attaching elastic, and then securing it with Velcro. Originally, I designed the inflatable to be worn around the neck like a collar with the electronics pack situated around the waist. This decision arose in part from an attempt to try and create touch sensation on a more centralised part of the body, shifting away from using the extremities as in Project 1 and the vibration bracelet. The neck area possessed the desired level of sensitivity but during the pilot stage, it became evident that practical elements necessitated a shift of location (see pilot transcription, Appendix K) requiring the wearing of the electronics pack and inflatable close to each other at the waist. As the SWT needed to be in contact with the skin, this necessitated further development of an extendable strap for accommodating different waist sizes.

6.2.2 Nitinol prototype

The development of the nitinol prototype began by exploring examples of simple charges of varying lengths and thicknesses of the alloy, noting the way each piece contracted back to its original length. I observed that nitinol produced different types of touch on the skin while also being lightweight and less cumbersome than its alternatives (Hamdan *et al.*, 2019). By initially recreating aspects of Hamdan *et al.*'s (2019) work, I used sections of nitinol, silicone layers, kinesiology tape, and heat resistant tape, discerning how their use provided a surface for contact with the skin.



Figure 24: Initial testing of nitinol

Foremost, the circuit needed to be both small but still able to control the required charge of the nitinol wire. I made different circuits using a Metal Oxide Semiconductor Field Effect Transistor (MOSFET), effectively assisting to help the nitinol contract and release with a heat sink drawing the heat from the circuit. The parameters of the circuit required controlling voltage to the nitinol and calculating the time frame for the on/off function, and in so doing, creating a digital touch resembling a grasp. The final prototype for the pilot was developed from a circuit containing resistors limiting the flow of the current to its parts, then combining this with MOSFETs. Powered by batteries, the early prototype held a powerhouse for the nitinol on one side and then, on the other, the feather microprocessor and rechargeable lithium-polymer battery for controlling the on/off loop. I designed the nitinol strip to be worn just beneath the collarbone with the batteries strapped to a harness.

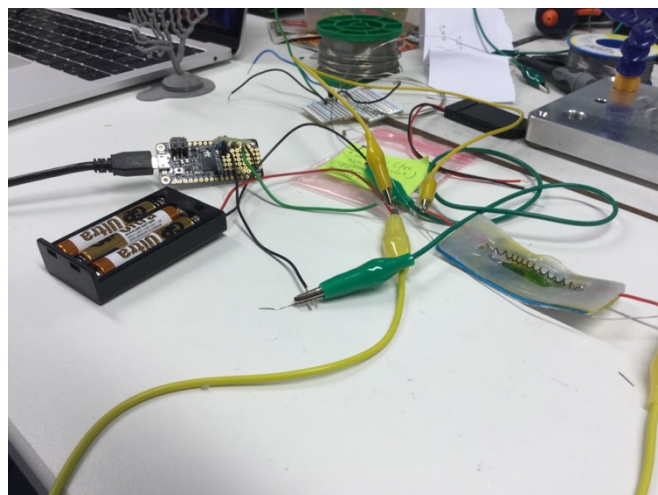


Figure 25: Circuit development - nitinol prototype

6.3 Pilot

In June 2019, I used a dance studio at the London College of Fashion in Holborn to conduct the pilot for the new prototypes. During a short workshop, I taught two participants an existing dance phrase who then used the prototypes to edit and develop the movement phrase. Their feedback (see the transcript of the pilot, Appendix K) proposed dampening the vibration from the pump motors to further facilitate the participant's concentration on the presence of the silicone inflatable and also suggested siting neoprene between the electronics box and the body for absorbing additional noise and sensation. The participants further discussed the placement of the inflatable part of the pump prototype, recommending that it might be more usefully worn over the waist as it would then be located at the core, giving a different location for comparison with the vibration bracelet worn on the wrist. In addition, the nitinol prototype became very warm during the pilot, with one participant recommending adding another layer of material for heat protection. Following the pilot feedback, over the following months, I added more layers of silicone above and below the nitinol wire with heat resistant tape to improve the prototype. With the pump, I further developed the electronics box by encasing it in a form of solid neoprene commonly used in music soundproofing, later replacing it with a softer neoprene material used for wetsuits.



Figure 26: Neoprene bag for housing the pump prototype motors

6.4 Workshops

The intention of Project 2 was to use the new SWT (in addition to the existing vibration prototype) with more experienced dance artists/choreographers for longer periods of time. By embracing the existing practices of the participants and the diversity of their backgrounds and interests within more naturalistic settings it would enable a wider sample of choreographic practices. Subsequently, I created the workshop plans with flexibility in mind, allowing the different participants the possibility to use different combinations of the prototypes and focus on different areas within the workshops. The table below summarises the timespan of each participant working with the prototypes and the activities completed, reflecting the timeframes contributed by each participant.

Participant	Location	Timeframe	Activities
11	Laban Building Studio 1	4 hours	-Improvisation with pump and vibration prototypes
10	Studio Wayne McGregor - Studio 1	9 hours	-Improvisation with pump and vibration prototypes -Improvisation with both prototypes simultaneously -Structuring a short phrase with both prototypes -Editing an existing phrase with both prototypes
12	Christchurch Hall, Lewes	5 hours	-Improvisation with pump and vibration prototypes -Structuring a short phrase with both prototypes
14 and 15	Laban Building Studio 6	5 hours	-Improvisation with pump and vibration prototypes
13	Studio Wayne McGregor - Studio 2	5 hours	-Improvisation with pump and vibration prototypes - Editing an existing phrase with pump prototype

Table 8: Indicating locations, timescale, and activities of each participant during Project 2: Digital Touch (July and October 2019)

The participants primarily came from contemporary dance backgrounds, two practitioners also having training in urban dance, specifically breakdance, locking, and popping. One held additional experience in a classical Indian dance form and martial arts, and the other, in gymnastics, ballet, and circus. Half of the participants had knowledge and experience of working with dance and technology - although not necessarily wearable technology - with the remainder possessing no prior experience, therefore reflecting a mix of knowledge and understanding of the making, workings, and potential of the technology. The workshops took place in three locations: Studio 1 and 2 in Studio Wayne McGregor (Stratford, London), Christchurch Hall (Lewes, East Sussex), and Studios 1 and 6 at the Laban Building (Trinity Laban Conservatoire for Music and Dance, Deptford, London).



Figure 27: A participant using the vibration prototypes

Where working practices and time allowed, the participant taught me movement from their devised phrase, as with Project 1. I sometimes worked alongside the participant in improvisation, experiencing the same prototype task when appropriate to the space and participant's practice. This allowed for me to acquire tacit knowledge and facilitated richer discussion in between tasks and during the interview.

In some instances, I employed the playback of video footage so that participants could view their actions and talk about their movement choice, what they saw in the video, and how this aligned with the feeling of moving with the prototype. As each

participant utilised individual strategies and working patterns, I implemented playback according to when the participant requested it or if they felt unable to answer the question without visual support.



Figure 28: Two participants using the vibration prototypes

During the first workshop of Project 2, the nitinol prototype would not work properly and having limited time, I discontinued working with it. In the following workshop with Participant 10, there were reoccurring difficulties with the nitinol prototype, and after several attempts to get it to contract as the code had intended, I decided that it was too unreliable and that the workshops would instead just use the new pump prototype and the existing vibration prototype (see Appendix K – field notes for extended discussion).



Figure 29: A participant using the pump prototype

6.5 Findings

6.5.1 Interviews

Across the participant workshops, the interviewees described a *changing relationship with the prototypes* through continued use. Overall, there was a trend towards the *attentional focus* of the digital touch sensation, with some describing this as a *disruption* or *interruption* and others as a *fulcrum*, organising their improvisation experience. At the beginning of working with the prototype, participants felt that they needed to 'listen' to what they were receiving from the silicone inflatable. Despite using the neoprene material and encasing the motors around the pump prototype, sound still escaped from the motor and subsequently, the participants struggled to just respond to the felt sensation and reacted to both the sensory elements of sound and tactility. With further practice, this initial response subsided, evolving a different stance or relationship to the technology. We could describe this as working alongside or in collaboration with the prototypes, resulting in less direct attention to the sensation and sound.

A sub-theme of *attentional focus* is the *coded loop* and how it may affect the participants' creative responses. There were moments of anticipation and repetitiveness verbalised during participant interviews, while also the occurrence of the time element as a marker in the experience. Two participants explicitly questioned what the prototypes 'do' and their role, asking "Does [the prototype] restrict? Does it inform? Does it heighten?" (Participant 11, 2019, Interview 1). In answer, there is evidence to suggest that it influences all three elements. For example, Participant 13 discussed the vibration loops – the two bracelets worn on different loops - and how they *disrupted* the *flow*. His dissatisfaction in the process of improvising with the SWT was due to a mismatch in his movement intention and production and a restriction of the desired aesthetics. In terms of the SWT heightening the experience both Participants 11 and 15 commented that it was not that their movement necessarily changed during the improvisation but that it enabled greater awareness and a magnification of the body in action.

Further sub-themes of *attentional focus* include *listening* and the imaginative response to something both felt and heard. The participants communicated that these are connected to the subtleness of the prototype sensation and the act of *listening*, but this may be a result of processing tactile information with the possibility of being an underutilised *multimodal* skill.

Participants considered the placement of the prototypes and the localisation of the digital touch sensation; moreover, this aspect was connected to the theme of the *internalised sensation* of vibration and an association with the internal and external awareness of the body. The vibration prototype provided traces of sound and sensation, offering reference points both in external space and internally within the body. Accounts from Participants 12, 14, and 15 all talk about having a greater understanding of their body parts, whether in the present space or where they had just been. This marker enabled an awareness of travelling between or across space with movement, and how the body related to the prototype.

I felt like I could hear the rhythm or the impulses, and I suppose that gave me quite a visual in terms of the stillness and the breathing. If it was going that way, my breath would visually follow that pattern in space. So, drawing out my kinesphere this way or that way, or towards XXXX. Cos even though we are on our own, we are together spatially. So sometimes I felt like a frog with a tongue – foomp - catch her and come back again. (Participant 15, 2019, Interview 1)

Participant 14 mentioned their awareness of the body with other elements: “I suppose when I think about these [vibration prototypes], there’s more a sense of this around me. The air around me, the sense of space, where I position this or what it is in relationship to. Is it in relation to me, or am I bringing it towards myself to give myself a deeper internal experience?” (Participant 14, 2019, Interview 2). Some participants played with both rhythm and *trajectories*, with their bodily relationship to both visual/auditory stimuli combining the real with the imagined response. In reference to the *trajectories* theme, the focus fell on the movement’s pathway through space and its relationship to the body.

We can connect the themes of *attentional focus*, *disruption of flow*, and not being able to actualise the initial creative intention (“*it doesn’t feel right*”) to the idea of *entrainment*: synchronising with the patterns of sensation or rhythm emitted by the sound. This can be seen in the participants adaption of their movement to the rhythmic pattern of the code, resulting in the pump prototype at times “flattening” the pace or dynamics.

Participant 13 described not feeling the prototype when he sped up his movement or put weight into his arms, with Participants 10 and 12 reiterating this in their interviews. The possible reasons for this are beyond the scope of this research, but in this dancer’s experience, the cause may be linked to the *disruption of flow* or adaptation of our mechanoreceptors to frequent stimuli effectively forming the body’s strategy for not overloading the central nervous system. Several participants described using a ‘rule-based’ response within their explorations of using the SWT in improvisation. Participants 10, 12, and 13 created further rules that allowed them to work in opposition to the location, rhythm etc. of the prototypes. This appeared to be an approach for coping with the repetition of the loop or the dominance of the code, with one participant (10) describing the pump prototype as a “backseat driver” (Participant 10, 2019, Interview 3).

6.5.2 Fieldnotes

My field notes cover the topic of the researcher's presence in the space. I debate the participant-observer role and whether it provides a distraction to the choreographers in the workshops. This conversation occurs in several separate notes with different participants, but the conversation tends to be weighted on the positive aspects of sharing the space.

...but learning the phrase he had created gave me a real appreciation of the physical effort (relaxing and tensing) and understanding of the flow of energy. Even 10 mins of learning from another person and trying to embody the movement is a step towards sharing a physicality of their movement in space. (Field notes, Wednesday 2nd October 2019)

My notetaking considers the different shapes of inflatables attached to the pump prototypes and highlights the contact on the skin being more prominent in one episode of improvisation compared with other explorations throughout the project. The reflections also contemplate the complexity of editing with the prototypes, discussing the challenge of editing an existing phrase in tandem with interpreting the sensory information of the prototypes.

6.5.3 Movement analysis

6.5.3.1 Improvisation with the pump prototype

The use of the pump prototype during the improvisation process tended to create movement rippling and undulating from the lower torso through the body. We can also see this in upper body curves and by hunching over in lower contractions (see Appendix M - video footage). I observed rocking and playing with the transference of weight and this was referred to in the experience of Participant 11. There were occurrences of hip isolation, shifting the pelvis forward and back, and hula movements rotating around on the horizontal plane. There were also rolls on the floor and playing with balance and off-balance.

Overall, most participants started with quite a slow and steady pace and then the speed increased as the improvisation continued. This may be related to the subtlety of the inflatable as mentioned by Participants 10, 12, and 13, whereby at the beginning of use, the participants listened and paid attention to the sensations on the skin. This could also be due to the change as the participants became more accustomed to the prototype and consequently more selective with its use in the workshops. All the movement occurred on the middle and lower levels. Occasionally, there were little hops on demi-pointe in turns, but this was minimal and unrepresentative of any extensive use of movement on a higher level.

6.5.3.2 Improvisation with vibration prototypes

Trends across the participants included hands carving out space - sweeping arm gestures and port de bras - combined with a small to medium kinesphere reach. The arm movements were quite close to the body and framed the face and head, with forearms moving back about the body and constantly placed in various positions in space, almost reacting to the stimuli. In some instances, the arms were placed in space reorientating the body based on that position (see Appendix N, video footage). The stepping of the legs, for example, using stepping patterns - behind, side, and back - also indicated a reorientating of the legs about the arms in space. The gestures of the hands and wrists involved wrapping, pressing, and crossing, with spirals, lunges, and sudden drops of weight also appearing across the participant group. The qualitative dynamics of the movement oscillated between juddery-bound to lighter and free-flowing movement, therefore representing a start-stop quality to the movement.

6.5.3.3 Combination of both prototypes

Two prototypes were used together during the improvisation of Participants 10 and 12 with both creating movement with spirals and tilts, playing with their weight forward and back and exploring weight transference and their centres of gravity. Participant 10 used her arms, in the same manner, to carve out space while Participant 12 used them to trace where the arms had previously been before replacing it with another body part. The movement analysis matches with what participants disclosed, with the wrists and vibration prototype becoming the primary stimuli and the pump prototype the secondary resource. However, I also saw transference of weight and playing with the centre and so the pump prototype's influence remained apparent.

6.5.3.4 Structuring a phrase - Pump prototype

The same two participants, 10 and 12, completed the structuring of a small phrase with the pump prototype, both included ripples, spirals, and turns within the short phrase.

6.5.3.5 Structuring a phrase - Vibration bracelet prototypes

Only one participant created a phrase with the vibration prototype and so, therefore, as this is the only episode, we will not consider it in detail within the analysis.

In Project 2, the participants were permitted more time working with the prototypes, with some choosing to edit existing phrases whilst wearing them. The following section will discuss this additional area.

6.5.3.6 Editing an existing phrase with the Pump prototype

The continuous rhythm - on then off - influenced the dynamic quality of both participants' work, stabilising the speed and creating more of a constant flow from one thing to the next.

6.5.3.7 Editing an existing phrase with the Vibration prototype

As with above, only one participant chose to work with the prototype in this manner and as such, it is therefore difficult to consider influence or trends. From the analysis, more external space and travelling movements were observed within the edited phrase, but by comparison, the movement was less defined than the original phrase conceived without the prototype.



Figure 30: A participant using the pump prototype

6.6 Discussion

6.6.1 Attentional focus

The reoccurring theme of *attentional focus* during Project 2 requires further deliberation to address several questions related to the presence of digital touch on the body. Firstly, what were the attentional demands of the prototypes during improvisation? Secondly, does the intimacy of something worn on the body prevent or inhibit awareness of that in the space beyond the direct kinesphere or peri-personal space? Lastly, what was the influence of these foci on the dance making process of the participants?

The findings suggest that the pump prototype dominated the initial improvisation. The core of the body - where both the electronics box and inflatable section were located - influenced movement initiation and the body-space relationship. For example, the edited footage of improvisation with the pump shows a disposition for movement initiation from the torso. Participants used the general space in the room during movement, but with minimal kinaesthetic reach and movement appearing within an easy range of the body (see video footage in Appendix O). The participants' speed of movement varied during improvisation, but Participants 12 and 13 specifically commented on a perceived deceleration to their normal speed of movement, with Participants 10 and 12 mentioning a flattening of its dynamic qualities. Participant 14 further explains this point within her commentary "I found I was much more within myself. Earlier in mindful walking [with the vibration bracelets], I felt I could be and see the space and kind of treat things with equanimity again. But with this [pump prototype], I felt like I was really in on myself" (Participant 14, 2019, Interview 3).

Some participants viewed this pull of attention from the SWT as a positive implication of collaborating with the technology and described the benefits of working with the vibration prototype, whilst others found the focus and localisation of the prototypes in both cases excessively dominated their improvisation experience:

I think the technology keeps me more thinking about [the sensation of vibration] like I didn't go off on a tangent. So much as I normally do, like a random thought, it kept me more connected to points in space. Where that part of my body was in relation to me. I'd say it was more focused in that way. (Participant 12, 2019, Interview 1)

No, it's just interrupting. It's just interrupting, and your attention is always drawn to the wearable, whereas when you are doing stuff in an imaginative way, you literally just have your body, so you can flow at any point and attention can flow. Whereas here I felt like it was always tethered to my wrist or tethered to my waist. (Participant 13, 2019, Interview 1)

Importantly, the interviews indicate a change in attention directed towards the prototypes following continued use which I will explore under the theme *relationship to prototype*. To reiterate, attentional focus dominated the pump prototype due to being located at the core, creating a demand to 'listen' to the subtle sensation. The intimacy created by patterns of digital touch enables an internalised perspective, influencing movement initiation, range, and to a lesser extent, dynamic qualities.

Observable within Birringer's extensive work into interactive environments and improvisatory exploration, the meaning-making process in this activity was mostly led by the body and its relationship between the internal and the external; "[i]n neurophysiological feedback environments, such real-time improvisation concentrates less on semiotic processes of sense-making but on the immediate physical and emotional experience of movements inside or on the body." (Birringer, 2008, pp. 214-232)

The affordances of the environment and the abilities of 'what the body can do' in this feedback setting require direct and intuitive sensory-motor responses. As a result, attentional focus towards the body - both internally and on it - may be an inevitable part of working this way, even when simplified by the passive touch of the prototypes. However, during this research, some participants remarked on the requirement for slowing down their improvisations to consider the prototype and the sensation

patterns, and therefore, Project 2's findings suggest slightly different repercussions from both working with this technology and the created digital touch, compared with Birringer's research. The implications of time proved to be a factor, both when experiencing subjective time and building familiarity with the prototypes over greater periods. In this research, I observed the direct response discussed by Birringer (2008) but also recorded several other ways an improviser might work with a tool/aid. This point will be addressed further in the following chapter, where I will consider the collective findings of both projects and further explore the connection between attentional focus, time, and changing working relationships.

6.6.2 Trajectories

The heightened focus and attentional demands created by using the prototype connect with how the prototypes encouraged trajectories or pathways through the body. For example, Participant 12 talks about her internal- external space relationship during her improvisation.

Because I think when you focus on your periphery, you do tend to focus on points in space and they are away from you. This [pump prototype] is more, it feels a bit more organic and it's more anchored, or I wasn't really thinking about my relation in the room... I was thinking about how things travel through, rather than drawing something, just different ways of thinking about trajectory... (Participant 12, 2019, Interview 2).

With the pump prototype, the use of the core of the body dominated the observable movement, involving participants moving their backs, hips, and torsos. The tightness of the strap and the subsequent sound of the motors influenced the sensation of the inflatable in the pump prototype. Generally, the even pace of the coupling of the code and the connected sound/ sensation made the prototype both predictable and soothing. By contrast, housing the vibration prototype bracelets at the wrists promoted greater use of the extremities; so that using both bracelets together created pre-emption, adaption, or an interruption of the movement intention.

As we saw in Project 1, the location of the SWT guided where movement emerged from, subsequently influencing the spatial pathway and its relationship to the body. Project 2's participant responses to improvising with the vibration bracelets showed similar use of the arms with the wrapping and replacing of hands and the framing of the upper body (observable in the edited video footage found in Appendix N). Participants also used their arms to establish fixed points in space, placing the arms into positions and then moving the lower half of the body to accommodate the arms. With the pump prototypes, the trajectory often began at the centre with the movement emanating from the lower torso before passing through the body (Appendix M and O).

As Ravn (2017) discusses, the dancers' kinaesthesia and subsequent awareness of space during movement connect to both the real forces and imagined trajectories:

A shift in a sensed energy is thus closely connected to an experience of exchanging the sense of their body with a sense of a corporeal imaginary of spaces. As these imagined spaces are experienced as being rooted in and part of corporeality, their bodies are not just located in space. The space they relate to also originates from how they conceive the physical materiality of the body. (Ravn, 2017, p. 68)

The coded data from the interviews revealed trends relating to how the vibration prototypes allow for a change of perspective, specifically, a developed sense of how participants proprioceptively feel and see their body when internalised sensation travels within the body. Moreover, it suggests how participants may place (and replace) their body parts in space and by extension develop a body-part relationship.

Similar to the project 1 findings, the participants made connections between sound and sensation, and this influenced their imaginative responses. The process of improvising with the prototypes assisted in making different connections inside and outside of the body, both real and imagined and as such reveals a multimodal process implicated in an adapted kinaesthetic awareness.

6.6.3 Internalised sensation

Half of the participants stated that the prototypes allowed for greater sensitivity in the locations of the body and the types of sensations interoceptively. Participants felt the vibration sensations internally within the arm, with the “[s]ensation of the vibration going up and down” and influencing the direction of and type of movement: “vertically, in a swing fashion” (Participant 11, 2019, Interview). Because of its location on the body, the pump’s inflation and deflation were felt at the diaphragm and internal organs; “[a]ctually the sensation of the breathing quality or pulling, I felt it was pulling in on my diaphragm, or creating a false breathing” (Participant 14, 2019, Interview). It also provided a heightened awareness of the exterior of the body against other surfaces:

I could feel the sensations heightened by it being in contact with the metal area [the participant pushed her body against the air-con metal grate] and then trying against the glass [window in the dance studio] and different temperatures with those. Then going “ohhh”, I could feel vibrations and sensations in my nails and fingertips that I wouldn’t normally see. (Participant 11, 2019, Interview)

As corroborated by research into sonic wearables, there is a different approach adopted using prototypes requiring the user to participate in greater sensory reception. Birringer and Danjoux consider the use of the whole body:

...extending beyond it to a wider form of listening and sensory engagement where other factors such as internal sensation come into play. The dancers realign ears with the body, the bones, and the pores of the skin, the whole body becoming [a]... skilful transceiver of vibrational waves and sensation. (Birringer and Danjoux, 2013, p. 5)

Despite the usefulness of the prototypes for framing or focusing these experiences for the body, there is an element that consumes the attention of the participant to make the experience further internalised when using the pump prototype. With Participant

11, she decided that the sensitisation and sensation were of more interest to her in the improvisation setting, returning at the end of the workshop to take a slower and introverted perspective with the pump prototype. We must critically consider the prototype's capability to create internalised sensation and magnify sensory reception during use as a choreographic tool/aid, and to ensure such introspection does not dominate. As Fortin cautions, "...to me, Feldenkrais is like a microscopic dance, unfortunately I got so interested by this internal dancing that I stopped dancing for a while. Instead of travelling into the space I kept discovering my inner landscape" (Fortin *et al.*, 2002, p. 172).

6.6.4 Amplification

I just feel it doesn't necessarily make me move in a different way, it somehow shines light on a brighter area of my understanding of what I am doing in space with XXXX. It's like if I was in a room and they only followed me with a torch but wearing... like... six torches. (Participant 15, 2019, Interview 2)

As Parisi and Portanova (2011) clarify, "...the main scope of every digital art 'application' becomes to extract or amplify the qualitative, organic sensations emerging from the aesthetic experience" (Parisi and Portanova, 2011, p. 2). The participant's anecdotes suggest they establish a new sensitivity, and therefore, a heightening or amplification emerges due to the somatoperception.

The stimulation of the somatosense and the construction of different connections between the body internally and externally occurred differently between the two prototypes, but across both, placed a greater emphasis on the internal. Participant 11 refers to sensations within the body - vibration going up and down the forearm – influencing both the direction of the movement and the type performed. She was aware of external factors in the room, but redirected this to her body by placing it against different surfaces:

In terms of internal and external... I felt a lot more awareness in terms of internal. Because I was thinking about my relationship to it [prototype] and

what it meant, rather than in terms of the space and environment. (Participant 11, 2019, Interview 3)

Participant 14 considered the communicative possibility of using different forms of digital touch while experimenting with alternative locations for the pump prototype and how this made a difference to the sensation travelling through the bone and organs. Unfortunately, it is beyond the remit of this research to consider the potentials of sound, vibration, and pressure on the interoceptive awareness of the body. Nevertheless, speculating about digital touch and its capacity for amplifying the functions of the body, its use as a tool for focusing and changing perspective may present wider implications. During a creative experience, the ability to examine and re-evaluate practice is extremely important and consequently, an aid for developing somatoperception would prove beneficial.

6.6.5 Code and the effects of a loop

In both SWT, the code created different loops of sensation. With the vibration prototypes, the bracelets were used both singularly, with ten distinct types of vibration on a loop, and collectively, with the second bracelet containing 100 plus vibrations. The pump prototype was more simplistic, whereby the code inflated and deflated the silicone structure and induced a binary 'on and off' effect. Movement analysis of the participants' improvisations and the themes exposes the aesthetics of the code on a loop or the interaction of two or more loops. However, of importance to this line of inquiry are questions surrounding the influence of the code on *how* we might embody and perceive time and space differently as a participant/creator. This is particularly relevant to the main research question when considering the kinesphere supplemented by wearable technology.

As discussed in the previous chapter, the unfolding of the temporal event during a loop effect may enable a slightly different pre-reflective consciousness within improvisation. The second project's findings concur with an altered perception of time and space allowing for participants to investigate this during specific instances based upon their working methods. In the cases of Participants 14 and 15, their existing

strategies included structured timeframes for improvisation exploration, specifically using a timer to indicate how long they had to explore a certain aspect of their practice. Participant 14 notes how the vibration supported an awareness of time felt through movement.

This is interesting... with the regularity with the vibration, it brings a temporality and sense of measurement to my experience. A bit like a clock, it's kind of like a... hmmm... a baseline. Which is interesting when you are working with time and duration to have an experience within that. I found myself definitely aware and kind of moving with or moving around the rhythms. Certainly not directly in relation to them, but they were very much supporting the temporality of my movement and my experience. And also, a feeling of it being sometimes a fulcrum for the way's things were organising. So, it would every now and again become the centre of gravity for my perception and awareness. (Participant 14, 2019, Interview 2)

Consequently, by being a focal point or 'fulcrum', the vibration bracelets and the looping effect provided a more explicit measurement and experience. This repeated sensation and sound creates marks, with the body's related movements generating a new type of awareness. Maxine Sheets-Johnstone describes sensation as being a "temporally punctual and spatially pointillist phenomena" (Sheets-Johnstone, 2011b, p. 461) assisting to explain why the loop becomes a marker within the experience as it cuts through or defines a point in time, and then through its regularity solidifies and allows for the repeated condition to be a structure for altered awareness.

Within the area of music perception, there is evidence to suggest that the fulcrum experience occurs through a repetitive rhythm denoting points in time. In certain circumstances, it pinpoints the *location of movement to that timeframe*. Thaut, McIntosh, and Hoemberg (2015) refer to this as Continuous Time Reference (CTR), suggesting that this process influences the efficiency of muscle movement, and the speed and ease of performing a movement (Thaut, McIntosh and Hoemberg, 2015, p. 3). This information relates to dance performance and enhancing the technical

accuracy of movement, but I will consider the further links to creative movement during the consecutive section.

The concept of the marking of time and movement explains the flattened dynamics of the pump prototype described by Participants 10 and 12. In this process, the body considers the time reference, trying to efficiently work according to this time/movement template. Certainly, Participant 12's experience of working with the pump leads us to believe that rhythm - or the timekeeping created through repetition - influences the qualitative aspect of the movement.

Then I was noticing the dynamic of it being quite relaxing and mesmeric, a bit floating... and the sound, it's the repetition and the predictability that kind of lulls you into a calm state. (Participant 12, 2019 Interview 1)

The effects of the code on digital touch sensations or patterns of stimuli connect to how the participants experienced time and space. The following subsection will consider mark-making in time and the subsequent pull of synchronisation.

6.6.6 Entrainment

Academics have established that there is a human desire to synchronise or adapt to rhythmic patterns such as a heartbeat or breathing, known as entrainment (Hall, 1984; Himberg and Thompson, 2011). Thematic patterns across the participant group suggest that we can extend this to the SWT to explain in part the ongoing process within improvisation. However, discussions relating to entrainment hinge on a precept of 'reciprocal influence' and therefore, I will closely examine whether passive digital touch is conceptually acceptable. By doing so, this research will not make a case for the prototypes 'feeling' the dancer/choreographer's response or willingly adapting, but instead arguing for practical forces demonstrated by physics, and how this may occur between two moving objects. For example:

In entrainment, the different amounts of energy transferred between the moving bodies due to the asynchronous movement periods cause negative

feedback. This feedback drives an adjustment process in which the different energy amounts are gradually eliminated to zero until both moving bodies move in resonant frequency or synchrony. (Thaut, McIntosh, and Hoemberg, 2015, p. 1)

If we entertain the possibility of entrainment occurring between the participant and the prototypes, then we can compare the readjustment process described above to the *effects of the code* theme, observing a flattening of the dynamics. We can witness the synchronisation process within the theme of *disruption to the perceived flow*, with an anticipation for the looped vibration sensations and then a process of readjustment through pre-emption. Gill's point below explains how rhythmicality and intention become connected to anticipation and flow and subsequently, the process of adjustment towards entrainment.

This may be because rhythm enables anticipation and flow, which seems to be part of sense-making. Rhythm carries within it the intent of the interaction... To be able to experience the rhythm, you need to trust the anticipation. To follow a rhythm, you have to take that risk and risk does involve trust in the expected time intervals. When the beat does not come in expected time, then you have to readjust your expectations for the next beat. (Gill, 2012, p. 112)

Entrainment generated through digital touch brings further questions about how technologies require us to process information differently. What is apparent from the use of the SWT is that it assists in pinpointing attention, and if the user chooses, can lead to what is called "selective entrainment" (Mandanici, Rodà, & Canazza, 2017). Despite the usefulness of the prototypes as a fulcrum, any ability to do so connects to the amount of time spent using the wearable and the changing relationship to the technology. More than half the participants found themselves wanting to deviate from the direct interaction or interpretation of that rhythmical structure, therefore, demonstrating an impression of selective entrainment. Moreover, this desire to retreat from the rhythmicality of the prototypes may relate to the creative desire to divert from the prominent structure, which I will further elaborate upon in the section discussing the changing relationship to the prototypes.

6.6.7 Listening

Listening through the skin, bones, and organs - in addition to the auditory channels - forms part of the experience of working with digital touch as a stimulus. Therefore, we must investigate how the channels of listening to the body operate and what is interoceptively communicated to fully understand the influence on the dancers' kinaesthetic awareness. Interviewees commented that listening and attention were required when working with the prototypes. For example, Participant 12 recalled, "It's got the feeling of listening to something. That was the sensation I had when doing it, that paying attention. You can hear it as well..." [Participant 12 using both vibration prototypes in improvisation, Interview 1]. Participant 14 considered it a collective process:

I think there's both a simultaneous listening and an awareness that you are giving something. Which is the same with these [vibration prototypes]. I'm listening to the vibration, and I am aware of that, but also, I can bring that into the world, I can bring that into space, and I can offer that to XXXXX... But it doesn't feel me. (Participant 14, 2019, Interview 2)

Tuuri and Eerola (2012) clarify the distinction between hearing and listening; the former being a "'passive receiving' of a sound and the latter as an intentional and attentional creation of meanings on the basis of the sonic experience" (Tuuri and Eerola, 2012, p. 137). In the context of Project 2, it is useful to consider that sound created by the prototype and the tactile sensation require the participant to listen. Effectively, we accept "listening" to surpass the sonic experience, alongside intentionally comprehending the tactile aspects of the prototypes.

Tuuri and Eerola (2012) propose that listening creates meaning through an "embodied resonator". As presented below in the diagram, this uses experiential knowledge in the form of images combined with configurations of sensory information (Tuuri and Eerola, 2012, p. 145). This illustrates how mental schemas are formed through embodied cognition and explains how we utilise imaginary sources in combination with sensory

information. If applied to this research, it explains the participants' use of listening, demonstrates a concurrent enactive use of sensory information - i.e., 'what is felt' - and subsequently, what is possible in the space trajectory, and the potential movement responses.

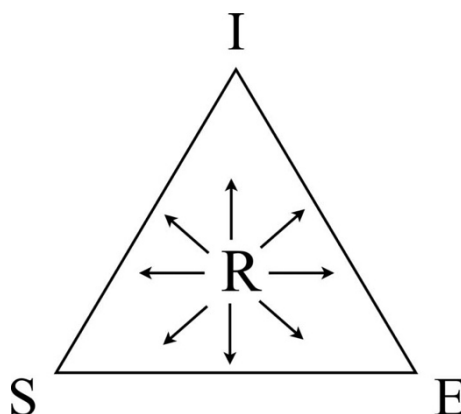


Figure 31: Schematic overview of an embodied resonator: (R), and its elements - action-relevant mental images (I), experiential patterns of sensation (S), and well-structured patterns of sensorimotor experiences (E). (Tuuri and Eerola, 2012, p. 145)

The embodied resonator proposes a similar means of utilising and combining information through movement and sensation to that of Barnard's Interacting Cognitive Subsystems with choreography (2013). In this model, the body state is influenced by the external world of sights, sounds, and forces, alongside those we feel internally in real-time. The lower part of the model represents how our body can express these through voice, movement, and the bodily expression of feelings (i.e., sweating). The inner loops explain how "...over time, specific ideas emerge out of embodied schemas, intuitions and feelings and how those specific ideas can lead to images in the mind's eye and in the mind's ear" (Barnard in McGregor, W. *et al.*, 2013). Barnard's theory assists in explaining how sensation, previous experiences, and imagination are called upon, collated, and expedited for creative response in choreography. Combining the elements of listening and hearing promoted by Tuuri and Eerola, with the more corporeal elements of Barnard's theory provides a bigger picture to explain the ongoing cycle of creative process.

Returning to the 'in the moment' creation of movement in improvisation and the process of listening and hearing with the prototypes. There are points during which the

participant can follow a more passive approach of letting the sound/feeling occur and reacting, which is suggestive of 'hearing'. They could also pursue a different approach, actively attending to and using the information intentionally through improvisation, reflecting the approach of 'listening'. Or, as Participant 14 suggests, this may happen simultaneously, whereby moving creatively with the prototypes requires intention and attention. Subsequently, *listening* becomes an essential part of using the prototypes and making sense of the creative experience of collaborating with them. Furthermore, we can couple sensing the body moving in kinaesthetic awareness with both approaches of hearing and listening.

6.6.8 Changing relationships with digital touch

It was evident that when participants spent an hour or longer with the prototype, they experienced either a changing relationship or a journey of exploration. At the beginning of the workshops, the participants expressed difficulty in trying to understand the prototypes. Participant 14 described the first instance of working with the pump prototype as "hard work", later changing her attitude to using the pump prototype as a resource, suggesting a changing relationship to working with the technology.

I think this time I went into it with a bit more of a loose attention towards the equipment within 'first choices' and 'second choices' and I just got on with my thing. Umm - and I think that shaped the way I was able to experience it in 'mindful moving' in terms of being comfortable and easy with it being there already. Because I had gone in a more casual way, it was a partner, as opposed to something I had to work to find out or discover. It was running alongside me. Yeah, it felt more like I was in collaboration with it this time. (Participant 14, 2019, Interview 4)

The attention needed to understand the prototype during improvisation did not necessarily engender an easy experience, with a less direct focus on the prototype enabling greater equality for this participant. Participant 13 reiterated this changing relationship during his experiences using the pump prototype. He found the

attentional elements and the subtlety of the sensation difficult to use as a stimulus, stating “[i]f I wanted to respond deeply to the tech, I had to really slow down and really tune in. It was weird because it was taking me out of my bodily experience and I almost trying to tune into and get inside a piece of tech, rather than inside of my own body” (Participant 13, 2019, Interview 2). After an entire day of working with both prototypes and using different urban dance forms - including popping, locking, and break dancing - Participant 13 found that in the editing of an existing phrase he developed a more productive and positive relationship with the pump prototype:

...but I do think it was a really good choreographic device when you have created a sequence, going through each thing slowly and what can be developed from there... It had a similar structure [to the initial phrase], but the movement qualities were very different. It also meant that I chose not to go on the floor, I found a representation of the floor work that I was doing.

(Participant 13, 2019, Interview 2)

By slowing down the movement, conscious decision making became more prevalent during the act of improvising:

Slowing down was key... I think in terms of actual movement generation it definitely opened up some new pathways. In terms of ways in which my body would not normally typically move. Or in terms of sequencing, my body wouldn't naturally want to go to. It disrupted that. (Participant 13, 2019, Interview 1)

The location of the vibration prototype on the wrist could also have been a factor in the difference between the ease of use. Compared to the pump prototype, which was located at the torso, the bracelets allow for more freedom of movement at the periphery. Despite initial reservations, after further time using the prototypes, Participant 13 became more accustomed to working with them: “the more I went... the more I flowed with it, the easier it became. I think it would take a hell of a lot of practice with it to become an unconscious experience. Because as well you start pre-empting stuff” (Participant 13, 2019, Interview 1).

For Participant 11, she explained the experience with the pump prototype as “exploring weight and sensitivity and physical awareness of it, it was more a series of journeys, a flow with it...” (Participant 11, 2019, Interview 1). This points towards a dynamic, evolving relationship with the prototype, particularly related to ‘being more grounded’ by its location at the core.

Participant 10 described “fake movement” at the beginning of improvising with the pump prototype. This can possibly be explained by ‘moving for the sake of it’, whereby the participant might have felt pressure to move before comprehending the SWT or the mismatch between the sensation and execution of her intended movement. However, this reaction should be considered within the socio-cultural context of contemporary dance improvisation, namely, those participating seek authenticity for connecting movement with ideas.

It is clarity of intention at an intuitive or rational level which helps you to determine which material fits and which can be thrown away. (Blom and Chaplin, 1982, p. 10)

This adjustment process for unifying intention with tactile stimuli is partially responsible for the changing relationship between prototypes and participants. This linked to an attentional association with the prototypes and was vital for their use as a creative aid, through entrainment or a developed understanding of the looped code by the participant.

6.6.9 Flow and disruption

Within their interviews, Participants 11 and 13 introduced flow and *disruption of flow* as a theme relating to the integration and assimilation of working with the prototype during improvisation. Within creative practice, flow state is a sizeable field and therefore would require a considerable extension to this discussion not necessarily pertinent to this research question. However, I should mention the existing tension regarding top-down models of creative thinking lacking any role for the body to play in

the process. Banfield and Burgess's research (2013) highlight this omission, criticising prior research into flow for having "...taken for granted the fact of doing rather than exploring the significance of the varied nature of doing, resulting in an emphasis on cognitive rather than somatic factors in experiences of flow" (Banfield and Burgess, 2013, p. 64). Using phenomenological interview and practice research methods, Banfield and Burgess cite immersion and control as factors affecting flow in the visual arts genre. They reference other considerations including tool assimilation and the "bi-directional merging of body and tool" (*ibid*, 2013, p. 78), focus, decision making, time, and the merging of action and awareness within their experiences of flow.

In reference to Project 2's findings from the vibration prototypes, this explains how the flow of movement is disrupted by the expectation and anticipation of the loops. Specifically, predicting when and what would be felt kept the participants guessing and if their assumption ended up different to that envisioned, it disrupted the thinking/feeling process. With the pump prototype, there was initially a feeling of "spending too much time looking out, feeling out and listening out for it... when's it coming or when's it happening?" (Participant 13, 2019, Interview 1) subsequently preventing immersion or the merging of action and awareness. For Participant 13, needing to pay attention to tactile sensation made it difficult to feel the movement and complete its intended aesthetic realisation. He felt that he had to slow down to maintain his connection to the prototypes, impacting his usual speed of improvisation as a result. Cseh (2016) notes the obligation of 'idea-execution congruence' as one of the essential conditions for flow made possible by coherent feedback. For Participant 13 there was an insufficient match between the physical enactment and the intention. Moreover, Ravn's research (2017) focusing on contemporary dancers supports connecting the sensation of the body's movement with 'what feels right'. She describes this within one participant's experience:

...his practice includes conscious monitoring and evaluation of how the movement flows: how the momentum of one part of the body takes other parts of the body – and the whole body – into a longer combination of movement. In that sense, the proprioceptive-kinaesthetic sensations relate to a 'partly abstract and articulated representational idea of the body'...his sense

awareness by using kinaesthetic and proprioceptive sensations as the primary sensations to control the way he takes the weight of his body into sequences of movement. In this sense, the proprioceptive-kinaesthetic sensations are central to the dancer's body image and thereby his evaluation of what his body movement should be like when dancing. (Ravn, 2017, p. 73)

As the participants became more accustomed to working with the prototypes in both cases, there was a transition from almost undivided attention to a looser focus dealing with the 'disruption' or the 'pre-emption' differently. Certainly, there is a difference between how the pump and vibration prototypes work based on their locations on the body, but also the interaction of coded loops. Within the process of continual work with the SWT's, there was no obvious assimilation like that suggested by Participant 13, as this would take considerable use, but there transpired an evolved manner for working alongside and taking creative elements or aspects from the digital touch sensations. This adapted way of receiving feedback from the body and prototypes also contributes to the experience of heightened awareness.

6.6.10 "The movement doesn't feel right"

When using the SWT's for editing existing movement material, I observed and experienced difficulty in adapting or developing the original phrase. How choreographers make editing and refining choices is not always clear, but as I explained in the previous section, we can best attribute this to the instinct associated with movement and execution. Montero (2006) proposes the idea of proprioception being an aesthetic sense, her main argument maintaining that dancers describe an experience of 'what feels right' when explaining movement choice, alongside mirror neurons enabling kinaesthetic empathy (Montero, 2006, p.231). The experiences of Participant 10 support this, as she felt conflicted when using the pump prototype to edit existing material, torn between her previous work and the movement promoted by the pump. If, as Montero suggests, we possess the means for kinaesthetically understanding the desired movement and its aesthetics, then digital touch interrupts or diverts this approach to physical aesthetic feedback.

Despite some frustration incorporating the pump prototypes into existing practices, individuals used various methods for moving towards an easier working relationship in the editing phase. During a break in the workshop, Participant 13 looked at the inflatable section of the pump prototype, stating “I had a chance to feel it with my fingertips, the aesthetic of it and feel the energy that goes through it. So then when it got applied to my body, I could utilise that information to infuse and use that as an impetus” (Participant 13, 2019, Interview 2). Participant 13 looked at and felt the inflatable section to fully comprehend what it was doing, adding visual and tactile impressions (provided by greater sensitivity in the mechanoreceptor of the fingertips) to secure an understanding. The participant commented that this helped him, supporting the concept that the multimodality of the senses falls at the centre of working with digital touch stimuli.

6.6.11 Multimodality of experience

According to Kirsch (2011), dancers’ have the ability to transpose elements of sound, images etc. through the moving body via ‘modality translation’ (Kirsch, 2011). Therefore, it is unsurprising to see visual information and sound connected to tactile and kinaesthetic experiences within the project data. In the case of Project 2 - using the vibration prototype containing one bracelet with a 10-effect loop - Participant 15 discussed how the sound induced certain imagined visuals, projected from an internal perspective externally into the space:

I felt like I could hear the rhythm or the impulses, and I suppose that gave me quite a visual in terms of the stillness and the breathing. If it was going that way, my breath would visually follow that pattern in space. So, drawing out my kinesphere this way or that way, or towards XXXX. (Participant 15, 2019, Interview 1)

Participant 14 reiterated this, describing the stimuli to be part of a larger recognition of the sensory information processed by the body and brain. “So, for me, it’s another piece of physical information, it started to function in the same way as a sensation in

my knee, or noticing my breathing, or feeling my heartbeat. It was layering in the same way any of those would, at times” (Participant 14, 2019, Interview 1).

As Jewitt and Leder Mackley (2019) propose, the interface of multisensorial and multimodal experience in digital touch enables us to study different modes/mediums involved in creating meaning. In relation to multimodality and the communication of choreographic ideas, the SWT informs movement by creating flexibility between internal and external sensations. In turn, this influences the participants’ use of space and time, provides a relational context for the part of the body where the digital touch prototypes are located to the whole body, and provides a different means for considering the dynamic qualities or the ‘how’ of the movement.

6.7 Summary

The repeated sensation/sound created by looped codes became markers in the dancers’ temporality, generating a new type of awareness or ‘fulcrum’ for experience. The participants’ ability for synchronising with the rhythms or understanding through pre-emption was apparent, particularly as ‘listening’ to the prototypes became a thematic element in their accounts. This chapter makes a case for selective entrainment forming part of the varied and changing relationships witnessed during movement created by the dancer/choreographer and the prototypes.

Attentional demands were perceptible during prototype use, subsequently promoting a greater internal focus and use of peri-personal space. However, different trajectories of movement, the relational awareness of body parts in space, and a developed sensitivity to internal sensation - i.e., vibration through the bone - were noticeable in participant accounts. The manner with which the prototypes intervened and mediated an understanding of the body in space and time was evident. We can infer from the interview responses that a relationship to the prototype evolved through use, allowing the participants to take different approaches responding to the attentional demands of the sensations. Using theories on listening and hearing, we can explain how the participant processed the action-sound-tactile couplings with the affordances of the

direct environment while accounting for making meaning during the improvisation process.

A perception of heightened or amplified interoception emerges within the interviews, with accounts of developed sensitivity, feeling sensations within the body, and a different bodily awareness during body movement. Since skilled tool use takes lengthy practice, the possibility of flow experience became disrupted. With the vibration prototype, the anticipation of the left-hand loop also disturbed the proprioceptive/aesthetic feedback system for creative thinking. Participants who had several opportunities to work with pump and vibration prototypes found ways of working with the technology that were less demanding and required “looser” attention. Multimodal connections in the body/brain were evident in participants’ descriptions of the stimuli and how the experience extended beyond the sensation of digital touch. These kinaesthetic, tactile, auditory, visual, and imaginary scenarios entwine with creative movement responses and so, we must acknowledge multimodality as integral to the use of body-worn technology during the dance making process.

7. Discussion

The purpose of this research was to investigate body-worn technology and its use during the process of making dance, and for furthering conversations about how digital touch may influence kinaesthetic awareness. By recording, documenting, and dancing alongside its participants, I explicitly address the ontology of technologically assisted creativity, while tackling a visible gap in research looking at using digital touch within the improvisation process alongside structuring and editing movement phrases.

By focusing on *how* individuals use technology in the creative experience and *what* occurs, over two projects, this research has gathered data to identify trends within the experiences of both dance students and professionals. Subsequently, this has allowed me to identify commonalities within participants' perceptions of the experience, and through movement and thematic analysis, consider what is observable among practitioners working with SWT. By investigating technologically assisted creativity and the relevant factors when working with an aid/tool, this work acknowledges individual differences in choreographic process and output, while also recognising the need to consider multiple episodes of prototype use and its contribution to understanding using digital touch stimuli in the context of Western contemporary dance practices.

Over the project, it became possible to create predictable and repeatable sensations of digital touch which different practitioners then used as a stimulus for creating movement. Although the wearables could be worn on a small variety of positions, they all replicated a coded loop producing sensation on the skin which I then studied across different choreographic practices. We can identify the traces of this interaction in the movement produced – which I analysed through videoed movement and embodied sharing - and the participants' discussion of their experience. I have grouped the findings from the projects into themes for discussion, building a more coherent picture of how stimuli are recognised or incorporated into the conscious experience while considering the participants' movement choice or perceived experience of this process. Despite the methodological complexities of consciousness, intention, and creative movement, advancing our understanding of technology use in the creative process

necessitates moving beyond subjective, stand-alone experiences to consider the body and wearable technology through the collective experiences of the participants who used the prototypes while making dance.

Consequently, I have grouped the project findings for comparison in Table 9, enabling a clearer picture of the theoretical implications of working with digital touch in workshops and its impact on the kinaesthetic awareness of the participant.

Theme	Digital Intervention Project (1)	Digital Touch Project (2)
Heightened awareness	Heightened awareness brought to the body from the vibration - The vibration sensation disrupted the perception of the boundary, between the internal and external of the body - The qualitative dynamics in which they moved - Emphasis on the 'how' of movement	Heightened awareness brought to the body from the vibration and pressure to establish new sensitivity, creating an emergent heightening or amplification of interoception and exteroception
Space	The body part in relation to the whole body	How body parts may be placed in space -Trajectories (visual and sound pathways - imagined and real) -Peri-personal space
Foci	Reference point/Focal point	Entrainment - synchronising with the patterns of sensation or rhythm of the sound emitted -The pump prototype promoted a slow and internalised perspective - Fulcrum experience
Multimodality	The response to the stimuli combined sound and the imagined elaborations producing a multimodal creative response	Listening: different responses to something that is both felt and heard - An attentive and intentional means of receiving sensory information -imagined and sound/tactile response to stimuli
Time	The repetitive coded loop along with the physical reminder of the digital touch sensation provides a basis for protention, retention, and primal impression	The coded loop affects the creative response: - anticipation and repetitiveness - time element as a marker for the experience
Relationship between prototype and choreographer	During movement generation within improvisation, there were shifts between intention and potential automaticity	The attentional relationship changed throughout use: - <i>disruption of flow</i> and not being able to actualise the initial creative intention (<i>"it doesn't feel right"</i>) - a creative desire to divert from the prominent structure/rhythm - greater equality and collaboration/working alongside

Table 9: A thematic comparison between Projects 1 and 2

From the table, we can see similar experiences and elements shared by all project participants when using the vibration prototypes, with greater details emerging following extended prototype use in Project 2. Despite using only one new prototype in Project 2, the subsequent hours of use and data produced were sufficient for considering the sensation of pressure - with a different code (binary) – sited at a new location. The following discussion will amalgamate the main theoretical points from both project findings and discussions. To fully interrogate participants' practice when using digital touch in the choreographic process, I have adapted questions originally presented by Malafouris (2013, p. 8) for exploring Material Engagement Theory. These questions will provide a structure for answering the research questions and highlight this thesis's novel propositions.

- *What can the prototype and the human body do when acting together (in partnership)?*
- *How does the body/brain/prototype relate or connect?*
- *What is affected?*
- *What do they bring forth?*

7.1 What is affected?

7.1.1 Heightened awareness of the body

We can ascertain from the participants' verbally articulated experiences that *awareness of the body is heightened*. Firstly, let us consider the different ways that the participants expressed how they viewed and felt their bodies in motion to understand how this heightened awareness manifests.

The Project 1 participants received the same first prompt encouraging the individual to close their eyes, focus on the sensation, and move from this starting point; consequently, we can expect to be presented with a more internalised perspective. However, in Project 2, four out of the six participants received no such prompting and yet I still observed the occurrence of listening to the sensation. The vibration sensation and pressure from the prototypes provided a more internalised perspective

demonstrated by the participant interviews for both projects. Therefore, the prototypes allowed for utilising a different framework, one allowing for greater interoception, and channels of sensation to be internally magnified.

I have gathered from analysing the data over the two projects that this heightened awareness involves external and internal awareness according to digital touch sensation and the sound generated by both prototypes. As emphasised in the introduction, kinaesthetic awareness is used frequently in dance often interchangeably with proprioception, but this term combines far more than the sensation of the body moving in space. Even before we added technology into the dance making process, the information had combined to allow “an interaction between mechanisms underlying the perception of our body in relation to space, sensibility to internal signals, and awareness of our inner state” (Valenzuela-Moguillansky *et al.*, 2017, p. 11). Therefore, when looking at how tactile digital stimulation influences the body, it must also function in tandem with the participant’s consciousness of their body and their surrounding environment. But do we require a different conception of kinaesthetic awareness to readily understand the convergence of exteroception, interoception, and proprioception with digital touch stimuli?

By considering the effects or changes possible from working with technology, we must question what skills in interoception may already be employed by some or all the participants. Somatic practices for improving the efficiency of movement or attuning to the body and its sensory processes and functions have been influential in dance education and training. The impact of dance science scholarship, contact improvisation, and somatic practices has steered the development of dancers using internal feedback or somatic attention to cultivate inner sensing. For example, when a dancer uses breath to prevent tension in the body, they may focus on maximising the expansion of the lungs or the engagement of the diaphragm and the movement of the ribcage, improving the quality of the movement and attending to the feeling caused by the rush of air against the skin when moving through space.

Based on training and education, we can assume that most of the participants in the projects will have developed skills in interoception. Neuroscience research links the

training practices of dancers with an exactitude of interoception, particularly when there is “attention to bodily signals (such as heartbeats, sweat response, muscle contraction), as well as... the use of these signals for the expression of states and emotions” (Christensen, Gaigg, and Calvo-Merino, 2018, p. 9). What influence has digital touch as a stimulus had on creative movement choice and design? In answer, the experience of what the dancer feels when using the prototypes combined with the sensation of moving the body becomes altered, as in the case of the first prototype, where the vibration permeated the boundary of the skin. Sensations originating on top of the skin resonate inside tissue, bone, and organs. Following this heightening of feeling to localised places, we should also consider sensitivity to relational textures, heat, other sensations of the environment, and other objects.

As a result, there is greater fluidity of interoception and exteroception when using SWTs, here illustrated below in Figure 32.

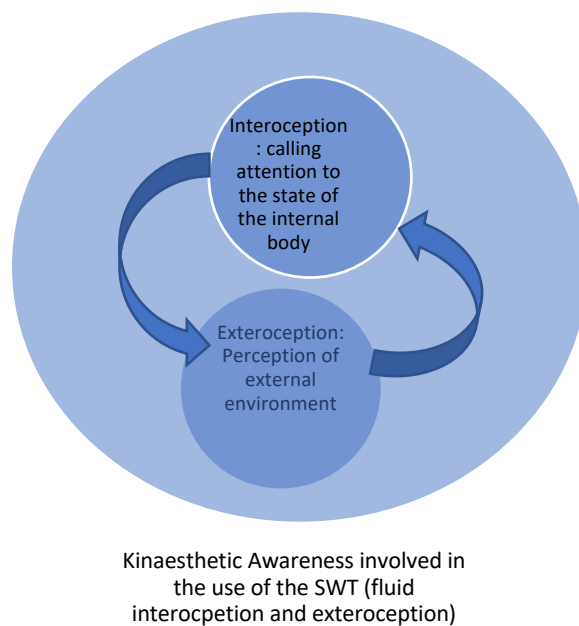


Figure 32: Kinaesthetic awareness involved in the use of the SWT

The work of Davidson (2013) supports the concept that technology can enable different and multiple ways of being present, corroborating findings that digital technology opens and varies our perceptual viewpoints. She considers the work of

three dance artists working with technology, drawing parallels between their experiences:

De Lima, Brown, and Choinière all note the vibratory or 'excitable' nature of the body and the dancer's ability to sense internal, micro levels of energy/movement which usher from a mutually embodied and dynamic interoceptive/exteroceptive activity that 'affords' heightened inter-action with the environment; again, be it mediated or not... Further, they point to how technological interfaces allow for a 'multipleness' of presence in contemporary creation and new forms of presence that can be shared with spectators.
(Davidson, 2013, p. 11)

Moreover, there is growing evidence to suggest that technology itself invites different approaches to how one might utilise information from the body. In this research, some comments proposed that the prototypes may be useful for anatomical communication with separate vibrations resonating differently depending on the body tissue, potentially enabling different spatial frameworks/perspectives interoceptively. Certainly, Choinière's suggests that "a transformation of the body's interiority occurs as it becomes mediated - for example, under the influence of sound feedback in real-time that is registered sensorially as a penetrating vibration issuing from a technological environment" (Choinière, 2015, p. 353). In summary, the digital touch felt on the skin enabled a heightened awareness of the moving body and informed greater mutability between the interoception and exteroception of the participants. This occurred because the fluidity of the body's boundaries created by the vibration/pressure was sensed within the body, presenting a greater capacity for using interoception to influence movement choice.

A greater awareness of how body parts relate to the entire body occurred largely because of the location of the worn prototypes. The participants sometimes portrayed this localisation as having a less favourable impact, with one describing the experience as being "tethered" to the technology. However, combining imagined visual markers with sound and tactile sensation also facilitated participants to consider marked 'points in space' and different 'trajectories' within the occupied space and their bodies.

As presented in Chapter 6, the coded loop of the SWT creates through the pre-reflective process a type of spatial- temporal marking. Sheets-Johnstone describes pure sensation as being “temporally punctual and spatially pointillist phenomena” (Sheets-Johnstone, 2011b, p. 461), and as a consequence of this type of repetitive experience attached to the moving body, allows for a marked experience of space and time with the prototypes.

Carol Brown considers how moving in space and spatial design actively negotiate between what she perceives as the “organic” and “inorganic”, suggesting strategies for working creatively with virtual reality.

Rather than harness the virtual other with its impossible geometries into our existing systems and making it speak as ‘other of the same’ through colonising and appropriating it, we negotiated the identity of our performance through improvisation processes that incorporated its geometries and spatial forms. This involved moving between a geometric or bilateral body-based symmetry based on the cross (horizontal-vertical axis and anterior-posterior axis) and a biometric or arthrometric model based on radial symmetry (concentric circles which move from the centre to periphery and periphery to centre). Whereas the former is geometric the latter is biological. In working between these two models, we had a device for negotiating relationships between the organic and the inorganic. As tools for improvising and thus relearning embodiment they provided a degree of responsiveness to the forms and images generated by the system. (Brown, 2004, p. 45)

Brown considers how we can use space differently by feeling and visualising the spatial design. Her findings are useful as they encompass worn technologies principally involving visual perception. In the case of this research, the prototype location impacted the movement trajectory, becoming a major influence as to whether it emanated from the centre or elsewhere. The idea of negotiating between what the technology promotes and the choreographer’s agency further explains a developing and changing relationship with the prototypes. Coupling sound, sensation, and imagined trajectories within the multimodal response to working with the prototypes

supports the 'kinesfield' theory proposed by Gretchen Schiller, whereby the "kinesfield can be understood as constructed from these intersections of mental perceptions and physical interactions" (Schiller, 2003, p. 129). Schiller's concept encompasses the dynamic spatio-temporal relationship between the environment, objects, the dancer, and their socio-cultural influences, appreciating the combined factors participating within interactive environments. These findings also resonate with Birringer's discussion of kinetic atmospheres (2022) where - in his example, using a VR setting and installation - the performer is involved in a dynamic and evolving relationship with technology, their body and surroundings, requiring their use of "subliminal and peripheral sensings, rhythms of sensation, vibrations, proprioceptive and imaginary relations, dreaming, and dancing as a kind of morphing, detailing the imperceptible, surrendering the curves and edges of others and other things" (Birringer, 2022, para 13.26).

De Vignemont (2018) suggests that tactile sensation on the skin can assist the awareness of the body part located in space (egocentric space), named the "bodily presence" (*ibid*, 2018, p. 44); however, in this research, the ongoing loop of tactile sensations also influenced the reception of the internal body and its pathways, through flesh, bone and organs. With the SWT used in this research, a complex mediation occurs between the environment and the body - internally and externally - and the relationship between the real and imagined becomes an indicator of how creative movement is based on the physical body, with sensation and sound impacting its movement within the space. In summary, the existing awareness that dancers have of their moving bodies becomes heightened through a greater fluidity of internal and external sensation involving the digital touch prototypes. Firstly, the feeling of vibration inside the body magnifies both interoception and the contrast with other textures and temperatures. Secondly, exteroception becomes modified; the body parts and the whole body possess relational elements with different considerations of spatial design and trajectories actively negotiated through the prototypes, their location on the body, and the combined traces of sound and sensation.

7.1.2 Fulcrum/Focal point

Both project findings suggest that the embodiment of a coded loop affected the participants' perception of time. The use of the 10-vibration loop prototype or the binary on/off code employed for the pump prototype afforded a 'fulcrum' of temporality, with its repetition providing a more solid or conscious awareness of the passing of time during improvisation. As Enrico Pitozzi (2014) describes when discussing the 'Laban Orienté Lisp' software used by the choreographer Myriam Gourfink, this implicates a different perception of time and attitude to the body: "This approach implies an inner visualisation process and a certain degree of attention even to the slightest modification in body form. The quality of time achieved is elastic..." (Pitozzi, 2014, p. 184). In Gourfink's work, body-worn sensors and visualised measurements encourage attention to the micro changes of the body to consequently implicate the experience of time. During improvisation with the vibration prototype, there was an explicit looping mechanism situating participants on a more overt continuum creating a heightened awareness of the body. As discussed in the previous chapter, this could also be the result of tactile patterns marking the spatio-temporality of experience. This mark-making within time links to synchronisation and the subsequent entrainment of the participant to the prototype.

7.2 How do the prototype and body connect?

7.2.1 Listening and hearing

What is apparent from the project findings is that it took time to become accustomed to the prototypes. Forms of passive touch from the prototypes encouraged the participant to make associations through *hearing* and *listening* to make sense of the tactile/auditory information. The connection between participant and prototype may involve *hearing* and a passive reception of stimuli and *listening* involving both attention and intention. As discussed within Project 2's findings, the participants described their experiences as a 'series of journeys' or a continuation of different approaches, suggestive of a shifting relationship between participant and technology.

This thesis will use the terms of working *through/against/with/alongside* the prototypes to explain the relationships described and witnessed in the research.

Katherine Hayles (2012) proposes these relationships in her book ‘How We Think: Digital Media and Contemporary Technogenesis’. She theorises the extension of thinking through technological objects and how metacognitive capabilities may evolve through co-development with tools (Hayles, 2012, p. 95). This is a thought-provoking proposition and assists in explaining the actions and workings observed, embodied, and analysed over the two projects. Both Hayles (2012) and Malafouris (2013) consider symbiotic influence in these interactions, with Hayles’s discussion heavily weighted to the influence of cognitive load in thinking through tools to explain the seemingly unconsciousness experience, whereas Malafouris views the artists’ responsiveness to affordances and influences, both material and imaginary, as consciousness itself. This thesis surmises that the creative response to digital touch can exist in many different forms of attentional state, largely because of the working relationship between the SWT and the dancer/choreographer.

Hayle’s theory (2012) proposes that these types of relationships will be expanded through examples in creating dance with digital touch. I do not intend to present the changing relationships and modes of attention as a set path of progression from *through* to *alongside*, instead expressing them as viable options in the creative exploration of movement with digital touch.

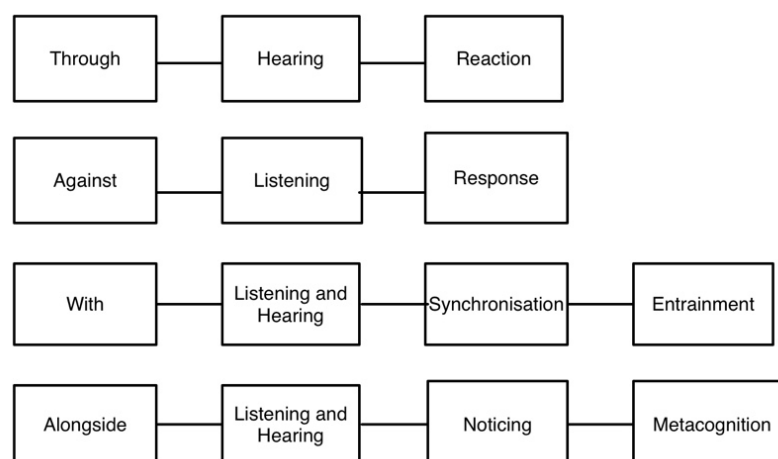


Figure 33: Diagram of the changing relationships and attentional states with prototypes

The combination of sound and tactile sensation created rhythm, providing a structure or framework for participants to either ignore or synchronise with. The occurrence of selective entrainment, whereby the participants are physically drawn to synchronisation through pre-emption and understanding the interaction of the two loops (both bracelets of the vibration prototype), can be seen to evolve and be implicated in the changing relationship with the prototypes. We can also use Malafouris's discussion regarding the creation process and how material and movement adapt and respond to each other (Malafouris, 2013, p. 7) to explain this phenomenon. Within Material Engagement Theory, the material, creator, and environment are mutually influential, both guiding and being shaped by this interaction. Similarly, in the process of selective entrainment, *hearing* and *listening* were recognisable acts of working *with* the prototypes in this conjoint dynamic, forming part of the response and adaption needed when utilising digital touch within the choreographic process. In the case of *alongside*, the participants' found an approach enabling them to decentre their attention and consider their approach during the moment of creation.

7.2.2 Wearing a body-worn prototype and consciousness

Consciousness in tool use was initially used to consider the experience of participants and outline theories of assimilation. However, the findings suggest that theories promoting tool absorption into the body schema (Merleau Ponty, 1962) cannot necessarily fully explain digital touch and the constant somatosensory stimulation provided by the body-worn prototypes. Although the timespan for using the prototypes and familiarisation remained a factor within both projects, the prototypes did not allow for a straightforward mediation due to being always present as a sensation on the skin, rather than transparent in movement as in the well-known example of the blind man and his stick. As discussed earlier, Ingold's theory of fine-tuned modes of attention explains the seemingly automatic or unconscious action found in creative tool use. He suggests that this awareness is positioned in the foreground and led by sensory information allowing us to adapt and respond to the changing environment around us (Ingold, 1993, p. 437). Ingold's view does not suggest

that the tool recedes completely into the background during this assimilation, but that one can use what appears as non-direct attention to the material and environment through the process of working with the tool.

The apparent experience of 'not thinking and just doing' described by participants in both projects and presented here as working *through* the prototypes is, in fact, more aligned with Hayles's (2012) consideration of how the brain's plasticity and body forge new ways to consider technological information within multi-sensory environments. Ihde (2002) also promotes this notion in his post phenomenological discussion of technology. He considers the body and its interaction with technology as relational, and a mutual adapting process brought about by the body's/brain's capacity to change.

We are our bodies- but in that very basic notion one also discovers that our bodies have amazing plasticity and polymorphism that is often brought out precisely in our relations with technologies. (Ihde, 2002, p.138)

Similarly, receiving information described as *hearing* may better explain this initial occurrence of working with the SWT. As such, the participant is not necessarily involved in an extended choice of movement but is instead coping with the sensory information presented by the digital touch during its preliminary stages, making intention and attention less prominent. The coded loop and marking through its presence in the pre-reflective consciousness is a way the body/brain adapts to information and interpretation through movement. Thus, reflecting the plasticity or adaption to working with the SWT through improvisation.

That aside, the speed with which participants used the prototypes could also be a factor. As outlined during Project 1, the quicker the movement the greater the possibility of accelerating the cognitive speed of information processing, and therefore promoting the use of pre-learned movement and developmental/genetic factors (Savrami, 2017). Certainly, Project 2's participants noted that they had to slow their normal dancing/making speed to initially make sense of the prototypes.

7.3 The prototype and the human body acting together in partnership

According to this research's findings, there were several approaches to using the prototypes creating different working relationships. As a result, there are varying degrees of acknowledgement, communication, and influence. This range of perspectives became possible through engaging with the digital touch from wearing the prototype on the body, providing a means for seeing oneself or kinaesthetically feeling and perceiving the body differently. In suggesting that creating movement with digital touch stimuli involves enactive cognition, then somehow, we must recognise the *mutual* shaping of the creative product. However, when using passive digital touch stimuli there is of course no empathetic response from the prototype, following Participant 14's interview statement that "...it can't feel me". Yet, if we concentrate on the experience of mutual coupling between movement and the tactile sensation, then we could argue that participants and prototypes became involved in a new understanding of the body in the environment. We generate such comprehension through a different form of kinaesthetic consciousness, promoting fluid perception and heightening awareness of how the body is moving. What makes creative exploration different is the desire to break free or divert from the dominance of the code, and as such, I will discuss further this interplay between syncing and ignoring the rhythmic structure.

Firstly, Project 2's concept of entrainment from a physical perspective may explain how synchronisation, the involvement of anticipation, and re-adjustment to digital touch could form components for working *with* the prototype. As suggested in figure 33, this relationship or manner of working *with* the prototypes can involve both *hearing and listening*, sometimes intentionally using active readjustments to the sensation patterns, and other times being more passive. Selective entrainment or the pull of synchronicity to the rhythms (sensation and sound), did feature as part of the working relationship with the SWT. In the case of the vibration prototypes, the anticipation and adjustment to the pattern of vibro-tactile sensations features in participant responses and subsequently in the 'listening' element of attentional states. In the pump prototype, the less complicated binary code acted more in the frame of Continuous Time Reference (CTR). As Thaut, McIntosh and Hoemberg (2015) explain,

this is implicated in an adaptation of the spatial-temporal aspect of the movement in synching to the rhythm. As the project workshops focused more on the dance making process of creating movement than performing set movement phrases or dances, a propensity for moving beyond this stage or working relationship occurred.

I recorded this type of reaction during Project 2, where participants devised rule-based tasks disrupting the response of synchronising with the sensation and building another layer for exploring and experimentation. The manner with which participants conceived restrictions also relates to Western dance theatre practices for problem devising creation, as discussed by Cveji (2017). Her research looks at the use of rules and problem-based frameworks for disrupting and fracturing habits to develop new ways to create and receive movement. Certainly, this type of pathway produces more explicit decision making and can be associated with working *against* the prototypes, divergently using aspects of sensation and sound to explore movement material.

Furthermore, Ingold (2011) considers that when using technology, the skill of humanity is its ability to adapt and subvert machines into something useable and useful to their lives (Ingold, 2011, p. 62). De Spain echoes this, discussing the role of intimacy when improvising with interactive technologies. He dismisses the need to fully assimilate with the tools and for “technology [to be] ... a transparent conduit for... expression” (De Spain, 2011, p. 32), instead positing a “decentred intentionality” approach (*ibid*, 2011, p. 33). Subsequently, Ingold’s and De Spain’s reflections support the mutual shaping between technology and body alongside a propensity for working beyond the direct, or obvious, through continued prototype use. Therefore, reflecting the improvisatory journey/process of using technology, rather than mere traits associated with the stimuli and its creative exploration.

Returning to the question of what the dancer/choreographer and prototype do together, we could argue the engagement resembles a ‘mutual’ process of influence between the two. The concept of shaping expressed by Marshall McLuhan acknowledges the influence of technology physically; “Physiologically, man in the normal use of technology (or his variously extended body) is perpetually modified by it and in turn finds ever new ways of modifying his technology” (McLuhan, 2001, p. 51).

The process of working with the prototypes moves between that of a direct relationship, to one opposing, or else working in a collaborative/co-existent manner. The development of attentional states is born out of the active exploration and mutual shaping reciprocally occurring between prototypes, the imagined and real environment, and the body.

7.3.1 Attentional states

How a dancer/choreographer connects with the prototypes is crucially associated with attention and intention when generating choreographed movement. As Broadhurst and Machon stress, the development of technologically-enhanced performance rests on the “importance of developing our own technical sensory and attentional skills, ones that enhance our ability to discern, experience, create and transform our digital world” (Broadhurst and Machon, 2012, p. xi). Despite basing their discussion on live performance/artforms involving technology, it remains relevant due to the crossover between improvisation in the process of generating movement material, and as a live product within interactive environments and costumes. Broadhurst and Machon’s words resonate alongside Birringer’s call for new ways to work with performance technology, namely “new behaviors that reintegrate body-mind conscious and sensory functions through electrical, electronic, and digital means” (Birringer, 2008, p. xix).

There is evidence to suggest that this area of study warrants further research, specifically as attention/intention and consciousness lie fundamentally at the centre of this investigation. Receiving information - described here by either *hearing*, *listening*, or a mixture of both - is central to the proposed modes of attention. In the *through* relationship, the participant accepts a more passive role for receiving information from digital touch, resulting in what may be perceived as an absolute reaction to stimuli. As discussed in chapter 5, the occurrence of “don’t think, just do” manifests through the coded loop of pre-reflective experience, and as presented here, the result of the plasticity of brain/body in its interaction with the SWT. When the relationship performs *against* the prototype, there are circumstances of active listening but with decisions based upon preconceived rules or agendas. Whereas when utilising *with*, the relationship involves both ‘listening’ and ‘hearing’, to result in selective entrainment.

Within the prior state, this relationship explains how the participant and the prototype work *alongside* one another using a mixture of ‘hearing’ and ‘listening’ to enable noticing and a more equitable body/technology relationship leading to meta-cognition.

Academics have given attentional states some consideration within HCI and philosophy; historically, they have been associated with early literature on embodied cognition. Over 20 years ago, Varela, Thompson, and Rosch’s book ‘Embodied Mind’ called for a consideration of mindfulness drawn from Buddhism using different attentional states to cognition. In the revised edition (2017), Thompson clarifies the connection between mindfulness²⁹ and enaction; "From the enactive perspective, mindfulness practices should be viewed as forms of skilful know-how for enacting certain situated mind-body states and behaviors..." (*ibid*, 2017, p. xxv). The book compares the expert action of the musician or athlete with *full awareness* to the state of being fully present in mindfulness meditation. Which begs the question: does the full awareness described reveal an existing skill in dancers for being fully present in the moment or does the mutual shaping of prototype and participant generate this phenomenon? Undoubtedly, the dancers/choreographers demonstrating metacognition within the workshops held experience of utilising aspects of meditation within choreographic strategies. However, the themes across both projects associated with the prototypes including ‘foci’, ‘fulcrum’, ‘amplification’, and ‘heightened awareness’ support how the process of working with digital touch stimuli can enable ‘doing’ and ‘noticing’ simultaneously. De Spain’s concept of “decentred intentionality” (*ibid*, 2011, p. 33) in his discussion of improvisation within interactive environments resonates with the attentional state of working *alongside* the prototypes through being influenced by the technology and vice versa, but with a process of filtering information/thoughts during use.

Liane Gabora’s line of enquiry in ‘Art, Technology, Consciousness: Mind@large’ (2000) critically considers how multiple sources of information drawn from the environment can impact cognitive capacity, subsequently resulting in different attentional states.

²⁹ Mindful meditation is “to experience what one’s mind is doing as it does it, to be present with one’s mind” (Varela, Thompson, and Rosch, 2017, p 23).

The more features of the environment one attends or is sensitive to, the more memory locations potentially involved in its storage; thus, a large activation function may manifest as a state of defocused attention or heightened sensitivity. (Gabora, 2000, p. 162)

Attributing this relationship and these attentional states to cognitive processing demand can provide an answer for why they occur while creating movement with the prototypes. However, the question remains of what the dancer/choreographer and technology 'do' together. Different attentional states produced through a process of creating with body-worn technology may allow for a new means for understanding. For example, we can explain attentional change as a method for sensing and digesting information promoted by Myer's and Dumit's "creative mode of attention" (Myers and Dumit, 2011, p. 252). Using time-lapse film loops and 3D immersive environments, their premise considers the partnership between a participant moving with technology as responsible for refiguring their understanding of data and the studied phenomenon.

[T]his is not just a practice of placing objects in direct relation to human durations and dimensions; it is one that allows researchers to transform their bodily capacities and refigure what they can see, say, feel, and know. For the researcher this process is experienced kinesthetically and affectively, as well as visually; and they are drawn into movements and into forms of expression they may not have known in advance. (Myer and Dumit, 2011, pp. 258)

Although in their example, Myer and Dumit consider the communication of scientific data, the workshops and participant responses in this research support a concept of making meaning from their own bodies. Heightened awareness of the body through the stimulation of digital touch creates opportunities to address the evolving situation, enabling different prototype/participant relationships with which to understand the body. Clark and Ando also consider how a dancer's kinaesthesia is transformed by the active attention generated through the technology and the introduction of diverse ways of feeling/moving within this exchange.

Both choreographic instruction through imagery and the digital representation of movement can help dancers not just to become aware of their own kinesthesia, but also to reshape and reconfigure it... Kinesthetic attention is also almost always at stake and often transformed, when dancers enact with digital representations of the movement of either themselves or virtual others.” (Clark and Ando, 2014, pp. 9-10)

If we revisit Ravn’s work whereby kinaesthetic awareness is both involved with imaginary aspects of space and the dancer’s sense of their own body (Ravn, 2017, p. 68), considered in conjunction with Clark and Ando's (2014) suggested reformation of kinaesthesia, then by association, the prototypes could produce an altered kinaesthesia. For example, the sensation and sound produced by the prototypes enabled both real and imagined trajectories and points in space, enabling the participant to connect to their body/prototype/environment dismissing the boundaries of interior and exterior. For this reason, the participants' sense of movement utilised information more fluidly through interception and exteroception.

In considering the theme of ‘attentional states’, this thesis has presented the case that its different forms can be utilised whilst creating movement with the SWT. A heightened awareness or sensitised bodily experience can enable participants to notice ‘how’ they are moving in real-time to their response. The focus created by the prototypes magnifies this experience and as such enables a re-evaluation of the body’s sense of movement with real and imagined sources, both internally and externally. We should not necessarily view different attention states as the negative result of cognitive demand, but as a way to make new meaning by using prototypes in the formation of creative movement.

7.4 What do they bring forth?

Tim Ingold (2011) proposes that the 'properties' of materials are established by their interactions and governed by what emerges from the process of experience (*ibid*, p. 30), seeing the exchange and all that happens to the properties as a narrative. This view of the body and wearables as a story of their mutual adaption is largely why the

process itself dominates the discussion within this chapter. Despite the difficulty of trying to understand what the participants' moving bodies felt, the properties involved and how they mutate or develop within their movement responses, there is still worth in examining the story of digital touch and what they generate together.

By subscribing to Barbara Montero's proposition (2006) that through proprioception we understand the desired aesthetic realisation of movement, then arguably, in some instances, digital touch stimuli disrupted this in a participant's movement. For example, during improvisation, several participants in both projects discovered a divergence between their intention and movement creation. In Project 1, the movement analysis of the first prompt and interview anecdotes support the stop-start quality of the movement, resulting from the anticipation of two different patterns of vibration and the looping dialogue. Similarly, in Project 2, the pump prototype regulated the pace, influencing the dynamics of movement. Despite a process of negative feedback or readjustment taking place between the aesthetics of the code and the moving body, we can also view this as part of mutual adaption and the development of selective entrainment.

However, the data suggests that most participants moved beyond a reaction to the stimuli (*through*) with extended use of the SWT. Therefore, establishing a different relationship with varied modes of attention. When working *against* the prototypes I saw either resistance to the rhythm, the dominance of the prototype location, or participants using a rule-based strategy for building further complexity in their improvisation. In an *against* or *alongside* relationship, the prototypes hold less obvious influence over the movement, particularly as structuring it into or editing an existing phrase allowed for a greater diversity of movement action, dynamics, effort structure, and levels.

In the case of Participants 14 and 15, their existing practice involved elements of meditation and mindfulness and therefore, their approach to using the tool encompassed a different attentional practice. However, we can see working *alongside* in Project 2 with Participants 12 and 13, with participants noticing their thoughts and somehow filtering these to indicate a process akin to meta-cognition. Considering

potential attentional differences provides some pedagogical indication as to how aids/tools/devices and their usage may be approached within future research.

7.5 Summary

7.5.1 Digital touch and its influence on kinaesthetic awareness

Several scholars (Csordas, 1993; Sklar, 2000; Rouhiainen, 2003; Potter 2008; Ravn, 2016) across the fields of anthropology, dance, and philosophy consider the “double act of moving and feeling oneself move” (Sklar, 2000, p. 72), acknowledging a greater depth to kinaesthetic awareness than merely sensing one’s own body moving in space. For the highly trained dancer, this experience involves an openness to the sensations of weight, tension, and gravity felt within and on the skin’s surface and internally within the flesh, organs and bones. This awareness relates to the subjective nature of experience but also other dancers within the situated space and environment. Within this research, body-worn devices and specifically, the reception of information from digital touch requires the user to be open to both multiple channels of information and the multimodal manner with which it is interpreted and communicated, demonstrated by the use of sounds, tactile stimuli, and imaginary imagery in the creative response of participants. Despite the simplicity of passive touch, the “bodily presence” (de Vignemont, 2018, p. 44) gained through somatosense heightens the participant's relationship to their own body. As such, the body part where the prototype is located becomes amplified to the rest of the body and space surrounding it. This thesis extends de Vignemont’s proposal by suggesting that this develops interoceptively and influences internal reference to space. The participants described the prototypes as organisers of time or a focal point; this thesis argues that the repetition of the code through a loop contributes to marking the pre-reflective experience. Subsequently, the continual process of digital touch sensation during the unfolding of consciousness in improvisation punctuates the spatio-temporality of ‘primal impression, protention, and retention’.

The expanded sensory participation of both internal and external sensations and sounds generates heightened awareness. As explained during Project 1, this assists

consideration regarding the "how" of the movement, amplifying the experience of moving and feeling through the body. Vibration and pressure on the skin and the subsequent sensation of this travelling through the body dissolved its perceptual boundaries of internal and external. Although dancers may normally call upon interoception, exteroception, and proprioception to inform their movement, the data reveals greater fluidity between what we find outside and inside the body, with the interpretation of the stimuli provoking a different consideration of the moving body.

During the creative process of making dance with body-worn technology, the attentional focus became closely related to the relationship with the technology. In the case of digital touch sensation, there is a heightened awareness within the body, with kinaesthetic awareness incorporating a more sensitised and fluid interoceptive and exteroceptive perception.

7.5.2 Digital touch and its influence on creative movement

The movement analysis suggests the influence of the code, or the recognisable properties of the aesthetics of the code during the initial improvisation - prompt 1 in Project 1 - where participants were encouraged to explore the sensation felt by the prototypes. This stop-start quality was created by reacting to the patterns of sensation and dialogue between the two vibration bracelets. Participants initiated a greater use of movement from the arms where the prototypes were located, and reorientated their legs with their arms in space, with their hands and wrists using wrapping, pressing, and crossing. Regarding the development of a small phrase of movement, there was a greater diversity of movement in the space, its qualities, movement initiation, and effort phrasing, and therefore less direct reaction to the stimulus.

During Project 2, most of the time spent using the prototypes was improvisational, with three participants choosing to explore structuring and editing with the pump/vibration prototypes. When improvising with the pump, greater emphasis was placed on movement initiation from the lower torso where the prototype was located. The prototype prompted ripples and undulations from the lower torso travelling through the body, upper body curves, hunching over in lower contractions, and rocking

and playing with weight transference. During the editing task, participants stated that the pump's rhythm of binary code flattened the pace of existing movement phrases, perhaps due to the selective entrainment of working *with* the prototype resulting in its synchronisation with the dancer/choreographer.

The response of participants to the digital touch stimuli produced by both prototypes combined sound, sensation, and their imagined elaborations, which we consequently recognise as a multimodal creative response. Of course, the participants' choreographic practice when not using the prototypes may also invoke this method of utilising information from physical and cognitive resources. However, the prototypes provided an aid for examining the dancing body in this process; they heightened awareness and generated a focus manifesting from the interaction between coded patterns of sensation/sound. The dynamic combination of body/code/environment during improvised movement facilitated the development of different relationships or stances to using the prototypes. As a result, this thesis suggests that the working relationships of *through/against/with/alongside* influences how we receive stimuli, the attentional states involved in their interpretation, and the approach to decision making during the choreographic process.

8. Conclusion

I completed this research during the Covid 19 pandemic and subsequently in a time when the value of touch has been examined and re-evaluated. In the United Kingdom, there were periods where the whole country was under strict lockdown, with proximity to others and human touch discouraged. As a result of these conditions there has been greater interest in how human beings can connect without being physically present in the same space. There is an argument that we must undertake more research in mediated and digital touch to further facilitate situations of remote learning or work and advance our understanding of how technology may assist these connections. Dance studies and movement computing possess the expertise to contribute to this area and despite being situated on the periphery, this research's contribution to knowledge could support the case for studying creative response in relation to digital touch. This research is not suggesting that touch through a computer can be a substitute for human touch, but its creative use can enable us to consider its potential beyond the functional mimicry of commercially-driven haptics to understand the multifaceted area of digital touch created by body-worn devices. Through exploring the imaginative potentials of body-worn technology, this research embraces the complexities of human decision making and the sensorial experience via an inductive approach, discussing both the movement and perceptions of a collective of students and professionals alongside current theories in anthropology, philosophy, and cognitive archaeology.

To conclude, this chapter will review the research question and directly address the findings and their contribution to new knowledge. Firstly, I will present a summary of each chapter linked with the findings and overall conclusion. I will then follow this with a section considering the wider implications of this research and the potential themes for future investigation.

8.1 Chapter Summary

8.1.1 Introduction

The catalyst for this research journey began during my investigation of adornment within several different genres of dance, eventually proceeding to an interest in wearable technology and its potential for the moving body. As the technology is worn on the body, it soon became apparent that this research would need to also address kinaesthetic awareness and so the introduction clarified its inclusion alongside that of somatosense, proprioception, and kinaesthesia. The chapter further considers how technological theory and performance promote an extension of proprioception and the enhancement of embodiment and consciousness. However, as Davidson (2019) emphasises, aside from a handful of exceptions, most of the existing literature fails to explain how the body is involved or interacts with technology during choreographic practice. In closing, the introductory chapter covered my position as the researcher, the main research questions, and the aims and outcomes of this PhD research, followed by a breakdown of the thesis structure.

8.1.2 Context and definitions

This contextual chapter described the need within interdisciplinary research for clarifying certain terms, outlining what is usually meant by dance making, but specifically in this thesis, the making of dance by a human body and a wearable device. Further sub-points sought to explain improvisation and practitioners' comments regarding the connection of sensation and movement. In turn, the chapter addressed the differing definitions of kinaesthetic awareness through phenomenological routes, particularly within the dance field and clarifies what is meant by the term 'the body' within this thesis. Entwined within this discussion are points on how we receive and combine information, followed by an examination of somatosensory feedback.

Preceding a section on the social and mediated aspects of touch, this chapter contained an analysis of touch within the field of somatic practices with research acknowledging its potential for waking the body and recognising patterns and habits associated with bodily movement. Socio-cultural influences on touch are present

within this research but the chapter directs its focus toward the microelements of participants' experience and movement within the thesis. It provides a rationale as to why haptics were not more fully engaged in this research, primarily due to its focus on the reproduction of touch associated with the hand. Development in this area is largely driven by commercial interests, making the investigation's alignment with 'digital touch' more appropriate and encompassing the whole body in the creative context.

As I designed the prototypes to be used as a tool/aid/device for developing creative movement, I included a brief overview of the phenomenological thoughts of tool assimilation within this chapter. To explain and expand the findings of each project, I drew upon research into cognitive science, cognitive archaeology, anthropology, and dance studies. At the centre of this discussion is a belief that the body, brain, and environment are connected during the act of cognition and that this transpires as an embodied process.

8.1.3 Literature Review

Similarly, addressing the interdisciplinary nature of the research, the literature review begins by considering the texts more broadly covering artistic practices and performance with technology. The literature revealed the theme of tools or interactive environments extending the senses. The texts also raised questions surrounding the role of technology in artistic creation (Dixon, 2007) and how technologically-assisted processes can perceptually alter time and space (Salter, 2010) with the possibility of evolving body image and multiple identities (Broadhurst, 2006).

By explaining the lineage of digital dance and key people within its development, the chapter details how projects and specific practitioners led the development and adoption of technology, until recently when choreographers and academics collaborated to further communicate about choreography through technology. Despite the increasing interest in archiving, recording, and revealing the creative process, there has been a lack of literature discussing wearable technology within the choreographic *process* of dance while using *digital touch*.

Subsequently, this chapter included research considering sonic and movement associations with costume, wearable instruments, and interactive environments within the work of Birringer, Danjoux, Schiphorst, and Kozel. Danjoux and Birringer's work with interactive costumes/instruments proposes that the aesthetics and functionality of wearable technology enables greater multisensorial communication (2009). Kozel's work specifically looking at wearable technology and data discusses the perceptual affordances of using technology (2008); while Schiphorst's account (2007) of the collaborative project *whispers* contemplates the role of touch and wearable technology in some detail, considering somaesthetics (Shusterman, 1996) and the sensorial information involved with the technology, reflecting the multi-phenomenological perspectives available within this interaction.

Next, the chapter addresses the kinesphere and kinaesthesia, with the surveyed literature suggesting that technology influences and re-orders the dancers' presence and sensorial awareness (Davidson, 2013, 2016, 2019; Sweeny, 2017; Pitozzi, 2019), with Choinière (2019) describing a de-stabilisation of the senses through a dynamic, ongoing process of perception with technology. Within the interactive environment, performance enables an extension of the dancing body (Bisig and Palcaio, 2016) and so we should consider the body's kinesphere relational to the changing architectural (Birringer, 2003) and interactive environment (Schiller, 2003). Karreman (2017) considers the Western propensity for mark-making and metaphor influencing the use of the dancers' imagery in the space and promoting outward and geometric kinaesthesia with technologies. To conclude, the literature suggests that collectively, our senses develop and change when using technology for performance. This adaption is involved with the increasing fluidity between the environment/objects/bodies through this interaction. However useful the literature on VR and sensor-based interactive environments may be, it only serves as a point for comparison to wearable technology and digital touch. Subsequently, the literature review suggests a need to consider digital touch and body-worn technologies due to the lack of detail relating to movement analysis and an established need for greater knowledge regarding a range of technologies in the making of dance.

8.1.4 Methods and methodology

I used an inductive approach within this research inquiry, largely because the complexities of the creative process and the possible factors associated with using wearable technology require a respectfully wide starting point for considering this interdisciplinary area. This resulted in a research cycle that started by reading, auditing, mapping tools/artefacts/clothing before moving on to prototyping. In the interdisciplinary context, prototyping provided a re-assessment of the meaning of terms and practice. The epistemological ramifications of discussion, sharing, and making with the DALab and my supervisors proved invaluable for scaling the vast terrain of physical computing and dance, particularly when gaining practical knowledge of the materials involved. After testing the prototype during the pilot, I ran the project with the developed prototype and refined my workshop plans. The data captured from the initial project enabled a further evaluation which I then used in the second project to create two more SWTs.

Methods for gathering the qualitative data included semi-structured interviews; videoed workshops; embodied participation; and field notes and observations. I interpreted and analysed the data sets through movement analysis - adapted from Laban Movement Analysis – and coding the verbal and written accounts. A mixture of invivo and open coding allowed me to determine themes and devise a matrix for collating data from the movement analysis. I employed a thematic analysis and through an extended discussion based on supporting literature, discussed the findings of each project. Despite presenting theoretical propositions about making dance with body-worn technology, I acknowledge that this research is situated within a culture of dance - predominantly contemporary - representing Western practices possessing specific forms of digital touch, with findings localised to specific uses and situations.

The chapter outlines my rationale for embodied research, including the influences of sensory ethnography, dance studies, and anthropology. My justification for using mixed methods included an argument for reflexivity, a deeper understanding of the participant's experience, and the means for recall during the analysis stage. My use of embodied methods attempts to appreciate the complexity of human actions, the

relationships to objects/environment and the production of knowledge through participation, and the recognition of factors involved in the influence of digital touch stimuli. Furthermore, the chapter considers why I did not select certain approaches and why I found mixed methods or a transfer/merger of methods to be advantageous. The chapter closes with a discussion of the ethical considerations and actions, followed by an outline of the limitations/challenges of the methods.

8.1.5 Digital Intervention Project - Project 1

Inspired by the work of Mark Coniglio (2017), Project 1 began with the development of a prototype operating somewhat as a disruptor or antagonist to the creative process. By way of auditing existing technologies and sourcing/experimenting with materials, I evolved the idea to create different manners of digital touch. The conceived bracelets housed the haptic motor controllers and vibration motors, and following the pilot feedback, I coded them with different vibration effects.

Each participant in Project 1 attended a half-day workshop at Studio Wayne McGregor in London where they worked with the vibration bracelet prototypes - the right with 10 prominent vibration effects, and the left with over 100 effects on a loop. I used only two conditions – wearing and not wearing the prototypes – guiding the participants through an improvisation containing three prompts pertaining to either the felt sensation or the imagined sensation of touch. The participants improvised for 20mins and then structured a movement phrase over a further 10mins, after which I learnt each participant's phrase. I repeated the prompts in each condition without the technology and then the participant discussed their experience with me during an interview.

The summarised findings concluded that improvising with the prototype created a more internalised perception of sensation, whereas the participants perceived imagined touch as an outside force upon the body. The two bracelets containing different vibration loops influenced the rhythm and quality of the movement produced by a start-stop pattern with participants alternating between bound and free movement. This was also due to the dialogue between the two prototype bracelets,

including participant anticipation of the left-hand device. Movement analysis showed greater use of the extremities - particularly the hands - in movement initiation, creating gestures of the arms including scooping, folding, crossing, and framing the body. We can attribute this to the location of the technology, with the prototypes providing a reference point for the rest of the body. In the structured phrase where participants had 10 minutes to consider how to select and assemble the elements explored during the improvisation, there seemed few thematic strands across participants and a greater difference between the actions, effort, space, and qualities of the movement. Thematically, my coding of the interviews revealed that the prototypes created greater awareness by honing the focus of the participants.

Qualitative data from the interviews suggested that the participants combined and interpreted the sounds and vibrations with their imagined thoughts. Wong's (2017) discussion on multimodal body schema and tool assimilation explains how the former may adapt, with research suggesting that SWT cannot extend our kinesphere externally in space but instead offer a heightened internal bodily awareness, referentially allowing a unique perspective of the body part to the whole body. Wong's research relies upon the established use of a tool, while in this research, the participants' improvisatory work raised questions about possibilities within a relatively short timeframe. Additionally, the speed of making creative decisions came under consideration, specifically conscious decision making and seemingly unconscious movement generation. In conclusion, the discussion suggested that the theory of tool assimilation was unable to fully account for the ongoing process with the prototypes, with Ingold's (2011) sensory participation theory better explaining such improvisation; namely, how the prototypes encouraged greater awareness/foci generating expanded sensory participation of both internal and external sensations and sounds.

Little evidence emerged from the research suggesting that the prototypes consistently enabled participants to find alternatives to composition outside of their habitual movement. Despite this, participants stated their movement 'felt different', with the digital touch allowing them to consider the 'how' of movement rather than the 'what', echoing the 'qualitative dynamics' mentioned by Sheets-Johnstone (1981). As the microprocessor within the prototype presents a coded loop of tactile stimuli, the

impact of this sensation on the pre-reflective experience (future, present, and past of moving) enabled a different manner of consciousness within the improvisational journey.

Some participants chose to react to the prototypes - using them to provide support with which to create - and therefore, we must acknowledge the distinct levels of engagement with the technology. Gallagher (2005) explains these seemingly intentional and automatic movement choices; discussing the dynamic process of the body schema, he explains that although this process lacks consciousness it can be pre-reflective and so subsequently, the continuum by way of repetitive vibration effects in this research created a heightened awareness. Created by the looped stimuli, mark-making in the temporal experience enabled the participants to implement movement intentions within a seemingly less conscious thought process. Neuroscientific evidence suggests that one will take time to cognitively process proprioceptive information when conducting fast-paced improvisation, and as such, this movement is explained by the theory of emulators predicting sensory feedback for motor control (Wong, 2015). We can associate the pre-reflective experience of the looped code with a 'reaction' experience rather than a longer, more reflective approach to movement creation. Whether this process is also implicated in predicted feedback as Wong suggests requires further research.

The chapter ended with a consideration of Material Engagement Theory. Despite the ephemerality of movement, mutual influence was involved in the process of making dance using SWTs. The affordance of vibration patterns, in conjunction with the dancer/choreographer relationship to the space and environment was evidently entwined in the participants' creative response. Furthermore, the promotion of internal and external perception upon movement and the relationship between the body part and the whole through sensory appreciation enables the interconnection of body, environment, and objects during movement creation.

To summarise, the findings revealed that speed of use and the possible associated cognitive load influenced intentional and seemingly automatic movement. However, the loop of the code provided structure – or a mark - to this process, informed by the

unfolding of the past, present, and future associated with pre-reflectivity. The relationship with the technology and what it yields is dependent upon the individual and their approach to using the stimuli, however, the perception of the boundary of the body became more permeable due to the sensation of vibration allowing the vibration bracelets to develop into part of a dynamic relationship with the body creating improvised movement.

8.1.6 Digital Touch Project - Project 2

The second project aimed to work with a range of prototypes utilising different digital touch sensations, including the vibration prototype used in the first project. I developed two new corresponding prototypes designed to be worn near the centre of the body in comparison to the bracelets worn at the extremities (wrist). The soft robotics inspired pump prototype operated via small motors, this enabled inflation and deflation of a silicone waistband. The prototyping process involved shrinking the circuit, dampening the noise from the motors, and curing silicone which when effectively inflated would exert pressure against the participant's skin.

In parallel, I designed a nitinol prototype to focus on touch via pressure; using different lengths and strengths of voltage to contract the material against the skin. After the second set of workshops, it became apparent that the nitinol prototype was too unreliable to use in Project 2 and was abandoned. The other main purpose of the Digital Touch project was to create a more naturalistic setting, asking participants to incorporate the prototypes into their usual working practices. Project 2's developments included using a range of different venues for the workshops, having a participant group of various training backgrounds, arranging a group proficient in dance making and communicating their experiences, and allowing participants longer timeframes when working with the technologies.

The Digital Touch Project's findings revealed the changing relationships between the SWT and the dancer/choreographer, with the participants' approaches and descriptions of their experiences demonstrating working *through*, *against*, *with*, and *alongside* the prototypes. At points, the prototypes disrupted the improvisation,

creating a disturbance of the desired movement aesthetics. At other times they enabled a greater awareness, highlighting what the body was doing whilst improvising. Attentional focus was a theme identified through prototype use, with one participant describing it as a “fulcrum” or organiser of time. We can explain this phenomenon through re-adjustments and synchronisation with the rhythm of the loop, in some circumstances creating selective entrainment. Attentional focus dominated the pump prototype usage due to its location at the core, attributing to a demand for ‘listening’ to subtle sensations. The intimacy created by patterns of digital touch enables an internalised perspective, influencing movement initiation and range. Accounts from Participants 12, 14, and 15 indicate that using the prototypes provided a greater understanding of body parts - where they were in space or where they had just been – therefore, influencing their real and imagined trajectories of movement. How we perceive time, space and the body’s rhythmic response has direct relevance to one’s kinaesthetic awareness, impacting how the participants use their kinesphere - the direct space around the body - in response to that felt internally. To conclude, participants experienced different means of internal sensation alongside imagined trajectories of sensation/sound, with the somatosense and developed interoception providing a heightened ability for feeling/sensing their moving bodies.

The working relationship with the prototypes involved listening and hearing, as outlined by Tuuri and Eerola (2012). They describe *listening* as active and intentional, with *hearing* by contrast being a passive reception of sound. Theories on listening and hearing can explain how the participant processed the action-sound-tactile couplings along with the affordances of the direct environment, likely accounting for making meaning during the improvisation process.

The pump prototype had a binary inflate and deflate code which could produce a meditative/calming effect or flattening of the dynamics of the movement. Synchronicity and selective entrainment were apparent when working with the prototypes, but at least half of the participants diverged from this pattern as the workshop continued. I explained this by discussing the rule-based strategy to the choreographic process and its existing use in Western contemporary dance practices. The ongoing reminder to the body created by the digital touch caused greater

awareness and focus, with Project 2's findings supporting the pre-reflective experience discussed following Project 1. This repeated experience of sensation and sound created by loops of code enabled markers in the temporality of experience.

We can explain the disturbance of flow within a discussion addressing rhythm and the anticipation of expected sensation/sound. Therefore, when wearing two bracelets, we saw an ongoing re-adjustment of the participant's movement choices. The subtlety of sensation, the speed of movement, and whether the limb was weight-bearing, factored into how the body received the touch sensation. Other implications of working with the prototypes were the aesthetics of the code and its implications during movement-intention realisation.

The multimodal connections of the body/brain were evident in the participants' descriptions of the stimuli and how the experience exceeded the sensation of digital touch. The kinaesthetic, tactile, auditory, visual, and imagined images became entwined with the creative response of movement, generating evidence of the multimodality of experience when imaginatively using the digital touch prototypes.

8.1.7 Discussion

The closing chapter considers the findings of both projects collectively, approached through adapted questions from Material Engagement Theory (Malafouris, 2013) to critically examine what the prototypes and dancers/choreographers do together, what is brought forth, how the body/brain/prototype relate or connect, and what is affected by the use of digital touch stimuli during the dance making process. Evidence from both projects suggests that using the prototypes enabled a heightened appreciation of the body resulting in a developed kinaesthetic awareness. By discussing the possibility that trained dancers – already holding experience of somatic practices - may already have a deepened internal reception of their moving body, I then examined how interoception was changed by prototype use. Particularly, the participants felt the digital touch stimulus internally allowed a different understanding of body movement/communication, perceptually altering the boundary of the skin.

The SWT provided contact through passive touch sensation and subsequently became a reference point. In Husserl's phenomenological accounts, he discussed how corporeality manifests through the experience of touching and being touched, but what was identified as different within the experience of the prototype was that through somatoperception, participants felt their own body differently, with the coded loop providing the opportunity for the repeated presence of sensation. The participant's kinesphere was bridged with a new understanding of an altered awareness of space and time, including internal (interoception) and external (exteroception) to the body. The constant reminder of the loop also transformed the participants' relationship to time, with duration and temporality marked by the sensation of digital touch.

Looking at both projects, there seemed to be a change in how the participants used or worked with the prototypes; which was discussed through the frame of working *through/against/with* and *alongside*. We can see the aesthetics of the loop as a direct interpretation or reaction to the code, describing this relationship as working *through* the prototypes and explained by the pre-reflective conscious experience altered by marking the coded loop of the prototypes. The participants considered their response to be a pure reaction to the stimuli. Some moved towards working *with*, supported by theory considering entrainment and synchronicity which is suggestive of active listening and passive hearing for understanding digital touch. Some participants moved towards greater equality working parallel to the prototypes - described as *alongside* - utilising an attention state more akin to metacognition. In creative exploration, there exists a desire to diverge from patterns or create rules to disrupt a response, labelled as working *against* the suggested rhythms and sensations of the prototype code.

The working relationship of 'alongside' resonates with the 'decentred intentionality' suggested by de Spain (ibid, 2011, p. 33) and supports the idea of different attention states while improvising with technology. As expressed by Malafouris 'and Ingold's theories of tool use and sensory processing, thinking through the creative act of doing is a conscious act, and in the case of the SWT, the somatoperception brings dual attention to the sensation of the digital touch- both on top of the skin and internally within the body. Therefore, the notion of 'gradient' attention does not necessarily

explain this phenomenon, as the participants' attention is brought back repetitively to the fluid boundary of interoception and exteroception.

We can view these different working relationships as an approach for making meaning with the prototypes. McLuhan (1964/2001), Ihde (2002), Hayles (2012), and Malafouris (2013), all recognise the reciprocal shaping of technology/body/environment, and we could argue that the experience of the mutual coupling of movement and tactile sensation in this research involves a new understanding of the body. This generates comprehension through further kinaesthetic awareness promoted by the fluid boundaries between the inside and outside of the body and its heightened awareness.

This thesis argues that passive digital touch created by different coded loops of vibration and pressure can influence the choreographic experience through heightened awareness. Additionally, I suggest that interoception requires further consideration when using body-worn technology, as the forms of digital touch used in this research assisted in perceptually dissolving the body's boundary. The loop of the code altered the participants' experiences of space and time, providing a reference of the body part to the whole body alongside trajectories of movement. The organising element of the loop provided a marker for the passage of temporal experience. The findings of the two projects suggest an evolving relationship with the technology and subsequently, the manner with which participants use the aid/tool is dependent on both the time allowed and their usual choreographic practice. There is evidence to suggest that we can utilise the combined feeling and sound of the prototypes when working strategies of *through*, *against*, *with*, and *alongside*. The relationship is determined by the attentional state, appearing to impact the approach to improvisation and the means for generating movement material. Across both projects, the experience of disruption caused by the second vibration bracelet altered the response, introducing an element of anticipation during the improvisation. Where I observed the establishment of a more autonomous *alongside* working pattern, there was similar evidence to suggest meta-cognition. Key to these findings is how the participants utilised imagined and real sound/feeling within the creative processing of stimuli, therefore influencing not only touch but a multimodal means for creatively generating movement.

8.2 Contribution to knowledge

This research and thesis contribute to new knowledge on wearable and body-worn technology in dance studies by studying the use of SWT in the creative context of making dance. The projects and data gathered allowed for an investigation into digital touch and the affordances available to the dancers/choreographers. In particular, the use of somatoperception in response to a creative stimulus.

In answer to the research question of what influence the two digital touch stimuli have on the participants' experiences, I have presented evidence towards a heightened awareness/ foci generated by the coded loops of tactile sensation and through somatoperception. By constantly providing a reference point, the prototypes enabled the participants to feel patterns of looped passive touch and their internal body sensations in a new integrated manner. The usually unnoticed background of sensory tactile information shifted to a more overt position of sensory reception, enabling the dancer/choreographer to experience the different relational perspectives of the body in movement.

The second research question asked what impact the somatosensory wearable technology might have on the participants' kinaesthetic awareness. Themes from the interviews evidenced a difference in how participants' body parts related to their body as a whole. This connection allowed for a different understanding of space (trajectories) and time (marker and fulcrum). The perceptual fluidity of the body's boundary transformed into a prominent resource within the improvisation process, including sensitivity to interoception created by the actual physical, tactile sensations and sound, and through the imaginative, creative extension of the stimuli. As a choreographic tool/aid, this may be beneficial for germinating new strategies for communicating meaning and utilising multimodal opportunities. Conversely, we must also consider the tendency to fixate on introversion or sensation rather than action as less favourable elements of movement generation with the SWT.

The last research question asked how different participants might utilise the prototypes and the various forms of digital touch. The second project expanded the research by using the two types of digital touch and integrating the prototypes into the existing practices of dancers/choreographers. The divergent use of the prototypes presented different working relationships and attentional states involving selective entrainment, marked pre-reflectivity of consciousness and metacognition. This revealed that the participants utilised different affordances with extended use of the prototypes, which involved active and passive forms of receiving tactile and sonic information.

Birringer's (2008) proposal to further consider sense and technological processes was a starting point for this research. By analysing data on how two forms of digital touch patterns can be explored by dancers/choreographers in the process of making dance, I have contributed to new knowledge within this area. The responsiveness of dancers and their understanding of their kinaesthetic relationship to space presented in this body of work differs from Birringer's interactive-based environments, where the performers were able to hone their senses to extend their bodies by 'wear[ing] the space' (ibid, 2008: 120). Instead, the use of body-worn technology and the forms of digital touch allowed the user to reference internal space and trajectories within the body in a fluid manner with external perception. This process allowed the participant to recalibrate their kinaesthetic awareness through the constant presence of tactile sensation on a repeated loop.

This research credits and builds upon the work of Jewitt et al. (2020) relating to digital touch. The wearable nature of the prototypes allowed an investigation into sensations of vibration and pressure to be used as creative stimuli whilst moving. Subsequently, it provided evidence towards the artistic use and dimensions of digital touch. The data gathered from participants enabled thematic analysis from fieldnotes and interviews to be compared to the movement embodied/observed and analysed; therefore, the micro experience was bridged to the broader themes of the boundaries of the physical body. Through the wider frame of somatosense and the interconnections of bodily sense of touch, movement and position (the grouping of somatosense with proprioception and kinesthesia/kinaesthetic awareness), this research was able to

discover that passive digital touch patterns enable greater fluidity of internal and external perception. Subsequently, the interoception or awareness of muscles, bones and organs in the moving body was used as a resource to inform creative decisions within the improvisation. The dancers'/choreographers' fluid use of internal experiences with the external reception of sound enabled a new means to sense their body parts, positions and trajectories in relation to the rest of the moving body.

8.3 Future Research

The projects occurred within the United Kingdom, with most participants trained in contemporary dance reflecting Western practices, using three coded loops of digital touch stimuli created by patterns of vibration and pressure. Therefore, we can recognise these findings and subsequent discussions as contributing original knowledge, while holding the potential for further development within certain areas. In a higher educational setting, the ability to heighten the awareness of dance students could enable a greater understanding of their bodies moving in real-time. By marking a pre-reflective loop or imagined trajectories, the digital touch prototypes enable different relationships and connections. Edward Warburton considers that choreography, by necessity, involves a meta practice:

Choreographic meta practice involves and signals the practitioner's ability to step back from dance, metaphorically as well as literally, and to engage critically with its technicity – that includes options concerning time and space as well as the dancer and her or his training and ability to contribute as well as the practitioner's aesthetic. (Warburton, 2011, p. 68)

Therefore, the prototypes could enable this to be more easily accessible to those in training by highlighting body parts to the whole body and facilitating focus by integrating sound and touch sensation.

It must be emphasised that within this research, the prototypes only demonstrate three different patterns of code and therefore in a similar fashion to using music or images as stimuli, further consideration in the future should be given to the types of

code and the different aesthetic realisations of movement according to the interpretation of varied digital touch. The use of prototypes in this manner would also require greater research into the ethical ramifications of ‘digital touch’. As discussed during the TOUCHLESS research project, AI and technology use in human haptic technologies is in its infancy and subsequently requires developing areas of ethical analysis and evaluation (Touchless Project, 2022) to tackle questions surrounding appropriate touch and locations of contact. Despite not aiming to emulate the real sensations of touch, this research suggests any future use of digital tactile sensation on the moving body should align with current developments in ethical design.

When considering the potential of the prototypes in the wider context, the development of tools and body-worn technology using vibration could be generally relevant within the remit of health and further developed in dance and wellbeing. The use of vibration to reduce tremors in Parkinson’s Disease (Jöbges *et al.*, 2002; Haas *et al.*, 2006; King *et al.*, 2009) and to improve mobility and balance in elderly people are areas currently under investigation. How vibration works within the body is still debatable, with some research considering it disruptive to the local sensory feedback to the muscles. Whilst others consider that the resonance of the natural frequencies of the body’s different parts, via vibration, encourages entrainment, promoting increased blood circulation, relaxation, and assisting in improving the metabolism (Zheng *et al.*, 2009; Punkanen and Ala-Ruona, 2012). More recent research debates whether vibration causes relaxation of the muscles or entrainment of the thalamic oscillations of the brain for reducing tremors (Leuk, Low, and Teo, 2020). Within areas of musicology and computing, new projects considering technology, entrainment, and body data have started researching and identifying the entrainment phenomenon caused by our inhabited audio-visual environment (Jensenius, 2022). There is equally enormous potential for future collaborations between neuroscience, dance, and HCI for considering digital touch and vibration within entrainment research, potentially helping us to better understand the possibilities of working with future technologies and technological environments.

The research findings suggest that future work in body-worn technologies and user relationships necessitate an ontological shift; namely, how we consider our reality with technologies and the intimacy of these experiences.

Whatever we might say about the mind, and about its propensity to mingle with the world along the multiple pathways of sensory engagement with its surroundings, the organism at least remains confined within the envelope of the body. This presumption, along with the division between mental and organic activity on which it rests, seems to me to be unsustainable. For how can there be any sensory engagement that does not also involve a flow of materials within a wider field of forces? For this reason, I would like to return to Bateson's declaration and take it one step further. I want to suggest that as a nexus of life and growth within a meshwork of relations, *the organism is not limited by the skin*. It, too, leaks. (Ingold, 2011, p. 86)

Ingold's words highlight that we need to resolve existing tensions when viewing our interactions with objects and our environment, embracing the body beyond the defined boundaries of the skin. In adopting a more fluid approach to the body and the affordances around us, we can enable greater appreciation of the complexities of time, space, trajectories, perspectives, and attentional states. By providing evidence for how we consider sensory information and creative affordances with body-worn technology, I hope that this research adds to the growing body of work by artists and academics discussing expanded sensory appreciation through technological creation. Using digital touch as a stimulus contains the potential for heightening awareness of the moving body and most importantly, allows greater opportunities for self-knowledge and further understanding of our interactions.

9. Appendices

Appendix A Project 1 – Interview Questions

Digital Intervention Project

Studio Wayne McGregor

Date:

Participant:

Q1: Can you describe your response to moving with the wearable technology. Consider how the body moved and felt during this task and if possible, could you give a specific example?

Q2: Can you describe your response to moving without the technology, and if possible, give a specific example?

Q3: Can you describe any significant moments with or without using the technology?

Q4: When you came to refining and structuring your movement for the 16 count phrases- can you discuss your choice of movement and why you chose that movement, with and without the technology?

Q5: Can you talk about your use of space with and without the wearable tech?

Q6: Can you discuss the quality of your movement with and without the wearable tech?

Q7: This research is concerned with how we use our sense and kinaesthetic awareness in the creative process of choreography. Based on your experience of wearing the technology, how does it compare to your experience of the purely imagined process?

Q8: Do you have an awareness of your movement preferences or movements that are habitual in the improvisation scenario?

Q9: Do you think these habitual movements were present in the created phrases?

Q10: In your opinion, what do you think are the benefits or disadvantages of using a digital aid in the choreographic process?

Q11: What do you think the technology is doing?

Appendix B - Map of Studios and Designers involved in Wearable Technology

PNG File -attached

Appendix C - Map of Institutions and Universities involved with Wearable Technology

PNG File – attached

Appendix D- Example of the Workshop Participant information and consent form

PARTICIPANT INFORMATION SHEET

Introduction

We would like to invite you to take part in the Digital Touch research project. Before you decide we would like you to understand why the research is being carried out and what it would involve for you. We will go through the information sheet with you and answer any questions you have.

What is the purpose of the project?

The Digital Touch project has been developed by Katie Rees (PhD candidate, London College of Fashion). The project is looking at digital touch. It is hoped that the research could provide information on how technology could be used to assist the teaching and learning of dance.

What will you have to do if you agree to take part?

The project will require you to work with technology and to join in facilitated movement workshops, which will take place at LCF Holborn. You will be asked to participate in interviews and observations (which will be filmed). All data will be anonymised and will be stored in hardcopy and on a hard drive which is locked in a filing cabinet. The work will also expect the participants to creatively work with technology, therefore problem solving and physically working in different movement possibilities which would be more demanding than your average movement range in everyday life. The benefits of such participation include working new technology and providing data which can be used to further the debates about how technology can enhance dance participation and engagement.

Will your participation in the project remain confidential?

The research from this project will be used and discussed in a PhD Thesis, and information could be used within subsequent academic publications and presentations. The researcher will ensure that you have access to any transcripts of interviews or film/photographs, allowing you the right to edit or change responses before the research is published. Your data will be anonymized and access to your contact details will be restricted to the researcher and research team.

If you have any questions prior to, during, or post project, then Katie Rees or a member of the supervisory team will be happy to help. You have the right to withdraw the information given as part of the project at any time and any further queries can be directed to Katie Rees: k.rees0720161@arts.ac.uk or via the postgraduate administration team.

Who has supported this project?

This Phd research is funded by London College of Fashion, University of the Arts London in partnership with Studio Wayne McGregor.

Contact Information:

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+44 (0) 20 7514 7696

PARTICIPANT CONSENT FORM

Thank you for agreeing to take part in the Digital Touch project. Please take the time to read the following information and indicate your consent by ticking the boxes and signing below.

Activity consents

	Yes	No
I understand and I have given my consent to participating in movement workshops using wearable technology		
I understand that I will be observed and asked questions about my participation in the workshops and give consent to these activities		

Data consents

	Yes	No
I give permission for photographs, film footage, personal data to be held, stored, published and exhibited in the findings of the Digital Touch project and they may be used in future research, reports, conferences, publications and exhibitions		
I understand that my data will be anonymized and access to my contact details will be restricted to the researcher and research team		

Right of Withdrawal

You have the right to withdraw from this participatory process at any time.

Statement of Consent

I hereby consent to take part in this study, the details of which have been fully explained to me. I will inform the researcher of any existing medical conditions, with regards to my own health and safety in this research environment. You will be given a copy of the Participant Information Sheet and Consent Form to keep for future reference.

Participant's name:		
Participants signature	Date:	

Researcher's name:		
Researcher's signature	Date:	

Appendix E - Transcription of Pilot Workshop- Digital Intervention Project

Wearable Tech – prototype 1a and 1b
PhD Room, 5th July 2017, 1 pm-2.30 pm
Participants: A and B
Facilitator: KR
Observer: C

KR: So, first of all, we are going to have look at some improvisation tasks; so a way to create movement. We have 5 different tasks and I just want you to explore the movement that comes out of those tasks and then I want you to do them again with the wearable tech on. So, if we face this way, so you have enough space, okay, and just be aware of various things that have been pushed to one side. First of all, we are going to imagine different types of touch, so obviously we haven't physically got the things here, so it's a process of your using your imagination to be able to stimulate different movements. And we are going to look at where it is happening on the body and the quality and frequency of this touch. First of all, I want you to feel relaxed, perhaps close your eyes and think about a type of touch anywhere on the body and think about how that might make you move. Think about the quality of it. Is it hard, is it soft?

Participant A: So are we imagining that somebody is touching us and we are responding, rather than going like this.

KR: Yes, rather than you touching yourself. It's imagining there's some sort of touch on your body and how does that impact your movement? So it might help to think about what that is, first of all. It's okay, your novices and it's your first time doing this. Think about the touch, where is it on your body? If it helps you can talk through it.

Participant A: I'm thinking about somebody pushing me.

KR: Okay, so if somebody was to push you, how would that feel on your body? Okay, so it would make you want to do sideways movements. Where would that take you?

Participant A: It could make me fall down.

You could fall down, it could make you wobble and re-align, it could make you do lots of things, couldn't it. What about you XXXX?

Participant B: I'm not sure, mine's more subtle.

KR: That's okay, it can be subtle.

Participant B: It's quite specific, it's the feeling of someone stroking up your arm, against the direction of the hairs.

KR: That's nice. That feeling ...

Participant B: It's slightly to one side and possibly a ripple.

KR: So think about where that movement might take you. I'm going to leave you to explore that movement and come back to XXXXXXXX. What's the frequency of the movement?

Participant A: It's just once.

KR: It's just once and recover. Okay. What happens now once you have recovered. Is there a different touch that might be happening there?

Participant A: Can I say anything?

KR: Yeah.

Participant A: It could be the same one again.

KR: Is it harder this time?

Participant A: In what way?

KR: Is the touch harder? Or is it the same?

Participant A: It could be harder.

KR: How could that impact the movement, perhaps a wider swing to compensate?

KR: XXXX, what about your frequency? Is it becoming more frequent or is it a stand-alone touch?

Participant B: I think it depends on the response actually, if I'm doing this move off ... then the touch would be a one-off? But then I need to think about what I would do next.

KR: Would it make you change your level? Would it make you come back? Would it make you move through a different space or on the spot?

Participant B: I suppose it draws you kind of across. I'm instinctively doing a step off to the side. I don't know where that goes

KR: That's fine, there are no wrong answers here. So what you could think about, is if you are travelling, what other movements could it promote. If it was that, maybe it could come into a gallop, or maybe it could come into a jump, or is it more subtle than that, perhaps going into walking.

XXXXXXX, so you are coming back to this again. Does this keep on happening to you? Does it get stronger- that response or the same?

Participant A: I'm thinking either way.

KR: Good.

Participant A: I'm thinking we have a kata (sp?) in karate, that's deliberately designed for problems in small spaces. I've imagined people attacking me from both sides.

KR: So think about the different levels involved with that, if it's both ways. Is that something further up on your head, or on the same spot? How can that affect the levels you are using?

I'm going to put some music on to help you guys.

Participant A: Not being specifically told what to do is difficult. (speaking to Participant B)

KR: Yeah, it is difficult and it's exploring what the options might be and that's fine. Those are your choices within that. Sometimes it's just thinking about different ways you might be able to go in the space. There are different levels: high, medium and low. Different ways it might make you travel. So it might be, you could walk, jump, turn or you could just have moments of stillness. There are lots of different options and trying those out and seeing what works. It's about keeping that thing in your head, touch as a stimulus.

Participant B: What I think you might find with us amateurs are that our sequences will change each time.

KR: That's okay because it's a way of improvising and trying out different things, so it's a way of trying out new things at the moment. Think about the pressure, does the pressure increase or decrease? Does this affect the way you move? So is it a strong, sustained pressure or is it something that just makes you feel uneasy? So you have to keep coming back to the same point.

XXXXXXXXX has started to think about the touch from either side. So now what I want you to think about is...if it was an object or a person, would you move around it, over it or under it? Would you try and get away from the pressure, would it disorientate you, or push you in another direction maybe?

KR: (Talking to Participant B) So, if it was from an object or a person.

Participant B: So moving around...

KR: Around, under, over ...maybe. It's re-orientating yourself around that imaginary object or figure.

KR: (talking to Participant A) Imagine where the pressure is coming from? Is it quite...

Participant A: I'm just thinking about somebody moving you.

KR: Would you try and move away from it or would you try and come back to it again?

Participant A: I could come back to it again.

KR: You don't have to. Just have a think.

Participant A: Break out into my karate moves.

(KR laughs)

Participant A: This is using strange parts of my brain I have never used before.

KR: Yeah, well unless you have experienced a form of dance composition before then maybe not. Now I want you to think about the pressure has relocated to a different part of your body now. So it's somewhere else. It's not here (turning to Participant B). Now you need to think about it relocating to another part of your body.

Participant B: There is a part of my brain that keeps on thinking about what I actually look like.

KR: That's quite normal. It's okay, your beginners. Try and switch off that outside onlooker.

I will move over here, so there's less...

Now the attention of that pressure has moved away, so how does that affect your movement, now you don't have that pressure anymore or sensation. Does it affect the quality of the movement, because of the absence or not?

So we have explored those different tasks with touch. We have explored pressure, whether the pressure was changing to a different body part, whether it was moving you in relation to orientation. We are going to try it again with the tech.

Wearable Tech prototype 1a on Participant B and 1b on Participant A.

KR: So we are going to look at the tasks again and we are going to through each one. We have each got pressure on us. I want you to think about this pressure and I want you to close your eyes again and think about the pressure, the feel upon your skin and the way it might make you want to move.

The quality of the touch. Is it changing or is it staying constant?

Participant A: I'm imagining...I'm remembering what I did before and because this is localized, I'm imagining the movements of what I did before with the whole body, but because (she points to her hand, with the tech) it's more focused.

KR: because of where it is?

Participant A: So it's quite a literal translation.

KR: Have a think about if there is any difference in pressure?

Your one is quite simple (addressing Participant B), whereas XXXXXXXX's should be different as it has different types of buzzes and hums.

Participant B: What degree are we relating this to the phrase we have just done?
Taking the same approach?

KR: Yeah, taking the same approach. You might inadvertently bring it back in, but see it as a clean slate in a way.

Participant A: I'm not sure if this is working properly.

KR: I'm not sure if the battery is fully charged, that, or it's the connections.

XXXX, is yours still working?

Participant B: Yes, the reason I was asking about the frequency, is it's definitely working, but it's very widely spaced. There was a while when it was doing nothing and then it would buzz. In the future, it might be worth bringing the frequency closer together. Also, it does throw you out in quite an interesting way, when you are not expecting it.

KR: That's useful to know. XXXXXXXX is that working at all now? (KR goes over to look at the wearable tech)

Okay thinking again about what movement it makes you want to perform? Bringing it back to that.

So even when you feel that sensation, whether it's frequent or not very frequent, I want you to think about how you move around that sensation, move through it, move under it, move over it. Does it help you move into another body part; does the technical touch reverberate anywhere else, does it make you want to do something other, with another part of your body...or is it quite dominant?

Participant B: I want to move my arms

Participant A: (Nods)

KR: Which shows where you put it [the WT], is always going to make an influence.

Participant B: This seems more gestural. It's easier to get planted on the spot. I think that the focus being on one part of the body makes you think about that part of the body. I keep on doing shoulder movements as this vibrates. (Participant B does a movement which ripples from the hand right through to the shoulders)

KR: It develops through the body?

Participant B: It's all through the shoulders, rather than anywhere through space, but then again professionals would think through this with their spatial awareness.

KR: But you do have limited space, and most people will use the space around them if they are not used to using the whole space more.

Participant A: It introduces a noise that pulls your focus to that. And it makes me less conscious of the space around me. And there are studies that look at noise and interference and people's ability to balance. It heightens alertness.

KR: I want you to think about shifting your perspective away from that sensation...moving away and disassociating yourself from that sensation and how your movement might be different.

If you think you have come to the end of that task, I want you to combine some of the things you have worked through with the wearable tech. Ideas of how the sensation makes you want to move, the sound, the pressure and I want you to develop a short phrase. It doesn't have to be long, it could be a few seconds, but you have to know it well enough to be able to teach me the phrase. Think of it as a sentence of movement.

KR: Is that not working XXXXXXXX?

Participant A: It was working, then it went mental and now it's stopped working.

KR: Okay, are you ready XXXX? VXXXXXX I will give you a few more minutes.

Participant B: So now I have to translate this for you. Modality translation time. Starting fairly even and quite well planted on both feet. Shoulder roll through both arms and then juddery back and jump backwards. Turn 90 degrees and a couple of steps backwards, settle yourself and then big symmetrical arm movements again.

KR: Okay. Once again?

Participant B: Jump back.

KR: Do the arms move and that makes you want to jump?

Participant B: I think the way of doing it starts with the hand, it's like, think of an electric shock to the hand.

KR: So the other hand doesn't move, just the one hand.

Participant B: Jolt to the hand and shoulder comes back and then a jump with it. And then a couple of steps back and then back to being even on both sides, and the big arm movements again, rather than just the one hand going crazy.

KR: Okay, one more time.

Participant B: Roll the shoulders, a couple of steps back, even arm movements.

Participant A: Start like this. And then

KR: So is it the wrist that moves?

Participant A: Then opposite directions

KR: So is it like a pulse?

Participant A: So I was trying to imagine what the opposite movement would be.

KR: Okay. No, that's okay. So it has one pulse and then back?

Participant A: A couple of pulses and then a bit jerky. There and back. That's it.

Participant A: I think if you had asked me to do the phrase before, it would have probably been more direct (Participant A reaches to the right and then back to the left, there is a swinging motion). Kind of going through what we had already done. Whereas this (touches the WT), gave a bit of rhythm, a bit of focus away from the whole body.

Participant B: I think this definitely made me focus on one side of the body, so the contrast of focusing on one specific part of the body...

Participant A: So when you are talking about shifting perception, sense, I understand what you mean.

KR: Yep, so I suppose you are going to have a richer experience using your imagination, as you are able to summon lots of things into that particular task. But I guess what I'm trying to think about is whether digital touch gives you different types of options in terms of a stimulus and how you move with that.

Participant A: If the choreography, the phrase was the result, I would imagine that before the WT the phrase would come from the generic movement that we normally would do. Before it would be very different

KR: So in this particular example, it focused you more on the dynamic qualities of the movement do you think? Or, did it...

Participant A: I think it focused on the quality, ...the rhythm. Ummm I might not be describing this properly, but I think that combined experience of that targeted sensation was rhythmic.

KR: She was wearing the controller that has loads of different...whereas XXXX had just the one type of sensation.

Participant A: I think with the first time I was doing movement from what I had seen before whereas with the wearable, I was disassociating movement from what I remember and what I know dance movement to be. I think I was using my imagination and bit more and the second was a bit more original.

Observer C: I suppose a bit more authentic. What I noticed with the tech was it was less generalized in the body. So you were doing something more specific and there was more articulation, rather than using the whole body.

Participant B: I think it's interesting because I was talking about it being one-sided, but both, the first one I had was one-sided in different ways. The other was one-sided based on my imagination. And I think about having an actual physical sensation is that I thought a bit more about what the rest of my body was doing in relation to it. The difference between one arm going and both arms being free to do this [DA rotates both arms - almost roll the shoulders forward]. I don't think I was conscious of the opposite of what was happening until I had the wearable tech.

KR: To contrast almost?

Participant B: Well, almost to focus it down.

Participant A: Possibly as the focus of your imagination was to imagine a push or sensation, whereas with the wearable you don't have to imagine the touch and you can just think about your response.

Observer C: And is the idea that the first task is about imagined touch and the second is about reacting to these. Or are you doing a similar thing, but this is kind of an augmentation?

KR: Yeah....umm...I suppose...the reason I kind of had that baseline, it's interesting to see...you will always, whoever you are working with, have to summon those cognitive abilities as a dancer, but I just wondered how it would be different. Because I think touch is really important in dance. Certainly, not just with duets, but sensation is important in terms of figuring out how you might respond to the task, you know....that feels a bit weird. Even the stuff when you are looking at modality translation in terms of sensation, obviously this time we made a sensation, but okay here's an imagined object, how does it feel and how does that translate to movement. We were explaining to XXXXXXXX that if you had the idea of broken glass, you wouldn't literally (KR show movement tiptoes – as if to try and not step on the glass), as a dancer, how would translate that into your movement, such as sharp, jagged movement. You would come about it a slightly different way.

Observer C: I suppose my question is more about when you are setting the task, the second time are they doing the same task with the tech or are they doing the task reacting to the tech?

KR: It should be the same task in terms of test and control, but inevitably their responses are reacting to the tech. So it's a bit of both I guess.

Observer C: I would be interested in a tech task that wasn't around touch. Because that would be interesting. So you did a task on visual imagery and then did that task with the tech...what's the difference.

Participant A: Would it be a visual image...

Observer C: It would be an image, and you could give tasks from that.

Participant A: Would the image change, like an animation or a film.

Observer C: Just whether it makes you move in a different way. Distracting. I suppose this is very much around touch, but if you are looking at it as a disruptor in choreography. You know Wayne sometimes does this horrible thing, a task when you are moving and then he asks you maths questions.

KR: That would be my idea of hell... seriously I'm not a numbers person at all.

Participant A: I am a numbers person, but I couldn't move and do it.

Observer C: It's like a disruption, like when you are listening to an aural acoustic when you are doing a task. You do the same task all the time, with different things coming in and out.

KR: Yeah...trying to disrupt in different ways, not just the obvious.

Participant B: I think the music is something to consider, as sometimes I found myself moving more to the music than anything else.

KR: I know, I did think to myself, should I have music at all, when I was planning the workshop, but then sometimes, not just for you guys, when initially you go into a room and start improvising it can be quite hard not to have anything on at all because you are trying to get into the swing of things. It is another input and ideally, you wouldn't have anything at all, which I suppose for trained dancers wouldn't be an issue at all.

Participant B: It's back to this comparison when looking at modality stuff and interaction design and interfaces, and all the interaction design studies that I have been involved in want to see what's influencing the behaviour and you want to eliminate everything you can except the one modality you are focusing on. If modality translation is key, then you kind of want to do a controlled study on one influence, or two, then the interplay between one another. That interplay might be between visual and tactile, it's just making sure there are limited variables and possible controls to know exactly what you are looking at.

Participant A: You could test that out. By getting people to perform the task with the wearable and by not telling them when the variable is going to come on. You could see the effect on what is a known routine.

KR: Yes, you could have one that was programmed and one that was random.

Observer C: Yes, and also, what you are talking about is performance, because if it's an existing phrase then you are out of the creation phase and into performance.

Participant A: and your focus with this is on creation.

KR: And after going to the Movement and computing conference, there is still an emphasis on performance. Mark Coniglio was a keynote there and talked about digital interventions and he talked about that there should be more stuff going into the creation phase. I suppose because of where tech goes and is used in the final product that it's kind of obvious that it goes in the performance phase. But I think there are more uses for composition.

Observer C: That was stimulus choreography, but if I asked you then take that same type of movement and use this for movement somewhere else in the body. Or you might use that as a floor pattern. It can lead you off in different directions.

KR: You can have quite a simple start and it then ends up being quite a rich phrase from the ways you can develop it. I suppose for you guys, if I asked you to take it into another body part, because you are novices...you did really well, it takes ages to hone those skills, and to switch yourself off from what you possibly might be looking like, it's tricky.

Observer C: That is a factor isn't it. When you are making choreography, dancers think about what this might look like.

Participant B: This is quite an interesting question. To what a degree can you get move away from what something looks like, the aesthetic of the dance movement to how they are responding to the stimuli.

Observer C: And it does move you away from that, and that's the brilliant thing about it.

KR: Trying to remove those habits maybe. But then does it become too literal, that's the thing, it's hard to know. But even if you use it in the compositional process, even if that is literal, where can that go. You don't have the tech on when you are performing and no one will even know.

Participant A: There's quite a lot of tools in various areas, even engineering to try and encourage engineers to think outside the box. Because when you are an engineer and you are looking to develop a technical solution, you are limited by your own skills and knowledge and then there's tools that have been developed by various people, looking at different approaches which take you out of your head and connect you to a wider inspiration sphere and potential. I don't know if there are such tools in dance?

KR: Yeah in dance, there are those things. I guess most choreographers build a set, as years go by of how to go about things in different ways...

Participant A: This was the document...

KR: Yeah this initial idea has come from modality translation.

Participant B: So people have different working methods. How many would go outside asking them to visualise things and actually engage with the sensory?

KR: They probably do it without tech. There's a lady at Middlesex, I can't remember her name right now. She uses costume, it's not got tech, but to change your weight. You know there are things like the Bauhaus - restriction, to change the way you move.

Observer C: Then there's things like somatic practice, which is about body sensation.

Participant A: Which is contextual, which feeds into your thinking around your methodology.

KR: Yeah, it's all contextual to it.

Participant A: That's not what you are doing, you are exploring something that's different.

KR: Yeah, some people use body practices, that try and get you in the moment, like Focusing. To use those sensations or be more aware of the body. They use it as a way to think through the tech, as opposed to it being a stimulus.

Participant A: If that's novel space.

KR: I don't know if it's novel, there might be people out there doing this, I will just have to see really.

Participant B: I think it's worth looking at what type of sensory modality translations are used in the creative process. Because that maybe gives you an angle in relation to what you can do with tech.

KR: One thing I would like to know your opinion on basically; would it be worthwhile trying to have something more sophisticated on different body parts on the same dancer? So obviously it was on your arms and that definitely made the work more gestural, and that's going to be an influence. To have a couple more things on the body, but not working at the same time...

Participant A: If you could recreate and have bands, which you could have here, here and around your ankles. Then maybe ...is that what you mean?

KR: Yeah, as someone who was involved [in the mock/pilot] would it be useful to have more wearable tech around the body, or would that just make it more complicated? In a way that's not going to help.

Participant A: To prove of concept you need to design WT that proves that the second phrase is I suppose more innovative than the first phrase; there is a difference, there is a qualitative difference. How will you articulate that? And you need to think about the obvious question, of "how do you know that the dancer wouldn't come up with this anyway?". So for me, this was really useful, I can see how it completely changed the way I was thinking about how I was moving. What we don't know, is if a trained dancer would do that anyway?

Observer C: Yeah, that a trained dancer might be able to imagine that anyway.

KR: Yeah.

Participant A: But then, if it had that impact on me, who is a complete novice. Would it have a more sophisticated influence on somebody more trained?

KR: Maybe its use might be better in the learning dance.

Participant A: We did talk about sort of that thinking of teaching tools.

KR: I suppose we won't really know until we try it out with the interns, and we can say it has or it hasn't made much of an impact. But maybe this is part of the process and if it doesn't then you try it on more novices again. See it more as an ability to help people think through choreographic tasks differently maybe. Particularly people who haven't had that much dance experience.

Observer C: You can recreate that, if you were working in a pair, you can do a task where you react to that body sensation. A similar thing without a person.

KR: And I was talking to Maria in the Digital Anthropology Lab, okay, and almost playing devil's advocate, "why would I employ tech to do these things?", and she explained that its tech ability to control things. Like on a loop or whatever. That's the reason you would implement tech in certain situations. I was trying to figure out, question myself, surely I can recreate these sort of things without tech. She did say it's the way you can control those situations.

Participant A: And there's almost a potential extending if we are talking about classroom situations: how do we extend the experience beyond the classroom experience...like a remote experience.

Participant B: I was thinking at Brunel they have done a lot with telepresence and performance. If you were trying to figure a set of cues to people on remote locations.

KR: That was my long-term thing, initially I was talking about audiences' ability to be involved and I didn't know whether I would get a chance to involve them in any of the studies. Maybe that might be able to come back in at some point. Like, remember when you (indicates towards Observer C) were talking about the potential that touring might not be able to happen. How they might be able to be involved in that process in some way. Yeah.... as usual more questions than answers.

Participant A: That's research for you.

KR: So over the summer I need to see if anybody might lend me some equipment that's more sophisticated than that, or make something that's more sophisticated than that.

Participant A: I think if you are looking at something like bands, then practising, you might need a more intense haptic motor.

KR: I suppose I can try the heat pads out.

Observer C: That's also really interesting in comparing what physical choreographic reaction that has. You know heat has a particular effect on the body and movement quality.

Participant A: Do you think it will be less literal than touch?

Observer C: It's how you frame it, isn't it. Because around whatever you give a set of instructions. Because if I was to say to you "every time you get a buzz, you have to put your leg there, or a turn or a jump"...that's something completely different to what you are feeling. That's the other. It doesn't always have to be an instinctive reaction; it could be a trigger for something completely different.

KR: Do you think there was enough 'think' time within that?

Observer C: What, in what you just did?

KR: Yeah, I didn't want them to kind of feel floundering, because sometimes I rush through things, to help people.

Participant A: For me, the timing was okay.

KR: It's tricky with composition tasks because you want to give people the space to think things through, but then you don't want them to think I'm done now.

Participant A: I don't know about you XXXX, but I don't know how to do composition and my entire experience of dance has been copying and doing what I'm told. So I spend most of the time looking over to you and copying.

KR: I didn't want to feed you too much.

Observer C: I thought you could give them clearer instructions. Now I want you to take that movement and think about level. You were guiding them a lot of the way through. So you could go... "now think about level, now think about speed". So you are just giving them the questions. Rather than saying "could it be faster, could it be slower"?

KR: Okay.

Participant A: As that will give you parameters to look at the data to analyse it very clearly and your influence will be taken out of the picture.

KR: I will have to be much more sort of X, W, Z.

Observer C: You can set it out really clearly, I want a phrase of 5 movements that is coming from the stimulus, but I also want to think about the scale of it, the perspective.

Participant A: So you can compare both the sets of the video very clearly because you have framed it.

KR: Do you think the interns would be okay with that?

Observer C: Yeah, that's fine.

KR: The only reason I ask, is most of the stuff I have seen has been not as prescribed, I know obviously there is room within that for freedom because they are coming up with their own work. So, the stuff I have seen has been "Now they put on the Myo armbands and are going to improvise first and then there's a section where they do a particular phrase with it". And it's not so broken down as that. I can see the pros and cons of doing it both ways.

Observer C: For me, if somebody says improvise, I would still want some framing. Am I just reacting in my own special way...

Participant A: Because you want to be able to assess the differences between the wearable and non-wearable phrase.

Observer C: It's what you said before.

KR: Yes, okey-dokey.

Participant A: How do you feel?

KR: It's really useful having all three of you here because it also helps to have somebody watching and being able to give that feedback. I kind of feel, it's a difficult thing, and perhaps it's a dancer thing, I want to be able to run before I can walk. I want something amazing before I know how to do it.

Participant A: "I want to chasse"...

KR: Yeah I want to be able to "Chasse before I can walk". Yeah, I look at it and go"yeah, they are alright", but I want something reliable, that can do loads of amazing things. Whether that will happen I don't know, but it's been useful to watch people working through it. And it has made me realize that I've got to be a bit tighter in terms of how I say things and my delivery.

Observer C: It's also about how you apply, what you talking around tech I suppose: all those different sensations, and how much are we actually reacting to those different sensations and how much are we just going "oh there is a different sensation".

KR: Like an impulse?

Participant B: That's why I thought the way this was going was really interesting because it's more a way of changing your timing and your perception of time, there was a while when it was exactly the same time as the heart rate almost, then faster or slower. The rhythms were changing. It's different from the short jolt of that other one.

KR: Yeah, that one was every minute. Was it every minute?

Participant B: It felt like longer. That one was constant but shifting enough that it throws you off every now and then.

KR: Was it on a loop. Because I haven't worn it myself, did it start again?

Participant B: When it was on the desk, and I was holding it, it did seem to be on a loop.

KR: Thank you, that was very useful. I hope my microphone picked up all of that.

Appendix F - Workshop plan – Digital Intervention Project (Project 1)

Context:

This PhD research is concerned with digital interventions and how we use our sense and kinaesthetic awareness in the creative process. Through the workshop environment, we intend to test physical stimuli (vibrotactile digital touch) and compare this with the imagined process, specifically related to touch. This work will contribute to new knowledge by presenting qualitative data surrounding digital tools for choreographic processes and methods, but also add to the field by revealing the relationship of the somatosensory feedback with digital stimuli in the creative process of choreography.

Aims:

- 1) The workshop will facilitate participants to create choreographic responses to three tasks, in two conditions: wearing vibrotactile technology and without.
- 2) To question participants on the role of vibrotactile technology/ cognitive process of modality translation in their choice of movement and process of refining and structuring a movement phrase.
- 3) The experiment/workshop will enable a comparison of the participant's phrases from each condition and across participants to identify any trends through movement analysis, and the perceptions and experience of the participants and facilitator (interviews and field notes)
- 4) To gain qualitative data which would enable further discussion on how we use our somatosensory feedback and kinaesthetic awareness in the choreographic process.

Outcomes:

- 1) To record participant's movement responses and perceptions in both conditions via video footage, the embodiment of movement by the facilitator in the teaching of the phrase, and verbally through semi-structured interviews.

3)To identify any visual differences or trends in the use of digital touch and the imagined process of touch in the creative process of choreography.

4)To identify any differences in the perceptions of the participants in both conditions, and to establish commonalities or trends in how each was experienced and influenced the choreographic process.

Timings 3 hours WHEN	Digital Intervention Project – Studio Wayne McGregor Tasks WHAT and HOW	Aims/Outcomes WHY	Resources/Tech
10 mins	Intro Go through the information sheet and get the signature for the consent form. Give participant quick info on fire drill etc	Overview to ensure participant understands context Consent	Facilitator (Katie Rees) Tech support 2 x Camera on tripod filming (this will be two cameras if possible)– remember to press record after consent is granted! Consent forms with information
10 mins	Ask participants to warm-up	Health and safety	Space cleared
	Choreographic Tasks		
	Haptic task: Buzzes, pressure, clicks, hums from WT Each participant will be a series of tasks, firstly without the WT and then with the WT (this order will be swapped over for ½ the participants). The participant will be given 10 mins to structure a short		

	phrase (16 counts) and 10 mins to teach the researcher.		
20mins	Facilitator Instructions: Explanation: you will be given a series of choreographic tasks to complete. At the end of these exploratory/improvisation tasks, you will be asked to structure a phrase of 16 counts. Using movement ideas that you explored in the previous tasks. You will then teach this phrase to the workshop facilitator. This process will be repeated in a different condition. WITHOUT TECH 1. Close your eyes and I want you to imagine a touch and the physical sensation of this. Where is it happening on the body, the quality of this touch and the frequency? How does this make you want to move? Consider: shape, level, space, time. Think about the dynamic qualities. 2. Imagine the source of touch, the materiality of it? What does it look like and how would you move in relation to this? Consider: shape, level, space, time.	To establish a baseline- how the participant moves in relation to the cognitive concept of touch. No physical stimuli.	

10 min	Think about the dynamic qualities. 3. Shift your perspective and attention away from the sensation of touch, how does this impact your movement? Consider: shape, level, space, time. Think about the dynamic qualities. Structure a 16-count phrase based on your improvisations from the previous tasks.		
10min	Teach the Researcher the phrase – re-enactment		
20min	WITH TECH 1. Close your eyes and I want you to concentrate on the touch and the physical sensation of this. Where is it happening on the body, the type of touch and the frequency? How does this make you want to move? Consider: shape, level, space, time. Think about the dynamic qualities. 2. Concentrate on the source of touch, the materiality of it? What does it look like and how would you move in relation to this? Consider: shape, level, space, time. Think about the dynamic qualities.	Physical comparison to the first response without WT. How does the movement differ in quality, space, speed, shape, levels etc.	Wearable tech in the form of haptic motor controller Set tech up on participant and a quick check to see it's all working properly.

	3. Shift your perspective and attention away from the sensation of touch, how does this impact your movement? Consider: shape, level, space, time. Think about the dynamic qualities.		
10min	Structure/develop the initial improvised movement		
10 min	Teach the Researcher the phrase – re-enactment	To establish what the participants deem as important, what they emphasise and how this is different within the two conditions (without tech, with tech and subsequently developed phrase). To also enable the researcher to embody material and physicalize the movement to have a better understanding of sensation/kinaesthetic experience (which you can't record from film/video footage)	Microphone- audio recording Video footage
10 mins	Comfort break Pack up WT and any equipment not needed for the interviews		
50 mins	Interview participants Semi-structured questions regarding the choreographic workshop Field notes – Researcher	Qualitative data recorded – dancers experience To provide reflective feedback from the researcher to	Recording devices (iPad or Dictaphone/pen or Moleskin pen) Static camera set up to record physical explanations of body.

Appendix G - Project 1: Data Summary Matrix – Group

(Edited sections Improvisation with tech and 16 count movement phrases without tech)

	IMPROVISATION WITH TECH Summary/significant points	Analytic memo notes	Notes from individual participant matrix
P1	First Prompt: Jagged movement. Isolations- gestures of the arms and then coming into the torso. Bound and then moments of free. Started as a small kinesphere reach but progressed to large. Second Prompt: Changes of directions, almost in a cube/box formation. Greater use of knee and elbow to initiate movement. Wrapping and folding into the body. The kinesphere reach is medium to large. Moving between medium, low, and high. Third prompt: Spirals and turns. Using the whole of the space. Floors, walls, high- low. Indirect, open quality. Extensions of the limbs. Pauses.		
P2	First Prompt: Shifting weight (stepping, turning, sitting), there is a rhythm of move and stillness. Smooth quality, but this still is quite bound and controlled. The focus of space is indirect. Medium to small kinesphere reach. Distal initiated, they lead and then fold the body back in on itself or shift to another point in space.		The movement in the improv doesn't necessarily reflect the movement in the phrases and therefore how much does this feed into this stage of the choreographic practice?

	Second Prompt: Twisting the body and shifting weight pattern, move- then settle – as above. Spirals and folding in on the body. There are a few more moments of mid-limb initiation. Third prompt: Shifting- stepping sequence. The dynamic quality has changed slightly it's a bit more sudden and more abrupt. More upright in the torso. Use of low and medium levels – although the most used is medium. Small to medium reach kinesphere.		
P3	First Prompt: Distal limb initiation (predominantly the right arm). The movement almost shifted around the arm in space in relation to it. The movements produced were fragmented, juddery and moments of pause. Bound, sudden. As the improv progressed there was more sequential initiation- the judder through the body, but then smoothness. Small to medium kinesphere reach. Second Prompt: Still fragmented movement, but a bit more bounce to it. The movements are sometimes core initiation and sometimes distal (R arm). The arm is held out in space and the body moves in relation to it (like it's an axis). Medium to low level. Same changes in dynamics judder – then smooth.		The improvisation sections with and without the tech seem to have more variation of different points of initiation of movement. The participant mentioned how the tech condition prompt 3 – caused confused movement. The movement recorded is quicker and does indicate quite a lot going on.

	Third prompt: Quicker, little springs. Core initiation (hips, shoulders), and sequential ripples through the torso into the extremities. Greater extension – small to large kinesphere reach. Some swing and rebound.		
P4	First Prompt: Distal initiated- but both wrists leading the movement, the dialogue between the two wrist bands. Melting inwards towards the core/torso and then the extension with the arms. There is a sense of the body being caught in the middle in relation to these two points. Rocking, swinging, pulsing, turning. As the improv progresses the movement becomes more angular, but still how the body relates to the wrists in space and in how they lead the movement. There are moments of moving then, contemplation. Use of middle and low level. The flow goes between bound and free. The dynamic quality becomes a bit quicker and erratic as the improv progresses, more jumps (little) Second Prompt: More core initiated coming into the movement, on demi-pointe, bent knees, contracted inwards. The arms still are present-wide open and then leading the body into turns and points of balance and then off balance.		The movement with the tech was more specific and focused on the body in relation to the arms. With the tech, it tended to be a lot slower, apart from the latter part of the improv. The movement with the tech influenced what the other body parts were doing in relation – always a reference point.

	Overall small to medium kinesphere reach – occasionally larger. Third prompt: Slower more sustained movement. The movement is still bound but has a lighter quality than before. There is an element that becomes more angular and sharp at the end of the floor.		
P5	First Prompt: Bending back in, stepping out. Coming back to the centre, but the arms lead the movement. There are pauses, then more accented movement. Spiral in the body and a bit more swing in the movement. The dynamics are free, indirect, light- sometimes with a little weight in the swing. The movement is mainly on a middle level, with some low. Medium kinaesthetic reach. Second Prompt: More wrapping movements, arms behind the body and around one another. The speed slows down a little and there is more weight in the movement. Then it speeds up becomes a bit jerkier, with a rebound, a flick and a bounce of legs and arms. Reach moves between small and large kinesphere. Third prompt: More use of core initiation (shoulders, hips), a little of the feet (distal). The movement is back to a constant flow of free		With the tech, there was a bit more rebound and a change in weight. The participant does mention in the interview that the tech made her want to stay up, with very little performed on a low level. The description of the movement in the improv without the tech- i.e., “slow” and “big” movement is verified by the movement analysis in the first prompt, particularly as I mention the line of movement projecting into the space beyond the dancer’s actual line. Initially, there is more core-initiated movement in prompt 3 of the improv with the tech, which does correlate with what the participant mentioned about trying to not use arms, but the distal initiation does eventually return (see habitual movement preferences column)

	energy, spirals and shifting and turning in the space. Shifting weight using the weight of the head. The arms do come back in and they lead the movement later on.		
P6	P6 First Prompt: The movement is led by the wrists, distal initiation. The arms pulse and fold and body over and then lead the movement to extend. The legs are shifting in response to the upper body and it's mainly just stepping and standing actions (lunges, crouching). Dynamics go between a weighted, bound element and then free, a bit like a rebound, but more complex because it seems to be a dialogue between the arms. Although it's mainly right arm dominant. The movement is mainly on medium level and the reach ranges from small to large kinesphere. Second Prompt: The movement is still similar to above, although more curves of the back and curved lines in the arms. The movements all happen predominantly on a medium level only using the central space of the room. Third prompt: Movement is still initiated by the wrists, but the dynamics are a bit slower and free, but still with a sense of weight. The movement		With the tech, there was more rebound, and it was a quicker change from free to bound. The participant discusses the “accompanying” element and the LMA mentioned dialogue between the right arm and left arm, and this is also identified in the improvisation with the tech. The right arm dominance is also recorded in both interview and movement analysis.

	uses the space of the room a bit more to the perimeter. Focus is more outward than before.		
P7	First Prompt: Slowly moving into the floor and adjusting the weight into different places of weight-bearing. The arms extend in moments that give sudden bursts to break the slowness of the other movement. Large reach of kinesphere. Spinning and spiralling to the floor. The initiation of the movement comes from the distal, mid limb and core. The movement works through all levels, the most dominant is the floor work. Its quality is smooth and free flow. The speed picks up and the movement covers more space in the room- more expansive. Second Prompt: The quality becomes a bit more bound and more emphasis on the weight of the movements in the rebound, but action-wise quite similar. The arms (distal) are initiating more movement. Third prompt: The speed increases, movements are more abrupt and sudden. Focus is often up and out. Still wrapping and opening of the body. Arms extend and then feed through.		The participant's interview discussion describes the movement as "wrapping" the body and the movement being under the body- with very little travelling in the space. This element is also present in the improv section- with wrapping also being quoted. The improv section with the tech is dominated by arms and distal initiation.

P8	First Prompt: There is an element of moving and then resting. The movement is predominantly on a low level/middle level. the arms (distal) initiate the movement and cross in front of one another or rotate around the body, wrapping around. Slow and sustained, the movement is medium weight (neither strong nor light), there are elements of bound. Second Prompt: The movement is small to medium kinesphere reach. The arms continue to dictate where the movement is initiated from (sometimes the wrists – distal, and sometimes the elbows- mid-limb. The lower body supports the gestures and the torso, steps and turning, crossing over and extended balance. The arms frame the body, rotating and spiralling. Third prompt: Quicker pace, the movement is mainly on the floor. Spiralling, leg swing away and ronde de jambe back, changing weight from feet into the arms and shifting across the floor. The quality becomes free and more indirect, but more angular. Distal and mid-limb as above. The movement moves to a medium level and uses off-balance, so there is a difference in the use of weight: falling and catching.		As suggested by participant 8, there is little use of travelling in the space, more in the condition with the tech on. His rationale for this is based on trying to concentrate on listening and understanding the tech. He also highlighted that distal initiation was predominantly used in both conditions, which also supports the movement analysis. In both conditions in the third prompt (to ignore or divert attention away from the touch) the pace began to quicken, there was more free flow and indirect movement

P9	First Prompt: Scooping the space with arms and framing the body. Slow and sustained quality. Fluid and free the body dips and twists from the distal initiated movement. Middle-level movement using a medium to large kinesphere reach. The movements do not shift much in the space and tend to stay in the stage centre for the most part. Second Prompt: Right-arm dominates the leading of the movement. It rotates and extends. The gestures become quicker and wrigglier. This then radiates up the body, into the torso. The movement is bound and sudden in this section. Third prompt: The movement changes to mid-limb initiation (knees and elbows). The movement started to travel in space, with more of a sharper quality. Twisting and spiralling, dropping down and pushing up, turns. The movement goes onto the floor and back up to the middle level. The movement is large to medium kinesphere reach. There is still a rippling through the body and translating the jerkiness into other body parts.		She mentions the tension in the arms with the tech, and qualitatively the movement is more bound with the tech, therefore confirming the perception of the movement. In the improvisation section with the tech, the participant talks about exploring the dynamics and aspects of pressure and then vibration and how that impacts different body parts. This can be seen in the movement analysis of the first and second prompt: the change from “framing the body – pressure” to the “gestures become more quick and wriggly”. This then radiates up the body, into the torso.
Similarities and differences	The movement analysis from the first prompt within the improvisation (in the condition with		

	the technology), asked the participants to move in response to the digital touch. There were occurrences of the arms leading the movement (distal initiated), but the extensions always came back towards the body/torso, which produces wrapping, scooping, folding and movements that frame the body. Highlighting the body in reference to the arms. There were also several references to the pace of the movement, where participants move and then pause. Indicating the rhythm of the loop and vibrations and trying to 'listen' the pattern of effects. The participants use a range of kinesphere reach and levels. In the second prompt ("Materiality of the touch") there is still evidence of wrapping, rotating, and extending the arms and bringing the movement back towards the body. However, there is more use of the movement being initiated from different places: core and mid-limb initiation than in the first prompt. There are also some similarities in dynamics, with movement being juddery and wriggly, with the use of rebound. In the third prompt ("Try and ignore the digital touch"), the movement is generally more complex, in quality and the actions performed. Some participants speed up the movement, some	Is this because the participants are in the second part of the improvisation, therefore more relaxed or pushing themselves to try different body parts and not just lead from the arms? "Abrupt" – trying to change quickly to stop falling into reacting to the loop?	
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	stay slow. On the whole, the movement has a greater focus outward, and some participants physically cover more of the dance space. Greater use of spiralling, shifting weight, turning. There is more use of the word "abrupt" to describe the quality and pace.		
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	16 count phrase WITHOUT TECH
P1	Series of accents in the movement phrase. The phrase uses all the different kinesphere reach. Middle and low levels are used, with curved pathways and then a small straight pathway. The quality of movement begins quite free, indirect, and light and this changes with the floor work, where it becomes bound and direct.
P2	Flexed feet and the use of flexion and extension in this phrase. The movement reach uses all of the kinesphere, from small to large. There is a quality of slow and sustained and direct and bound. Mid limb and distal initiated
P3	Use of all the kinesphere reach. Its predominantly distal initiation. The right hand has a connection to the movement throughout to the knee to face. The movement goes between low and medium levels. The pace is quite slow and bound. Travels in a curved pathway from centre stage to upstage centre.
P4	Series of accents in the movement phrase as a whole. The pace is quite quick, and the dynamics are generally free, indirect, except in the instances of rebound (where more weight is used). The movement travels from stage left to stage right and then back to the centre. All levels are used as there is floor work and a jumping turn. Low to high levels
P5	The whole phrase has a series of mini accents. The whole range of the kinesphere reach is used. Distal initiation, either hands or feet with lead the movement. The movement goes between middle and low levels. The flow is continuous, each action flows into the next, with the energy never stopping but continuing into the next. The actions are lunging, scooping, turning, spiralling, kicking- various ways of extending and shaping space. The pathway is like a v shape, travelling downstage and then upstage
P6	In general, an even movement phrase. Use of all the kinesphere reach. Distal and core-initiated movement, with the majority being distal. Movement on a middle level. The quality is sustained and slow throughout, with it being quite bound. The actions are extensions, spirals, plies and turns. The phrase remains mainly within the upstage right side of the stage and moves around on itself.

P7	In general, and even movement phrase- it maintained the same effort throughout. Free, sustained, medium weight. Using the whole of the kinesphere reach. A mixture of core and distal initiation. There is a sequential initiation running throughout the phrase and the movement natural resonates through the body like water. The phrase uses medium and low levels, it moves across from stage right to centre stage, quite a contained area. The main actions are shoulder rolls, brushing the body, spiralling the back, rippling down through the back and shunting along the floor.
P8	In general, an accented phrase. Small and medium kinesphere reach. Distal initiated. The dynamic quality is quite direct, and it changes between being bound and free. The arm gestures are quite angular and then this gives way to more sweeping gestures in arms and legs, which retract back, and energy continues into transition slide into the floor. The phrase uses medium and low levels and travels a little downstage.
P9	Accented/rebound movement phrase in general. Uses the range of kinesphere reach. Starts with medium tension, quick, strong, indirect, and then later this oscillates between free and bound, as the movement becomes more involved in the rebound. Main actions include spirals and lunges, turns to floor, scoop, and extension, but most of this is initiated by core, with a few distally. The phrase uses medium and low levels. The phrase travels downstage and then upstage in a little V shape.
	5/9 phrases were accented in general structure and effort. The other 4 were slow and even in their dynamic quality. The phrases used the whole of the movement range with kinesphere reach. However, they all used mainly low and medium levels, with only one phrase using a high level. The initiation tends to be a mixture of core and distal initiation. There doesn't seem to be that much in the way of similarities in the actions produced.

Appendix H - Project 1 Edited Video Footage: Influence of Prototypes on Rhythm and Quality of Movement (Improvisation)

See attached file.

Appendix I - Project 1 Edited Video Footage: Movement Initiation and examples of Movement Framing the Body (Improvisation)

See attached file.

Appendix J - Example of workshop plan Digital Touch Project 2019

Workshop Plan: Digital Touch Project 2019

Context: The first practical element of working with somatosensory prototypes was tested in the Digital Intervention Project in December 2017. This series of individual workshops focused on the use of two vibrotactile bracelets on two different loops of vibration. The findings from the semi-structured interviews included the perceived lack of use of the space (beyond the direct reach); the "focus" which was achieved through a digital repetitive sensation; and how sensation was sometimes perceived to bypass thinking, and more awareness of the internal body in the creative process. Anticipation, rhythm, tension was also listed as a result of working with the technology in the improvisation tasks. This next stage of research has aimed to create different types of digital touch to elucidate whether the above results were unique to vibration.

Through evaluating the first project, the researcher realised that a longer timeframe would be beneficial in working with the prototypes, enabling a thorough understanding of the tech and its potential. Working with more experienced dancers and choreographers would also enable deeper discussions in the semi-structured interviews, with participants being more versed in different choreographic processes and discussing these. In response to the above developments, the next project workshops venture beyond the facilitated prompts and tasks to use the prototypes in the individual methods and processes of different choreographers/artists and to see the different ways the prototypes could be used and experienced.

Research Title:

The use of somatosensory wearable technology in the dance making process: understanding how digital touch influences kinaesthetic awareness and its impact on movement choice and structure

Timings WHEN July 7/8th	Project 2 Venue: Studio WG Tasks WHAT and HOW	Aims/Outcomes WHY	Resources/Tech
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Day 1 15 mins	Set up on recording equipment and materials		
15 min	Intro Go through the information sheet and get the signature for the consent form. Give choreographer/participant quick info on emergency procedures and fire escapes etc.	Overview and participant info Consent	Facilitator (Katie Rees) 1 x Camera on tripod filming (this will be two cameras in possible – possibly one being the iPad) Go-Pro to be used from different angles Consent forms with information
15 min	Warm-up: individuals own warm-up	Health and safety	Space cleared
	Choreographic Tasks		
	In previous conversations with the choreographer – 2 tasks will be developed based on their working patterns/style. In this particular example of the workshop plan, I have given the example of Participant 13. His choreography is developed through looking at sensory deformation of sight and different glasses which produce this.		

20 mins	Explorative session: Movement Generation Existing approach- with sight impairment glasses	To further understand existing practice.	Vision glasses
15 mins	The researcher joins him to experience how this works. This is repeated in each section.	To establish what the participant deems as important, what the choreographer emphasises and how this is different with the different resources/tech. To also enable the researcher to embody material and physicalise the movement to have a better understanding of sensation/kinaesthetic experience.	Vibrating bracelets Soft robotic prototypes Nitinol prototype
20 mins	Trying the touch-related tech (Vibration SWT)		
15 mins	The researcher joins Participant 13 to experience each SWT in the space.		
20 mins	Trying with both glasses and (Vibration-SWT) simultaneously.		
15 mins	The researcher joins Participant 13 to experience how this collectively feels.		
Break (1pm)	Lunch		
20 mins	Discussion- based on the explorative session in the AM Question/Prompt sheet 1	Qualitative data recorded – Choreographer's experience	Microphone- audio recording Video Prompts/questions
	Explorative session: Movement Generation		Video

20 mins	Repeat process with Nitinol and Soft robotic prototypes		iPad audio recording
15 mins	Trying the touch-related tech (Nitinol -SWT)		Soft robotic prototypes Nitinol prototype
20 mins	The researcher joins Participant 13 to experience each SWT in the space.		
20 mins	Trying with both glasses and (Nitinol -SWT) simultaneously.		
15 mins	Researcher joins Participant 13 to experience how this collectively feels.		
20 mins	Repeat with Soft Robotic prototype	To understand the process and further record the choreographer's decisions.	Video iPad audio recording
15 mins	Trying the touch-related tech (Pump -SWT)		
20 mins	The researcher joins Participant 13 to experience each SWT in the space.		
20 mins	Trying with both glasses and (Pump -SWT) simultaneously.		
15 mins	The researcher joins Participant 13 to experience how this collectively feels.		

20 mins	Discussion- based on the explorative session in the AM Question/Prompt sheet 1		
30 mins	The researcher packs up equipment Field notes – Researcher	Reflexive approach/ researcher	Laptop and portable hard drive Back up film and audio files Recharge batteries for SWT
Day 2			
15 mins	Set up on recording equipment and materials		
20 mins	Researcher and Choreographer reflection on the previous day. Discuss any points which arose after leaving the studio. Identification by the choreographer of which 2 areas he would like to develop based on exploration from yesterday. Starting with using an existing phrase of movement and seeing how the prototypes might be used to develop or edit existing work.	Reflexive approach/ researcher Choice of the choreographer as to the next logical step in the creation/ development of work. Ask questions to ascertain why parts are deemed important and why/how?	Video iPad audio recording
15 min	Warm up	Health and Safety	

15 mins	Using existing material – teach researcher elements, so there is some physical understanding of movement.		Video Ipad audio recording
45 mins	Try the 3 different prototypes in dancing existing material and seeing if it redevelops and in what way. Pump, Vibration and Nitinol (15 mins each)		
15 mins	Ask Participant 13 to select an aspect that stood out and teach that element to the researcher.		
20 min	Discussion- based on the editing and development of the existing phrase Question/Prompt sheet 2		
1 hr	Go back through video footage/or via memory and ask Participant 13 to develop 1 section based on the improvisations yesterday. (n/b without tech on)		
(1.30pm)	Break - Lunch		
1 hr	Repeat the development of 1 more section, but with tech on (the choreographer's choice of which tech)		

30 mins	Sharing of Work Participant 13 shares the development with the researcher. Firstly, showing the dance and then verbally expressing what he was thinking and the decisions he made and why. If more time was available what he would do next with the material.		Video iPad audio recording
30 mins	Discussion based on today's work and then a reflection of the whole 2 days	To record his perception of the structuring phase and then overall discussion of two days' work with tech.	Video iPad audio recording
30 mins	Pack up equipment Fieldnotes		Laptop and portable hard drive Back up film and audio files Recharge batteries for SMT

Appendix K - Project 2 Pilot Transcript

Tuesday 4th June 2019
Activities Studio, Holborn, LCF
1pm-2pm

Researcher: KR
Participant D and Participant E

Participant D: The vibration from the device takes away from the...I've tried doing this (she puts her fingers in her ears), but I can feel the vibration on the chest.

KR: It's a bit distracting isn't it.

Participant D: So, I'm wondering if you need some whether you need some sort of...

KR: So what were you saying XXXXXXXX?

Participant D: You might need a dampening material underneath, like a foam, to absorb.

KR: the vibration, yeah, ok.

Participant D: The noise isn't so much as the feel of the vibration. Because this (indicating the pressure from the silicone) is very subtle. It's like somebody doing this to your neck (Participant D reaches out and touches Participant E's neck)

KR: Yeah, when I put it on, I was like, yeah...that's distracting. I suppose, it's the pumps making that noise, and there's no way around it. Unless you do it without pumps.

Participant D: But you can get foams that you can attach to the bottom and the back of it. So that it will absorb the vibration. Like a neoprene, or something like that.

KR: Neoprene.

Participant D: yeah, when I move this off (the pack with electronics) off- then I feel this way more (the silicone inflating and deflating).

KR: Because you are only having to concentrate on one thing. Okay I will look into something that might dampen that.

KR: I mean, it does stick out. So that's going to restrict your movement in a way. That's as small as I could get it.

Participant D: Or put something on here to move it further away? So, it's not touching me.

KR: Okay. Alright. I'm going to teach you. First let us just warm up.

KR: Let us warm up our shoulders, swing our arms, look one side and the other side. Gently warming up our necks, to the right and left and then through our feet. Move side to side, warming up our knees and our ankles. Spiralling around, then we are going to roll down through the spine, keeping our legs bent and then rolling up through the spine, with our head coming last. Back down and then coming up. That's just a quick warm-up for you guys.

So, we are going to do a really short phrase. Let's face that way. Shoulder roll, shoulder roll. One, two- then reach forward, we are lunging. With our right arm forward and then we are going to step back and turn and then back again. It's just a simple phrase.

KR: You alright XXXX?

Participant E: It's more trying to remember a simple phrase.

KR: It's okay, I will do it with you. So, we go one, two, lunge – same arm and leg, rise and turn this way, and then turn that way. So, we go right, left, right – up, turn to the right – so it's always right first, and then back. So that's the phrase. Shall we do it one more time?
Right, left, lunge, up, turn, then turn.

KR: We have a phrase, so this kind of almost testing out how this might adapt your phrase. Technically I should have put that on after you have learnt the phrase. Is it getting uncomfortable (asking this question to Participant D)?

Participant D: No.

KR: So, you guys have a couple of minutes to try the phrase with your thing. Seeing how it might adapt the movement or not. So imagine you are doing the phrase for the first time with that (talking to Participant D). I'm going to turn this on (talking to Participant E).

Participant E: So how long does this take?

KR: To cool down?

Participant E: No, to have an effect?

KR: It's pretty instant.

Participant E: So it stays in that shape until you turn it off?

KR: Yeah.

Participant E: Oh, okay.

KR: Is it too warm?

Participant E: It's okay, but I'm just trying to figure out what the sensation is.

N/B- KR repeats the phrase for the participants.

Participant E: I'm just trying to think what I might do. I want to make everything more clenched in.

KR: How you guys doing? One more minute?

Participant D: Yeah.

KR: Okay, so, XXXXXXXX do you want to show us yours? Then we can...

Participant D: It's not that different.

KR: That's okay.

Participant D: I synced it, the timing of it.

KR: So, you have changed it around with the rhythm?

KR: XXXX?

Participant E: I can't remember, I did this and more that.

KR: More concave?

Participant E: More trying to get the feeling of scrunching. Close things off rather than let them out.

KR: Sure, do you quickly want to have a little swap over?

Participant D: Do we have enough time for the

KR: Let's have a look at that (looking at the nitinol), we might be alright actually.

N/B KR helps Participant D and Participant D switch off and get out of the SWT.

KR: So fairly distracting then?

Participant D: It was more the curation of it. So yeah.

Participant E: It's weird how that sensation stays with you.

KR: Was it quite a pinch? How uncomfortable was it?

Participant E: It wasn't too uncomfortable. The combination of the heat and having it stuck to my skin, was quite strange. It wasn't horrendously unpleasant.

KR: Right, let's see XXXX, this might not even fit on you.

Participant E: It might work.

KR: You might be alright actually. Yeah, the tubes need to be longer. You can tell I was testing this out on my short body.

KR: You have a red mark there.

Participant E: Yeah, what did you do to me?

KR: If you want to tighten it up first.

Participant E: It will be enough to feel it without strangling myself.

KR: Yes, that goes there, that goes there. (Helping Participant D into the nitinol prototype)

Participant D: Cool...Welcome...I feel like someone who cleans windows.

KR: [laughs] Shall I start it, so you can feel it. It might not have as much grip on that (on the t-shirt).

KR: Alright. Can you go back to the original phrase when you feel comfortable.

Participant D: I feel something, yeah.

KR: I think it does work better on the skin.

Participant D: Is that contraction. Or is that just one clinch?

KR: That's just one clinch.

Participant E: I can't make it tighter without choking myself.

KR: So, I need a few more things to ensure it fits better.

KR: The original was this: should roll, reach, up, turn and turn. Have a little play around with the movement.

KR: You ready XXXXXXXX?

KR: can you feel that. I do, but just a tiny bit.

Participant E: This one is interesting, but it doesn't seem to have much of an impact. Because I did that one first, and that- it's such a strong sensation.

Participant D: if you just remove... then you really feel it on the neck.

Participant E: What have I done?

KR: That's okay, it's probably just the battery connection.

Participant D: See what I mean

Participant E: I know what you mean, but I don't think it inspires so much movement. There's a bit where it inflates and then goes flabby, and it makes me want to go err, make a movement like (he shudders and moves backwards)

KR: [laughs], like it's sucking the life out of you?

Participant E: Not so much, I just want to do something that looks like a balloon being deflated.

KR: Oh yeah, I saw that thing at CSM, do you see that student's work?

Participant E: That black Latex?

KR: It's amazing, I want to wear one.

Participant E: It's insane, I don't know how to describe it, it's like they have turned the sleeves of something inside out.

KR: I didn't even see it in a UAL thing, some dancer has forwarded it on social media.

Participant E: Yeah, I saw it on some UAL advertising, not from the actual show.

Participant D: So, for me, it makes me want to do ...

KR: expand?

Participant D: Do the opposite. But also, it is about this (she moves her arms outwards to the side and expands chest).

KR: Ok yeah.

Participant E: I'm still pondering.

KR: That's okay.

Participant E: With the neck, I still have the clinch movements in my head?
That's running down (referring to the sound and the battery)

KR: That's quite juicy then?

Participant D: With the motors – yeah.

Participant E: The shuddery, deflating thing wants to come in there. Back to here. It doesn't seem like it does much to the reach.

KR: it's a bit more internal?

Participant E: It's more when you come to a stop. It collapses a bit...or ... bows your back slightly.

KR: Melted?

Participant E: That deflating, rubbery, slippiness.

Participant D: I think XXXX has tapped into his dancer potential.

KR: Cool, thanks.

Participant E: yeah, you will find with the pumps that the batteries will run out pretty quickly.

KR: Before XXXXXXXX has to go. Are you alright with that (helps take the nitinol prototype off Participant D)? Yep, that's the strap-Velcro and strapping.

So, the type of questions for that lot. The sort of questions I was thinking of for project two: "Can you talk to me about the relationship between the prototype and your body in motion? What impressions do you have during the workshop?". So, the questions are more general, as each of them [participants – Project 2] will be quite different.

"What was your initial reaction and did this remain as you continued to work with the technology?" Because obviously, the first project was 20 mins improvisation and 10 mins to structure something together, that's all they had. It was ½ hr with the tech. So, the question, looking at literature they start switching off to the sensations as they continue to use them. I was trying to think, down the way, whether it would have an effect or not?

“What did you notice about structuring and editing material with the technology?”

“What did you notice about your awareness of your body moving in space with the assistance of the prototype?” That’s a bit like the first one [question].

“I would like to talk some more about the internal and external relationship of the body whilst creating movement. How does this relationship influence your choice of movement? Are there any similarities or differences using the technology or without?”

“What do you perceive the differences are between the prototypes and how do you think they were similar or different in the choreographic process?”

More general things, due to the nature of working with three different people.

Participant D: Who are specialists in their own right. Try and tap into their expert view. I think it’s quite probing.

Participant E: I’m just trying to think about what they would say to each of these questions. Obviously, I’m not a professional, so I won’t have the same response.

Participant D: I mean, from somebody that’s not a professional, their response might be... For me, recreating the sensations somehow, or either imitating sensation or responding to it in the opposite way, or...

Participant E: You were talking about making your movement bigger. Like increasing the space you were occupying.

Participant D: Because that was pinching, it was making me think of doing the opposite.

KR: Yeah, your interpretation of that. I think that’s the thing with the vibration. When I kind of think about the last project. Their initial first 5 mins in that improvisation, were often kind of listened to the rhythm, or they sort of, the longer they had it on the more obvious, they started focusing on different elements of it.

Participant E: I think with the inflatable one. Question 2 is quite interesting because it took me a while to get past focusing everything on my neck and almost tuning the sensation out and applying it to the rest of my body.

Participant D: yeah

KR: Yeah

Participant E: I think placement, has a fair bit to do with that one.

KR: Yeah, I know they are fairly similar (in position). I know with the nitinol you probably could put it in a different place. I know I have done that (she points to the inside of the wrist). I umming and ahing about whether to put it in the middle, the upper abdominals, or not. Do you think as a necklace it's a bit more obvious, but then...

Participant E: You were talking about bringing it back to the torso. So perhaps the neck is too far up. It makes you focus on head movements.

KR: I did think about it as a belt. Then I went back to it as a necklace, mainly because of having it on the skin. But you could still have it on the skin if people were happy to wear it underneath their t-shirt.

VK: I think that would be a better place.

Participant D: Yeah, a better place because then you are exploring something very different to vibration. The heat on the skin is not that bad, but I do think you need to think about a way to attach it that it doesn't transmit the heat too much.

KR: the nitinol? Yeah. It's got a layer of a sort of thermal masking tape. Sort of heat... So ,it goes silicone, the nitinol, then the tape, then it has the Kineo tape, the sort that people use to wrap themselves up (for sports). So you think another layer of silicone, under?

Participant D: How conductive to heat is silicone?

KR: It doesn't seem like it affects it that much.

Participant D: the thing that's lingering, is more the heat, than anything else.

Participant E: It wasn't that difficult to peel off. It did get quite warm when it was there. I'm sure there is a way to do it, even if it was to give it an extra layer.

KR: Okay, when I have embedded in the silicone, the nitinol. Then maybe it's just a really thin layer underneath it as well. As long as it doesn't effect the pull of the Kineo tape. But it should give a little bit more protection against the heat.

Participant D: See if you could get some insulating piece of material. Maybe a wool?

KR: Like felt?

Participant E: I was thinking of a layer of tape, a layer of neoprene and stick it onto the back of the latex.

Participant D: Yeah, neoprene could be good.

Participant E: Then you have a fairly thick fabric attached to the back of it, so I don't know whether it will work.

KR: I will have a look and have a little play around. Yeah, I think that's it. So, it pulls it. So, think of insulating from the vibration (pump prototype), insulating from the heat (nitinol prototype) and possibly changing where it's placed on the body.

Participant D: Having a structure, like the exercise you took us through was very useful. I think you could see the impact the technology would have had. You had a base phrase and then you asked us – question number three. You know, I don't have the training to fully explore that question, but I think it's a really good question for the people who know what they are doing.

KR: Okay, well at least they worked. As long as they work.

Participant D: It's good. Gosh, you made an inflatable and nitinol pinchy thing. It's just tweaking and thinking about where on the body.

KR: It's good to see how juicy that was, as it's only been on about ½ hr. So that battery lasted about ½ hr.

Participant E: I've got to go.

KR: Thanks so much

Appendix L - Fieldnotes: Project 2

Tues 16th July 2019-07-17

Studio Wayne McGregor

6pm- 9.30pm

Participant 10 and KR in Studio 1.

The evening started with setting up the room with the cameras as usual. We had agreed to try the nitinol prototype on the second day, due to running out of time on the first day. I asked Participant 10 to put on the harness and then I put the electronics into the neoprene socks. Then I stripped back the backing on the Kineo tape to stick it on Participant 10. Once everything was secured, I turned on the batteries. In the first one, we tried I saw the squeezing and pulsing of the nitinol wire; however, Participant 10 could not feel it, and therefore it was too minimal to be felt when stationary and therefore wouldn't have been felt when moving. We decided to try the other one I had brought with me which has a slightly longer length of wire. This one didn't seem to move at all and when we were about to give up and Participant 10 started to remove the kinesiology tape and suddenly it contracted very quickly and started to heat up, so we removed it. Participant 10 talked about how a friend on her old MA programme had used nitinol in an exhibition piece and he had experienced difficulties and she tried to think about another material or way that might produce the squeeze/pinch that it creates, but she couldn't think of anything.

Every time I have used the nitinol wires they have acted differently and even with the change to a Leonardo and MOSFET, this hasn't regulated the response. After trying the prototype with two dancers and it not being reliable, I have come to the conclusion that this type of pressure is not particularly useful in this context and when worn on the body.

We then moved on to the next area which was looking at the editing /development section. Firstly, we both taught each other our phrases which we had created the evening before with no assistance from the tech. Then we used the pump prototype to work with and think about how this might change the movement or not.

I found this quite a tricky thing to do, as it required a lot of questioning myself, what the movement was that I had put together, and whether this was right concerning dancing with the tech. This produced quite a stop-start in the studio. The vibration bracelet was easier to use in this context, but perhaps it's less intrusive and you don't always have to use it – particularly one. We decided to look at a selection of video footage from the past two days and reflect on this further and try both prototypes at the same time. We also thought we would try a duet section together with the prototypes.

Appendix M - Project 2 Edited Video Footage: Use of Torso- Ripples, Curves and Undulation Pump Prototype (Improvisation).

Appendix N - Project 2 Edited Video Footage: Use of arms framing the body and hands wrapping and replacing with Vibration Prototypes (Improvisation).

Appendix O - Project 2 Edited Video Footage: Use of Torso in Movement Initiation with the Pump Prototype (Improvisation).

Appendix P - Project 2: Digital Touch - Participant Matrix (compiled)

Participant 10	Extracts of Movement analysis	Interview Data
Improvisation with pump prototype (with prompts- only 1st prompt response included here)	Participant 10 is still standing in a relaxed neutral position. She slowly moves her torso to the R side and then gently concaves the chest forward. Weight is transferred across legs, and movement in the rib cage is explored. Slow and sustained. The movement becomes more pronounced, coming more into high release of the upper back and slouched over towards the feet. On the spot, moving in small space directly beneath the body. Weight into hands and hips lift, rise onto demi pointe. Lowering, and chest spirals, so focus is upwards. Transferring into kneeling and small movement initiating from the hips, spiralling forward. Travelling downstage, still slow, and steady in pace. Step to stand and step ¼ turn, gesturing L leg (middle level) and close parallel. Step out and ripple effect through arms and back, side to side transference of weight. Shoulder initiated concave of chest and	“So, I feel like at first there were a lot of not fake responses... I was moving for the sake of moving because it was moving, so I thought “okay”. There was a lot of that, and I had to keep stopping and actually trying to pay attention to what was actually happening. So, I really tried to think about the process of what was actually happening.” “I kind of liked the initial exploration around the textures and the air and things, as opposed to the rhythm and so I had quite a lot of internal dialogue during I think, to try and understand what I wanted to respond to, and we had just had the conversation about the noise, and I thought interesting...the rhythm is coming more from the noise than perhaps the actual sensation.” “When the focus was on it, whether that’s the feeling or the actual tech itself, my use of space was fairly minimal actually. I don’t know really why. But then the task was to distract yourself from it, I used the space to distract myself from it. I was using much more space and

slow walks which change facing to upstage. Leaning upper body back, L shoulder higher. Walks around again on the spot. R elbow flexes towards the body, and head leans more that way. Arm carves towards the body, and this takes the body to travel in a circular pathway, finishing in parallel, arm unfolds behind body. Rise, focus up to ceiling. Knee turned inwards and, hips turn towards other stretched R leg. Rocking into L leg. 10 holds waistline and turns, and undulation of torso and pressing into one leg in front of the other. Walking hands into the floor, hips to the ceiling. Hips, and then drop to the side and this turns the chest to the ceiling in a kneeling/squat position. This is slightly reversed and then returns into a 4th position on floor. Flexed foot, L leg raised in front of the body, rond de jambe behind then foot tucks behind leading into a turn. One foot in front of the other and then arms held at head level and then flex towards torso. Another flexed foot (L) in arabesque and supporting leg pivots around. Arms unfolds. Leg lifts again and slowly clochés back and forth. She quickens the pace in walks. Travelling further into centre downstage (facing downstage L corner). Walking backwards, arms lift from the elbows, in a parallel position and unfold away	touching the wall, or the floor, because then I think I got another haptic sense, and I can pull away from this, with this. So, I think use of space in general was much more, I particularly enjoyed working through how it was working and then I came back to the minimal movement for the phrase, so it doesn't really move. It's almost pretty static in the space that it uses, it's pretty small." "When I improvise, I tend to do a lot of stomach and floor stuff, and when jumping I felt like I had to be careful. But in one way it was opening up different ways of thinking about moving, it sort of closes this pocket of habitual movement that I like to do because it didn't feel like it would be appropriate, and I didn't want it getting in the way of the technology" "I noticed a lot of the movement because of where it was situated, a lot of the movement happens from the centre. Then I have a habit of moving my limbs anyway, but that was still there quite prominently."
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	from the body. High release in the upper body to the ceiling. The head travels forward and leads the body into a slow turn. Right arm flexes and comes towards the head and unfolds. Both arms raised and lowered. R leg flexed at knee and head and body curves towards knee. A series of steps around in a circle as arms gently unfold. Leg développé, which takes the body into a turn.	
Improvisation with vibration prototype (2 x bracelets, the 1st prompt response)	Slowly moving arms from side to side. L arm above relaxed and held above head, R arm middle level to the side. Épaulement in the shoulders, moving the line of the arms. Lifting R leg, flexed at the knee. Turn led by the arms and bent over towards the ground. L arm flexed towards body, R arm undulating and rippling, getting larger into more circular action and step side and turn. Stop –start quality. Left foot turns out in a series of three small rotations. Step over, turn. Stepping pattern, behind, side and back changing directions to settle in parallel. Forearms facing towards body and left arm pulsing down. Then pulse goes into the body with little rise onto demi pointe; then repeated with a change of focus to the L and L leg low gesture to the side, then repeated but with a spiral. Turn, step across to the floor in low lunge, R leg in front. Changing hip orientation and leg comes into 1st position (grand	“I found it easier, because I like to move my arms around a lot anyway and it likes to promote that a bit.” “But also, in other ways I had more dialogue this time around, because I was like, how should you respond to this? I had more of that with this one for some reason. That might have been because I had more of a rhythm on this hand and on the other it was sporadic, and I felt like because it only came every now and again. And I felt that I should really respond to it.” “So, then you end up getting this funny improvisation where you have this flow and then, something has to happen here. Sometimes it really was a “oops, okay”. Impulsive and something has to happen. I spent a long time trying to make myself a rule, like what if I only move when it is vibrating or only move when it is not vibrating.

plié) and L fingertips stretched to floor. She turns to sitting and legs stretched out in front. R arm circles behind, and then everything contracts and the limbs close towards the body and then stretch out. Slide on knees towards downstage R then stepping up. Step back and front leg bends, facing the ceiling. Circles of arms, getting bigger, arms cross in front of the body. Leg floats up behind and arms drop the body forward. Stepping sequence around in a circle led by the arms which are weaving through the space, but always bringing the arms and legs back towards the body. Picks up in terms of speed. Dialogue between the L and R arms, wavering and weaving through the space in all directions around the body, which repeats several times. R leading circle (windmill arms) around and down to the floor. L arm stretched out and L leg circles behind and Participant 10 crouched position, pushing the bottom of R the palm into the floor. Slows down, very placed and energy is more bound. Arms held out to the side, forearms facing each other. Sitting and then turn on the floor or half kneel (hands opening out presenting palms) R arm circles, then weight of head rolls the upper body twice, weight into R hand.	What if you move in the direction of that hand as it is vibrating? I spent a lot of time in my head... “what if and what if”, but not really sticking with any specific goal.” Vibration on the skin and awareness- consciousness: “I probably wouldn’t have noticed had the vibration not constantly brought my brain back here. Say if the vibration was here [legs] I probably would have noticed the trousers legs sliding down. Your clothes move as you move, so you don’t think about them.” “Whereas with the other, because it was the core, I had to respond to this, first and foremost. Because it is affecting everything else that was moving. But with this one I could do almost anything I wanted, and it didn’t really matter what my stomach or legs were doing and that was the process I had.” “This one, I didn’t have the issue of fake response. It feels much less invasive, somehow because it’s not at your core. I think its somehow, it’s not a norm at all, but it didn’t feel so strange to have this at my wrist, vibrating at the wrist like a watch. I have a Fitbit and it’s doing it all the time. So, it didn’t feel quite as strange and therefore I wasn’t sucked into it. Then I think I was less aware of the type of response I was giving because of that
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	Circles of the arms and walking backwards, following the arms. Elbow bends towards the body and initiating a turn, then body and head hangs over. One arm swings, then both arms rock side to side with weight, which gives momentum to come up. R wrist by ear into walking, posé turn (bent leg), which then turns into transferring weight, changing direction with steps around in a circle. R arm near head and unfolds to the ground. The hands walk slowly forward and then R is placed underneath the body. L arm is placed by lower back. Hips are placed down and Participant 10 sits to face upstage L. R wrist on hip, L arm swinging. Step swing of leg and then weighted en cloche and run with weight of leg. She leads with forearm (R wrist) and open 4th plié legs and then folds into the centre with leg and then arm. (Circular gestures towards the core). R arm leads round space, spirals and arms unfold forward, swing with arms and pitching forward to the floor, rise and rock back, arm leads 10 backwards into space (circular pathways).	perhaps. Whereas with the silicone, I was totally aware of it and I was able to say that's not a true response and I could just tell. You don't usually have something moving round this area, so it was quite unusual." "The movements were far less localised I would say. On the extremities you have more of the kinesphere. Then when I was trying to distract myself from it, I feel like used more space at that point." "I quite liked the bouncy, motory movement. When I was making it, I was thinking a lot about this documentary that I watched on the BBC about a woman who has Parkinson's and they made the tremor. I wonder if I can counteract it, then I can't feel it." "Then on the left side, something has to happen here, it's not constant, I should do something here. But I know something is going come back. Then I would forget about this, because this feels quite nice, or I've lost my flow and I will stop and wait until the next one. So, it was more or a distraction with that than the silicone one." "Because you are so focused on what is happening on your body I didn't really think about travelling through the space or anything like that. I don't feel that there is
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		an immediate need to explore all the areas that you have. If I was using an imaginary process, I think I would want to take a travelling across the space a bit more or respond to what I'm seeing. And you don't really feel like that's necessary or appropriate actually. It's on, and I'm in my little bubble and it should be in my bubble, so it should be there" [Participant 10 is talking about both prototypes here]
Combination of both prototypes together (Participant 10 by herself and then joined in space by KR)	In improvisation Gentle change in weight between legs and then hips initiate change in facing. Back undulates and then L elbow bends towards ribcage and changes to frame above head as the upper body curves over. Arms both move and almost small figures of 8 at shoulder height. Second curve over and roll up, and gesture L Leg, knee bend and at right angle. Stepping, side and across, upper body spirals around and arm pushes away then legs open into open 4th and then weight onto front foot, arms stretched. She steps backwards, Figure 8 with arm and step pivot turn anticlockwise and then clockwise. Curve of upper body forward. Arabesque in fondu, with high release upper body. Walks to stage L and R elbow stops movement as it unfolds in the air. Reverse turn back towards where Participant 10 just came from and stopping once more with a hand held up in the air. Turn in fondu again and arm unfolds forward and back.	"At first, I found it quite overwhelming. It was like too much information coming. I'm not sure how to deal with the information. But in time it became easier to listen to each, I had three, so to listen to all three of them. Not necessarily responding to all three of them each time, so making choices. But I definitely felt that even though having the vibrations on the wrist made the sensation from the pump feel stronger, it was still less prominent. There was a lot of time focusing in on that [pump prototype]." "Then I sort of tried to pay attention to what I was not doing in the improvisation. Things like jumps, floor work and there is quite a samey pattern to it, and I wonder why... and I wondered what would happen if you put those things in, does it disrupt the overall sensations and feelings coming in?"

	Walking and then both arms flick up to ceiling and then little rise. Step back, arm cuts to the side. Both arms come behind the neck and unfold. Step L leg across and then continue turning clockwise on both legs. Arms continue the circular motion round. Bend to L and stepping to recover moving more towards centre stage. Hips move and left leg raised behind and small pivot anti-clockwise. Rise with arms held above and then rocking forward motion and pitched forward at hips. R arm initiates, in flexes in towards body and then opens out and leads the body on a series of turns. Arms wrap the space towards the body and then one-legged turn on a pli�� and L Leg wrapped around the other. Demi pli�� in parallel and then scooping arms around and above head and towards body. Legs walk in and out and then stepping in a circular pathway unravelling. Step gesture L leg and step back on it and R arm unfolds behind the body. 10 looks at the wrist, step to the side and the head and the hand drop to the floor and then recovery is in circular pathway upright. Figure 8 with R arms and then both arms are brought parallel to each other (forearm facing out), on rise with bent knees, leg gestures to L side, knee bent and closes in a 5th position and arms unfold behind neck and forward again. Rocks back and forth and turning the facing. Fondu arabesque in parallel. Circling around in the walking and	“It was a little bit disruptive and that mainly comes from the silicone pump. It just makes you not want to jump. It just makes you not want to do it. And also makes you not want to be on the floor that much.” KR: Do you think that’s just the physical kind of box and the equipment? Participant 10: Possibly, yeah that’s the floor part possibly. The jumping I think it’s got such a mellow style. It makes me think of mellow, relaxing, meditative... and jumping just doesn’t come into it. It’s much more almost tai-chiesque. Sort of everything on a level kind of movement. That’s the place it puts me in.
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	curve then walking hands into floor and hips fall to floor, change of the torso to upright. Head initiates and body moves down towards floor, 10 props up on her shoulders. Then moving between kneeling and weight into hands to move to standing again. Walking towards upstage and then to the stage left, arms carving out the space in curves, then shoulders doing the same and turn. Step on L leg on demi point and gesture the R x 2 in front of the body (a bit like a grand battement) then swapping legs and pathway curves away from the wall to back to centre stage. Head initiates and rolls around; the body follows by going around in a circle. Head tilts to R and then Left arm initiates movement by scooping space gesture and turn on a diagonal. Stopping in parallel and wrists swing for a bit as the body is tilted forward. R arm and left leg extended and then shift back to hands in Figure 8 motion. Fingers then grasp each other and then let go and the letting go reverberates through the body with a ripple and recover. R arm circles forward and then behind. Stepping back and lean back R leg comes off the floor and then the weight goes back onto it. Shoulders lift and then a series of turns upstage R arm above head and L hand to the side (forearms forward).	
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	Pause in parallel facing front. Participant 10 lifts wrist one at a time to the side of the face (like she is listening to the vibrations) and elbows take the body into a ripple, turning with bent legs and step across with leg. Arms unfold from behind neck and then forward and step across turn. Neck rolls to R and then elbow goes up and leads into walking backwards in spiral. Step hop x3 on a diagonal pathway facing downstage L corner. The last two vary in that the leg steps behind and initiates a turn. Walking upstage in a big circle and head rolls and stops the body stage L. Walking to diagonal. Then walks backwards, arms circle behind. Ending upstage. Upper body curves forward and slowly rocks from one side to the other. Spiral, then turn the other way. Rise and then a series of steps backwards. Gestures leg with flexed foot and then focus up. Right arm pushes head down to the ground and then arms F8 around and then step across turn. Step arabesque on fondu. Walking. R elbow folding in and hands walk out along floor, and then hips sink down and R leg bends and weight on the side (almost like a lying down arabesque) the hips move to make contact with the	
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	floor and then leg gestures across the body, back to kneeling full pli�� and then hips lift and roll up to standing. Hand straight in gesture and body realigns, she carves space with arms in F8 and then step turns downstage with bent knees. Walking back upstage and hand to floor and pitch turn. Knee leads and rotates leg in hip, this repeats on other side. Elbow unfolds behind and leg lift. Walk to wall stage L and then like participant 10 is listening, she pauses and steps around clockwise and walks along perimeter of wall and then pause and backward, forwards, knee lifts and takes the body to look towards centre stage. Diagonal pathway and turning on middle level and arm stretching up. Series of d��velopp��s and then walking in a spiral with arm unfolding to the back.	
Structuring phrase	Pump structured phrase Wide legs. R, then L arm gestures (middle level), ripple effect through the arm. Turns to stage R and arms are placed, one then the other. Foot tucks behind and head leads a clockwise turn. Resting on bend R leg and stretched L. Elbow middle level and focus to ceiling.	“I tried to structure it in... I was really interested in this process, so the first thing I feel, the first thing is the feeling, that feeling, is sort of like bubbly, gooey feeling, and then I know that goes through the tubes and becomes very structured, its being processed again. It’s just a tiny phrase, I tried to start with the soft movement, the silicone and the air going through and moving onto more structured, the flick and the direct movement and then the processing and then coming

	back again to the silicone. It's a cycle of what happened in that electronic process. I tied to package it like that." "Mmm, I think a lot of the movements changed. Like if I was initiating previously from a different body part, then a lot of the movement became initiated from the core." "Yeah, not only the quality of the movement, but actually the movement itself. Somethings you think, it doesn't fit, you want to change it rather than doubt it. I felt like it has this subtle ebbing, flowing rhythm, which then ends up being in the movement. It was very difficult to stray away from that and then you end up with a continuous flowing movement, rather than any spikes or change in dynamics." "I do wonder if it was an easier task, just because we had done these before. Also, when I made that solo, I had just come off the back of making movement with that one [we had finished the improvisation and 6 count movement phrase and then taken the vibration bracelets off before creating a new phrase without tech]. There was an echo of that coming into that process anyway. It was much easier to throw material away, "I don't need this" or, "I don't want to use that", with this one, I didn't feel nearly as precious with it."
	Vibration structured phrase Body facing stage right diagonal. R leg slightly in front of L and in a loose parallel. Rocking forward and back between the legs x4, step behind, side, back (pas de bourrée) to face the stage L diagonal. Right arm swings at the elbow joint x 2. Then R leg gestures low in front of the body (flexed foot), supporting leg is bent on demi pointe. Arm swings one more time and stops suddenly down by side of the thigh. Quite matter of fact in quality.

Editing	Development of existing phrase with pump prototype Step to R and turn (3/4) in fondu, leg and arm in same position-opposite arm to leg. L leg middle level and flexed foot and R arm, shoulder height stretched out in front of body. Unfold of elbow and walk into lunge and like she is pushing something. Step across the body and then weight into hands and lower body to floor in foetus position, everything opens out to second position on floor and then R arm slowly collapses into the side of the body. And the back makes contact with floor and she rolls, with recovery to kneeling position and look to R (but more of a glance). Legs stretch and triangle shape of legs and right arm extends up to ceiling, arms windmill backwards and walks backwards as the body comes upright. Then body ripple through and the R arm is pointing to the floor. Hips take body off centre into walking circle backwards and then into walks forward. Participant 10 rises on the balls of the feet [then she says she doesn't know what to do here, i.e., at this stage]. Then she pivots around and walks, followed by an undulation. Continued flow from one thing to the next in the phrase.	Participant 10 has pump prototype put on for phrase development. KR is putting another electronics box back together. Participant 10 in the space trying to go through the phrase. She stops after a bit and says “tricky”. Then carries on working through the turn. She comments on how she finds it difficult to turn on the floor in the studio and I suggest putting socks on if she wants to. Her face looks a bit unsure, biting of lower lip. Participant 10 tightens the strap of the inflatable and KR joins in at 11.49 KR turns to Participant 10 and says, “it’s hard, because you almost want to do something completely different.” 10 responds “Yeah, that’s exactly I thought. It doesn’t suit it. So now I’ve started to adapt bits which doesn’t feel completely right. And then leaving other bits that I’ve got and going back over it.” KR: “It’s more listening and thinking than reactions.”

		Participant 10: “Yeah, immediately it [the movements in the phrase] feels too hard, and I don’t get that sensation [holding the inflatable] at all.” KR: “Yeah it’s like your mind is saying one thing and your body another thing and you are trying to figure out which to listen to.” Participant 10 comments that she is not exactly happy with what she has got, before presenting the phrase to KR. After watching: KR comments that “from the outside it looks dynamically different” and because of where the prototype is placed that the movement looks more “torso initiated, whereas before it was “more from the extremities” and “it’s a lot smoother, there are pauses, and it’s not that its flat, but...” Participant 10: “Yeah there were just so many things, so when I did that [leg and opposite arm gesture at same time] that just didn’t work and so I was just try and do it in the rhythm [of the inflatable] or incorporate the rhythm. Which I could, but it meant that I was just
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	Development of existing phrase with vibration bracelets Step to side and then R arm cuts across body in same position, there is a little pause, before running straight to the L diagonal, then stopping in pushing position (this is quite pronounced) and then stepping across L leg, arms both go behind and up to the ceiling in this action. Run and fall to floor, and little hop on the way down, finishing centre stage. Legs fold underneath hips and body lowers to floor, arms push body upright into 2nd position on the floor, stillness. R arm curves in and legs fold into kneeling position and a softer look to R. Hips lift and body uncurls and walks backwards and upper body extension. Then step forward	changing it in its entirety. And I thought I would like to keep a resemblance of its original structure. It was tricky.” Participant 10 goes onto say that she thinks that the phrase had the ‘echo’ of the previous work with the bracelet vibration prototypes [because the phrase was made at the end of Day 1] and that perhaps that is why it didn’t feel right. She talks about the phrase becoming more “mellow’ with the pump prototype. KR shows 10 what bits have adapted in her phrase and that generally it has more continuous flow and carries on through. She wonders how that will affect the effort of the whole phrase. Participant 10 comments that dynamically all the spikes have been she gestures across [as if she is saying flattened]. KR says that they have been “smoothed”. KR questions whether this is useful or choreographically interesting. Comments after showing: Participant 10: It certainly was a lot easier. Certain things like this [R arm held to side], I’m just going to wait until it does something. And depends on how, if it’s quite intense I will move quickly or if it’s quite minimal I will move slowly. But I felt with this that I didn’t want to faff around it felt like just get to the point.
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	and ½ turn anti clockwise and step forward x2. More space used and travelling through space. Still pauses, put on the whole less sharpness than the original phrase.	KR: yeah, it seemed more like that, like bursts of energy. Whereas the other one was more subtle and more mellow and this one was little balls of energy. Participant 10: I guess that makes sense, as you get little burst [pointing to the bracelet prototype]
Internal and External experiences	“And I felt that I should really respond to it.” [in relation to two vibration prototypes in the improvisation prompts]. It is interesting that we can ignore so many sensations on our skin, yet if the stimulus is the point of attention, there seems to be obligation to react. “I probably wouldn’t have noticed had the vibration not constantly brought my brain back here. Say if the vibration was here [legs] I probably would have noticed the trousers legs sliding down. Your clothes move as you move, so you don’t think about them.” ‘Internal dialogue’- to a certain extent the prototypes seem to exaggerate this tendency. As the participant becomes more familiar, there is an adjustment as to where they stand in relation to the ongoing stimulus. In this internal dialogue there is a conscious awareness of what is happening on the external (skin) and then how should this be interpreted in movement. “It’s on, and I’m in my little bubble and it should be in my bubble, so it should be there” [Participant 10 is talking about both prototypes here]. This reflection on the experience of space and awareness of the body raises several questions: can we conceivably cope with multidimensional aspects of our moving body in relation to an stimuli created by digital touch? Or does the intimacy of something on the body/near to the body prevent our awareness of what is around us? I can’t help but think about the discussions about children’s attention spans and the use of social media (how attention time is reduced through how we interact with) and how the tools we use shape us as we shape them (Ihde’s discussion on symmetry and McLuhan)	

	Using the prototypes as editors of existing material in the case of the prototype, was complicated due to the fact that Participant 10 felt like she needed to change everything with the pump, as it didn't feel right. Which suggests a quite definite decision aesthetically about what movement that fits to the stimulus (feeling, sound and location). The vibration prototype did not seem as complicated for reasons listed (echo; and order of working prior to making the phrase; ease with which you could ignore it based on the location at the extremities).
Influences from social cultural background	"So, I feel like at first there were a lot of not fake responses... I was moving for the sake of moving because it was moving, so I thought "okay". There was a lot of that, and I had to keep stopping and actually trying to pay attention to what was actually happening. So, I really tried to think about the process of what was actually happening" [improvisation with the pump prototype]. The question being here: how can one relate to a digital touch? What might have been occurring is moving through this situation, i.e., moving for the sake of it. In the cultural context of improvisation in a dance studio the participant seeks authenticity and to be connected "sense of whole and clarification of intention" (Blom and Chaplin, p.9). How can one achieve this, when there is an uncertainty about what the prototype is doing, on two levels- the subtlety of the feeling, but also in Participant 10's example, how the computer is achieving this (the mechanics/electronics)? Familiarity with technology on the extremities (location of the tech): "It feels much less invasive, somehow because it's not at your core. I think its somehow, it's not a norm at all, but it didn't feel so strange to have this at my wrist, vibrating at the wrist like a watch. I have a Fitbit and it's doing it all the time. So, it didn't feel quite as strange and therefore I wasn't sucked into it. Then I think I was less aware of the type of response I was giving because of that perhaps." "When I was making it, I was thinking a lot about this documentary that I watched on the BBC about a woman who has Parkinson's and they made the tremor. I wonder if I can counteract it, then I can't feel it." Obviously, there is a playfulness in wanting to see how the new tool or choreographic agent works with the body, but there is also the issue of power raised here. "When I improvise, I tend to do a lot of stomach and floor stuff, and when jumping I felt like I had to be careful. But in one way it was opening up different ways of thinking about moving, it sort of closes this pocket of habitual movement that I like

	to do because it didn't feel like it would be appropriate, and I didn't want it getting in the way of the technology." The perceived restrictions or uncomfortableness of the pump prototype added another step to the decision making in movement generation which helped in this instance bypass "habitual movement". Habitual movement being a result of training, body shape, and prior experiences socio-culturally. "Possibly, yeah that's the floor part possibly. The jumping I think it's got such a mellow style. It makes me think of mellow, relaxing, meditative... and jumping just doesn't come into it. It's much more almost tai-chiesque." The pump in the structuring of the phrase influenced the 'how' of the movement. This might have been to do with the pattern of 'on and off', which created a slow rhythm.
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Participant 11	Extracts of Movement analysis	Interview Data
Improvisation with pump prototype	Ripple through the back, continuing rocking and changing weight, tipping forward from the core, pulling up (cat stretch) on demi point. Movement initiation predominantly from the core. Spiral round to lower level and then returning to middle level. Walking and spiralling. Roll backwards, legs return and a collapse of weight into the floor. Rip cage pulls up and head and lower legs still on the floor. Torso leads legs to walk around the floor (body on the side). L side pulls the body up onto squat/kneel position. Slow, quite careful movement.	"...breathing and how centred I felt, having it on my front. I had my weight more grounded." "I found myself wanting to be using the core and wanting to play with that. I think it's that sensory feel of the pump, undulating, or waving, that was my creative response to how it made me feel, particularly where it was placed."

	Little jumps on a diagonal moving stage L. Turns and spirals causing the body to move quicker and through the space. 11 returns to a rise and then adds in R leg kick, but initiation still from core. Speed quickens. The movement often repeats and reverses (in spirals, undulations) Greater use of arms and legs, fingers tips climbing up towards the ceiling, sidestep to the floor, backwards roll over the shoulder leg leading the body back up. A lighter quality as the legs and arms are used a bit more. Walking and using space to stage R. Moving between the levels of space. Spiral down to the floor. Weight into the hands, and handstand. Series of turns on demi pointe. Backwards roll. Parallel rond de jambe on low levels and using the legs to turn the body. Walking to another part of the space (using more of the space in the room) and more direct. Hinging at joints: hips to sit down and then lying down on floor.	"Where it was did make me more aware of that sensation through the spine and around that torso area. So, I was aware my arms sometimes moved, but they were irrelevant, as this was the interesting bit." "Undulation. In that area, and where it would flow in the body. Where it would go, and how you exaggerate that?" "Softer. More contained. More...I want to say, more sensitive." Participant 11 at the very end just pressed her body against the wall and window: "I quite liked the contrast in temperatures. The contrast in different surfaces of my body, my skin, the juxtaposition." "...exploring weight and sensitivity and physical awareness of it, it was more a series of journeys, a flow with it..."
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Improvisation with vibration prototype	Crossing and unfolding the arms and wrists initiating the movement. Wrapping gestures. Pressing the tech against each other or her thighs. Stretching up. Focus on the wrists. Throwing, movement initiated from the hands and then this carries on through the body. Weighted, increased speed, flicking. Pressing of R wrist and then left to the forehead. Released arm swings and Participant 11 walks upstage. Spirals the back, turns and swing arms. Pressing both prototypes to cheeks, head down towards ground, low gallop to the side repeated. On the floor, legs shoot out to the side (1/2 Head stand) pressure on the prototypes: either holding onto the tech or pushing them against the floor. Sustained quality. Turns travelling Arms leading the body through space. Circles and spirals of the back led by the wrists.	“Sensation of the vibration going up and down influenced the direction of movement and type of movement. Vertically, in a swing fashion” “The one on the left, for me, didn’t feel so dominant, so I kind of wanted to do contraction and extension with the hand” “And an awareness of the sensation of them holding, it didn’t feel like it was restricting, but there was a different sensation of weight, the positioning of one side to the other that made me more aware of the different surfaces of the forearm.” “So initially there were bits I wanted to explore: hands, the forearms on the left and the shoulder joint with the swing. With the swing, I was feeling it more with the

	Dynamics change to lighter in a quicker travelling section across the space. Hands towards head and quick movement with head. L arm wraps over neck and restricts the head. Some swings of arms, then sinks to the floor. Wrists to ears and sat on floor, shaking head. Jerky movement but contained. Inward focus. She stands up, on one leg and R arm still attached to ear, she bends forward and gallops across space, swings arm (free) and start listening to the L wrist. Step rise, turn on demi pointe and step. Step turn, with head dropping towards body and she runs to the upstage. Step turn arabesque and développé in parallel forward. Attitude arabesque and then swinging the arms. Quite soft and balletic quality. She drops down to the floor listening to both and then lies flat on the floor.	trapezius and latissimus dorsi in the back and where did that go.” “...one against the other [layered wrists] to see how that felt. It was almost a flow through, like you often see in martial arts warmups, and I wanted to see the interplay of that, to see the rhythms, so polyrhythms in the body” “Initially I wanted to be quite contained with the wrists and the rhythms, but then there was a point where I could move whichever way I wanted to, but it made me feel a little bit more weighted. “ “The little details, I was looking at them at one point and I could feel the sensations heightened by it being in contact with the metal area and then trying against the glass and different temperatures with those. Then going “ohhh”, I could feel vibrations and sensations in my nails and fingertips that I wouldn’t normally see”
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Combination of both prototypes together	N/A	N/A
Structuring phrase	N/A	N/A
Editing	N/A	N/A
Interview Data-additional	Interview 3: “Obviously you have more sensation when you have the physical pulses or the sense of the pump with an interactive flow. So, in terms of moving with the technology, even when I wasn’t moving, there was movement in relation to the technology because even your resting breath or sensory awareness of heat or that kind of standing on the spot, there is awareness. Like with anything on you, you have a different type of posture and different relationship with your centre of gravity, let alone moving.” “In terms of internal and external, with the immediate responses to having the, going on a journey with each the prototypes, I felt a lot more awareness in terms of internal. Because I was thinking about my relationship to it and what it meant, rather than in terms of the space and environment” “It’s a McLuhan thing, our tools shape us as we shape them as a process.”	
Internal and External experiences	“...exploring weight and sensitivity and physical awareness of it, it was more a series of journeys, a flow with it...” [relating to the pump prototype]. The expression of ‘flow’ here is used to describe the pathway of exploration as opposed to describe being at one in the improvisation. However, the explanation of more than one way of exploring the prototype and particularly in relation to “being more grounded” and the condition of weight because of its location at the core is notable. It’s almost like an ongoing adaption or plasticity that is being described. This can also be seen with Participant 11 at the very end of the improvisation, she just pressed her body against the wall and window: “I quite liked the contrast in temperatures. The contrast of different surfaces of my body, my skin; the juxtaposition.”	

	Participant 11 mentions in her interview about questioning what it was the prototypes were doing – whether they heighten or amplify. In her case this is true and allowing for understanding of things in a micro manner, through the gained sensitivity. Participant 11 goes on to refer to the sensations within the body (vibration going up and down the forearm) which influenced the direction of the movement and type of movement. She was aware of external factors in the room but brought this back into relation to her body (against different surfaces etc) and supported by the quote in the box above: “In terms of internal and external, with the immediate responses to having the, going on a journey with each the prototypes, I felt a lot more awareness in terms of internal. Because I was thinking about my relationship to it and what it meant, rather than in terms of the space and environment”
Influences from social cultural background	“...one against the other [layered wrists] to see how that felt. It was almost a flow through, like you often see in martial arts warmups, and I wanted to see the interplay of that, to see the rhythms, so polyrhythms in the body” [relating to the vibration prototypes in improvisation). In this sentence there is reference to the use of energy and how this is used in martial arts, but also rhythms used in the body and different body parts. The experience or journey being influenced by the prototype and simultaneously knowledge of different practices.

Participant 12	Extracts of Movement analysis	Interview Data
Improvisation with pump prototype	Stands in the space, then slowly starts to move. Rolling through the spine, initiates from the hip area. Steps back and the weight of the head tips the body back and then sliding between feet and little hop, repeat hop. Throw arms up, stepping across and turn. Undulating sideways in spine as walking then travelling to the floor. Pace quickens and lighter in energy.	“So, I guess it’s moving from the periphery to the centre, which does make you move differently. It also made me think of those Body-Mind Centering exercises.” “...where the centre is their mouth and everything. So, I started moving a bit more from that point. Or whatever I

	R arm initiates and takes the body into a turn and then slaps against the abdomen and then back behind the body. Back bend, shoulder roll with hands held behind back. Step into contraction. Arms forward. Jumps with arms swinging in a weighted fashion. Then repeated swings forward. Heavier and more bound in quality, but quick. Arms frame the head and then repeated swing. Stillness and then cradling skull and then dropping forward with weight. Stepping backwards and holding ribs. Stepping forward and then back. Windmill arms, and then side contractions, making the body lean from one side to the next. Weight of head dropping forward, then contraction of back in quick succession. Arms sweep along the floor. Body moves to the floor, slow movements from side to side. Sitting. Stretched arms and legs out together in a second position on the floor. Grasping hands, one at a time, to the middle and then down to the floor. Grabbing, stroking the body from chest down through the thighs and down to the floor	did would pass from away from me, but through the centre to go. I was thinking about all those exercises you do from 'flying low', where you have to pretend you are picking an apple, eat it, digest it, on the floor. Umm... that's quite relatable to that sensation, from the middle being the driving area of what you are doing." "...more emphasis on the motor, rather than the jellyfish [silicone inflatable]." "Binaries, because of the sound, I couldn't help think.... "Far away...close to you...far away" "Yeah definitely, the sound. That way it divides everything into two." <i>"KR: I noticed there were two different sections within that improvisation. There was one later in the improvisation section where you were moving more quickly between the floor and middle levels. And I wondered what you were thinking about at that point in time? Can you remember?"</i> Participant 12: Yeah, it was probably, like previously, at one point I thought drop your attention from the thing, go into your habitual movement more and see how
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	Sliding backwards, roll up and contracting into centre and arms and leg flex and stretch. Stretched R arm and then repeat of stroking body to the floor, then roll onto the back and turn to the knees. Rocking back and forth on the feet. Weight of the head eventually coming into the rocking. Slower and more considered. Hanging over the feet, rolling up from the side. Throwing R arm away. Bent knees turn on the spot with both arms out to the side. Hands reach, change directions. The hands take weight on the floor and the feet side shuffle along floor and come up to standing, there is a change of direction and then arms wrap around the body and quick reverse turn. Feet now initiate and slide through and then weight is sent back up and standing. Series of side steps and then head initiates and sends weight down to the ground. Roll and then arms windmill backwards. Change dynamically: quicker and free flow. Shifting and sliding along the floor. Arms extend quickly into a V shape.	noticeable the thing is. And again, it's less noticeable, I still noticed it though, but with this one I didn't. But I thought I would switch my attention, and see if it was still there, and it was. So, I think that was that moment." Participant 12: Yeah, I was definitely less aware of space around me. <i>KR: Why do you think that might have been?</i> Participant 12: Because I think when you focus on your periphery, you do tend to focus on points in space and they are away from you. This is more, it feels a bit more organic and its more anchored or I wasn't really thinking about my relation in the room." "I was thinking about how things travel through, rather than drawing something, just different ways of thinking about trajectory."
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	12 stands up, steps behind and the L arm initiates, she drops quickly to the floor, turn and arms frame head. Knee is sent up and over, crossing the other and this is repeated and then a turn and wrapping. Fast and heavy. Quick changes of direction on the floor, pushing from the hands and head is involved in the rebound. Back to standing and opening of the arms out. Pump box moved to the back: Rotation of shoulders and then this is brought into the back. Stepping in the space and turning, arms held with tension, flexed and to the sides. Slower and more sustained. Heavy heeled steps, hand over L eye and hand flourishes (flicking wrists) above head repeated. Quicker speed, and heavier, more bound energy. Arms throw around extended in space, dropped weight from head initiation. Then elbows ripple in towards body. Arms are carefully placed hugging upper body and then around the head in stepping action. Stillness. Arms extended to the ground and body pitched forward. Head tips towards stage right and R arm extends up towards the ceiling. Pause and then more sustained movement	
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	Plie in 4th position and body folded over towards thighs. Then reversed back bend with focus towards ceiling. Sharp turn of the head. Hand flicks (change the light bulb motion) and heel stamps. Spiral with upper body and arm continues to unwrap. Change in speed, quick and sharp. Extended leg line to second, and then extended in arabesque attitude in crosse position and stepping onto back foot, foot reverse développé and then foot to knee. 12 spirals around and then reversed spiral, stepping around into turn.	
Improvisation with vibration prototype	With two bracelets: Participant 12 rolls down and stretching out arms, rolls up through spine. Both arms stretch up and gently make way to side, the wrists come close to ear and body moves to lower level on the floor. Arm gestures opening out and coming back nearer to the body, Folding in and out from the wrists. She turns, drops to the floor, and slides through to pause. Sudden break from sustained dynamic. Unfolding and leaning on arms	"Then I was noticing the dynamic of it being quite relaxing and mesmeric, a bit floating... and the sound it's the repetition and the predictability, that kind of lulls you into a calm state" "I realised that was influencing what I was and what I didn't do. I normally would be slithering or using the floor a lot more than I was, as a habit. You just get stuck on the floor." "I was using much more with the space in front than the space behind me."

12 Stretches with arms, pauses and then movement initiation. From leg and ripple through, turning to floor. Spatially moving in and out of the floor. Dynamic change to quick and light. Sweeping legs into the body on the floor. Pause to straighten the arms, resting in a lower V shape. Pause. Weight into arms to standing. Weight drops down and then calm recovery. Arms framing head and carving out the space, like a series of port de bras with spirals and changes of direction. Transference of weight between legs through stepping pattern and then sudden drops of weight into the floor. Head down and then a slide backwards on the floor. L forearm on the floor and sticking. Stillness, sitting. R arm pulls the body to standing. Stop, start quality. Elbows cut into the centre, one at a time and this initiates a turn. Weight of the head pulling the body down, rebound. Arms wrap around head, then torso contracts pulling the body backwards. Arm gestures scooping behind, coming into shoulders. Winding up and down (into the floor and back to standing). R arm flickering and scooping past head taking 12 into a turn. Two quicker turns on the spot and a slap of the hands at the side of the body. Wrists lead the movement, opening of arms and then	"Mmmm, they were less there. My habit would be to be unpredictable with time, and having this regular thing, flattened it out a bit" <i>After watching some video footage:</i> "It's calmer than I would normally be." "A softer dynamic than my habitual way of moving. I'm not moving my ribs much. Its blocked here a bit [Participant 12 recovering from surgery around the abdomen]. It's got the feeling of listening to something. That was the sensation I had when doing it, that paying attention. You can hear it as well..." "If I switch into my more regular timing, focus and dynamics, I do lose the connection to that... its somehow much less. It's quite a subtle thing." "I think the technology keeps me more thinking about that, like I didn't go off on a tangent. So much as I normally do, like a random thought, it kept me more connected to points in space. Where that part of my body was in relation to me. I'd say it was more focused in that way."
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	turn and extending R arm. Open and then scoop. Head initiates movement down to the floor. Leg extends and leads the body forward into a backbend. Arms swing round and round. Sitting, kneeling, arms floating. Dropped weight into the floor, grand plié, then épaulement of arms. Head initiated through spine and takes weight backwards. Moments of pause and then quick weighted movements. She turns, opening arms and legs. Leg initiates and flicks behind and in towards body. Placing the forearm in space in front and to sides of the body, then weighted swing of arms. Step and transferring weight. Greater use of weighted and bound movements. Lying on the floor, coming up to kneeling and then shifting to standing. R shoulder rolls forward and then is caught by the left leg coming up and over. Shoulder initiated ripple through to leg gesture, small jump changing direction, sidestep dropping body weight to the floor. Head brings the body back up, quick changes going from middle to low level. Arms extending and contracting but not leading the	"I think I was placing more emphasis on it being closer to me. It didn't make me want to move in a way where I was putting it far away." <i>When Participant 12 finished improvising she said that the legs became secondary.</i> "Yeah, so I swapped thing and the movement from my hands I will only do with my feet, I will try and subvert it. Then only move when it vibrates and then I was like this arm is lost [indicates right arm], as that arm [left arm] is just there but ..." "The left [10 loop] is quite calming and that was quite influential at the beginning and then it became annoying. I thought I could go into a zone with it, which would one thing to do, but then of course you can try to ignore it, switch it off. Then I tried to do an arbitrary task on top of this, a standard arbitrary task. But then this became redundant, I didn't notice or think about it."
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	movement. Quicker pace, lighter, shifting from one thing to the next With one bracelet: L arm circling and moving in towards the body and away in gentle motions leading the rest of the body to shift weight onto different legs and face different directions. Gentle, sustained and then suddenly changes of weight, but not very heavy. Head initiates and pulls body backwards, so it concaves and then she turns to face the L side of studio. Elbows move and frame face with forearms and the foot initiates a flex into a lunge. Spirals leading into reverse turn and sweeps of the space with arms. Sweeping arms lead into next transference of weight, in and out of the floor. She sweeps L arm and extends up and drops to the floor (like a full plie). Then the arm pushes through space and body follows in turn. Head drops and out into a plank. She walks hands back into side lunges (both sides). Right arm swings and shifts the body direction. Head drops and body twists and arms frame the head. Freer energy, and transferring weight into next movement with more forceful gestures.	
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	Legs initiate, pushing out, rond de jambe and stepping over in close contact with floor. The sense that the arms are naturally following the legs and body at this point. Rolling on the floor, peeling off the floor. Sliding, swapping. Pushing the L arm into the floor, slapping it on the side of the body. Moving to standing. Flinging the arm away, then holding the arms, braced and weighted. Chasse and side steps. Pausing and waiting with arms up. More fragmented and stop-start quality. Rotating the neck and bringing this into upper spine. This becomes more exaggerated and weightier; whole arms behind and rotate and then she flings the body and head down towards her legs and floor. Chest expands and contracts and make arms go in and out quickly. This starts slow and speeds up and repeats. Weight drops with bend and recovery, then slow roll on the floor. As the body goes back to middle level there is a reaching and replacing behind the body. Then placing hands on floor and then framing the head as there is a return to standing. She leans back and leg gesture.	
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Combination of both prototypes together	Right hand to forehead (palm facing outwards), then curve forward and she slid L hand along L thigh. Head to ceiling and slight back bend. Both hands meet at head and then twist to L as the back comes upright. She steps through, and arms move to mid-level in spiral to right. Stepping back to L and high extension of back as arm circles and forward into open 4th demi plié and then parallel position. Knee where wrist is (replacement in space) Hand where knee was, (replacement in space). Then tremor of L hand	<i>“KR: Was that any different for when you had both together?”</i> Participant 12: Yes, because you then have this peripheral information that makes the gestural part of that material and makes it more connected. Foremost, it wasn’t an embellishment of something else, if you know what I mean, it was the thing.” “The primary- that’s what I was looking for. The primary impetus was more than the arm gesture and the secondary was much more the central bit- on that second bit of material.”
Structuring phrase (with pump)	Step forward, hands layer one over the other and slide off, step behind and one leg turn. R Leg sweeps in front of L and then balances and lunges out, placed down then again heel heavy into the floor in turnout. Turn on the spot and upper body spirals around. Parallel bend and upper body curves over, right arm reaches to floor, then left. Right foot steps behind and replaces L, a curve-L arm curving over the body. Turn on the spot. Head initiates body ripple and then hands push down in front of the body.	<i>“KR: What did you notice about using the technology to set material?”</i> Participant 12: I found it answered the question of what next, because there was always this reminder of what could move next. I started with the jellyfish and that was all very talking through that area. I ended up with arm gestures layered on it a bit. Yeah, I suppose it gave an impetus for the starting point, for the origination of the

		movement which you could then embellish. Which is what I ended up doing really, in the first bit of material.”
Editing		
Internal and External experiences	Participant 12 talks about why she wasn’t really considering the external space relationship during improvising with the pump: “Because I think when you focus on your periphery, you do tend to focus on points in space and they are away from you. This is more, it feels a bit more organic and its more anchored or I wasn’t really thinking about my relation in the room.” “I was thinking about how things travel through, rather than drawing something, just different ways of thinking about trajectory.” Perhaps it is a change in locus or different trajectory that influences the use of movement and space? In essence we are seeing ourselves sculpting space and energy beyond or bodily limits of skin, therefore does the pump shift those boundaries? Or reinforce those boundaries? Or giving a change of perspective on those boundaries (like when you shade something in - visually you see things differently in contrast)? “Then I was noticing the dynamic of it being quite relaxing and mesmeric, a bit floating... and the sound it’s the repetition and the predictability, that kind of lulls you into a calm state” (taking about the vibration prototype). “I think the technology keeps me more thinking about that, like I didn’t go off on a tangent. So much as I normally do, like a random thought, it kept me more connected to points in space. Where that part of my body was in relation to me. I’d say it was more focused in that way.” Again, this point considers the changing relationship to space, but this time the body part in space and a reminder of where that part was in moving and its relation to the rest of the body. “It’s got the feeling of listening to something. That was the sensation I had when doing it, that paying attention. You can hear it as well...” [both vibration prototypes in improvisation]. When we listen in a normal context, what do we do with the rest of the body? Do we always stop to listen? We certainly can move and listen, but perhaps its more tentatively? This needs more consideration.	

Influences from social cultural background	In both instances Participant 12 discusses the prototype experience to different methods that she experienced in her training (Flying Low, Points in Space and Body-Mind Centering). This in part could be to relate to what is happening and a means to explain it to the researcher. How do these other means of exploring movement relate to digital touch stimuli? Participant 12 didn't talk about habitual movement from a negative perspective but discussed her usual way of moving. The main point of discussion was the "flattening out" relating to pace and speed, but also the quality. How is predictability and looping viewed aesthetically or in western culture? Binaries are used all the time to describe or categorise, but monotony is seen to be a negative thing. The participant also employed different rule-based tasks to work with the stimuli: "Yeah so I swapped thing and the movement from my hands I will only do with my feet; I will try and subvert it." This relates to playing with the prototype, seeing the boundaries of how it can be used. <i>KR: What did you notice about using the technology to set material?</i> Participant 12: "I found it answered the question of what next, because there was always this reminder of what could move next. I started with the jellyfish [silicone part of the pump prototype] and that was all very talking through that area. I ended up with arm gestures layered on it a bit. Yeah, I suppose it gave an impetus for the starting point, for the origination of the movement which you could then embellish..." Is the stimulus about being spoon fed? It always gives you a "what next", whereas other forms of stimuli in the creative context could be seen to be more open and divergent? Afterall, many resources have different layers and possibilities relating to how they can be used and abstracted, rather than the most obvious and literal use?
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Participant 13	Extracts of Movement analysis	Interview Data
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Improvisation with pump prototype	Pump and glasses Participant 13 faces downstage and both hands come up towards specs and his fingers flicker. He walks around to face upstage. He looks up to the ceiling and back down, several times and walks back to face downstage. Then the movements change in the use of the hands, the palms change so that palms are facing the body, reaching to the ceiling, then there is an undulation in the hips and this travels to the arms and they unfold round each other and down. The fingers then flicker again, the legs are in wide second and body is hunched over, arms then weave out and then there is a change and the body hunched and arms come back to the centre. Hands lead the focus again; a one leg turn and then this claw arm coming back in framing the face. Fingers flicker and arms and body weaves from side to side, with an undulation. Then down to kneeling facing upstage. The right leg is outstretched on the floor. This wraps around other leg x 2 and then a kick to the side a back (leg beneath shifts along the floor) Then there is wrap of leg and turn to floor, sitting cross legged. The hands rotate inwards towards the body several times, and then NG rolls backwards onto the upper back and pushes the hips up and down, the R leg is extended away and then the arms	“...otherwise you are spending too much time looking out, feeling out and listening out for it. Which gets in the way of the actual feeling the improvisation and the thought comes into it. “When’s it coming, or when’s it happening?” It can make dance a very intellectualised experience.” Participant 13: I think when I improvise its normally at a faster pace than I have done here, and so in order for me to connect with it, I have to slow my improv down, I have to slow my movement down. Participant 13: No, it’s just interrupting. It’s just interrupting, and your attention is always drawn to the wearable, whereas when you are doing stuff in an imaginative way, you literally just have your body, so you can flow at any point and attention can flow. Whereas here, I felt like it was always tethered to my wrist or tethered to my waist.
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	go. Back to the rotating motion. Flickering of hands in front of glasses, then hands come to right knee and Participant 13 sits up. He plays with arm leg relationships, straightening and bending, pushing straight and then back to flickering hands. Participant 13 leans on L hand and the legs switch back and forth on the floor, changing which is in front. Then he rolls round up onto upper back (shoulder stand). He then rolls over the head and holds L foot with r hand. Puts it down hand on the heel. He comes onto the balls of the feet (almost like a kneel and grand plié in 5th) facing upstage L corner. He falls to the R and puts his head on the floor and hands. He then extends L leg and hand (adapted headstand). He brings his body and legs back down to the floor and grabs his L leg behind the body and then let's go and looks up. Forearms are placed heavily on the floor, one at a time. Weighted and bound. You hear the body parts placed heavily on the floor. In a tabletop position, the undulations are through the spine, sending a ripple. Through the centre and up through the head. The left arm is not weight bearing and moves with the body action. Hips come up to the ceiling and legs slide out and Participant 13 places the weight into the heels and stands up.	
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	He stands facing upstage and his hands are placed together near the electronics box. He spirals side to side and then ripples from the back down into the hips which then go side to side. Arms go wide to the side and then come to closed parallel facing downstage and then arms frame the heads and facing changes to the upstage. Stepping around stage R, the forearms slide along one another and there seems to be the arms initiating a circle over the head and into a stepping turn (on the spot), the arms keep the momentum of the circle going. Then a step around and gesturing the bent leg up (R) then again with the L leg up. This circular motion goes into the whole of the back and then the same step turn anticlockwise. The R leg lunges out the arms go wide to the side. The L arm bends and sweeps across the eyes and then the right. This moves into a step $\frac{1}{4}$ turn clockwise. The arms go a similar gesture again. The R arm leads the focus of the head and the focus go up and then out in front of the body, Participant 13 steps with R leg. The R arm leads the head around and up and down. The Right hand goes into a vertical clap, which gets bigger and bigger. The L leg lifts up and there is a slight back bend and then closed in parallel facing upstage. Arms are opened to the side (forearms parallel) and down and back towards the body. Arms unfold in front of the body (shoulder height) and fingers are splayed. This fingers and palms come towards the chest and arm pump in and out. Step foot over, turn, and R arm shoots up to the ceiling extended.	
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	Hips side to side R hand connected to R knee. This then is explored on the other side and with stepping turn and then stepping turn and hop. Hips isolate forward and back quickly. Then rotation of hips, like hula hoop action, the lift of the knee comes into the action and becomes a bit like an Elvis move. Then this moves over the top of the L foot and takes the body down to the floor (over the leg) Push into the arms (like a press up), then rebound up, these repeat and then an extension of the R arm gets layered into this sequence and it repeats another 4 times. The arm then slides across, at shoulder height and drops to the floor. He holds onto the tech with his hands and then rotates the head.	
Improvisation with vibration prototype	Improvising with 1 bracelet (10 loop) Participant 13 brings r elbow up and in towards the body. Then he shifts his weight to the L foot and drops his torso towards the floor, but his r arm remains up on a middle level. He drops his hips into a squatting position. Arms cross at the forearm and then wrap around each other. He rolls up through the spine, head coming last. The R arm ripples, this then moves through the elbow into the whole arm, which he then takes into the L arm and elbow. His direction moves towards the upstage L corner,	"I think in terms of actual movement generation it definitely opened up some new pathways. In terms of ways in which my body would not normally typically move. Or in terms of sequencing, my body wouldn't naturally want to go to. It disrupted that" "I think one of the things that was tricky was the fact that it's very localised, so because the vibration is really localised your attention is fragmented. So, it interrupts

	standing he make the gestures smaller with the arms and plays with the relationship of the forearm, trying parallel arms, then on a right angle. This again goes through the torso, to the other arm. The legs shift around and move him round in a clockwise direction. The arms both rise and fall forward, like a wave and then Participant 13 brings the wrist close to the ear. Then both arms beat slowly like wings, as he transfers weight forward and back on the R leg. The legs and arms invert and then open out, then the right-side scoops in with the arm and sending a wave through the body and back gain from L to R. Smooth and continuous movement. Participant 13 starts bring in a pop into the transference of weight into the leg, almost like a full stop to the ripple. This continues, but the focus goes back to arms which become more fluid again, and through the body into the L leg and then reversing of the ripple. A turn on the spot, pushing round and the arm wraps over the head. Participant 13 lifts R and then L elbows and ripples through body (facing upstage). R hand takes him on ½ turn clockwise and then body is forward, there is softer popping in this section. Leg picks up and take him back to face upstage. The arms are constantly moving then are wrapping and juddering up, crossing. There is a same circular ½ turn, back and forth. The pace quickens.	flow. So the feeling you would normally get when you freestyle or improvise is very much interrupted.” “I think the more I went... the more I flowed with it, the easier it became. I think it would take a hell of a lot of practice with it to become an unconscious experience. Because as well you start pre-empting stuff. So, then the funny thing is you start to pre-empt stuff and then when it doesn’t come the way you expect it, your movement is interrupted, and the aesthetic that you wanted to get doesn’t quite get executed in the way that you envisage it to.” “I found out that when you do quicker movement that the vibrations get lost. So, I feel the interruption, it’s at its most effective the slower you go with your movement basically.” “To be honest the slowing down process was key because that was what led to more options. There were some movements I amplified more. You know when I did feel a vibration, I would go with it and that did lead my body into... um I guess, non-typical positions my body wouldn’t usually get into. So that definitely led to me exploring my movement in a different way. It was funny,
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He stands in a 2nd position and moves on a vertical axis. The arms are like a cross, and they move with the body up, around, and down and around. Then the elbows move to the side and swap, it becomes more angular and locking the joints (but not with force, everything is soft), then this leads the L hand to the ground. Both forearms are placed and replace each other, these building blocks of movement bring the body up and to a turn on the spot. The arms are on the horizontal plane, like there is a tabletop. Back to more popping moves with the legs, and flow in between, sometimes inverse, and outwards with the legs. There is more reaching in the periphery, but always folding back to the body and then out again. The R arm is always initiating. The movements become a bit more juddery. He is facing the upstage R corner, his upper body is curved, and he repeats a movement with his R arm, it judders at the hand, hinged at the elbow is scoops forward and swings back. This movement goes back into the cross shape with arms and movement (up, around, down etc) from before. The movement is amplified and moves more into the back, so has a curve forward and back this time. Participant 13 changes direction to stage R and moves backwards and forwards, there is a turn and still lead by the arms replacing each other in space. He curves over to upstage and the right elbow juts, wraps and presses against and around the head. Focus is up momentarily and then the forehead is back on the	it naturally made me call upon my Kung Fu and Tai Chi repertoire. “ With music “The second time around, the vibration it was more regular and balanced, I was able to become a bit more in the flow, so that helped it. Yeah, I found with the wrist straps on, my lower body became secondary.” “If I wanted to respond deeply to the tech, I had to really slow down and really tune in. It was weird because it was taking me out of my bodily experience and I almost trying to tune into and get inside a piece of tech, rather than inside of my own body.” “The vibration was good in giving you an impetus to move a body part in a different position that it would normally go into. Um, so within that, that one was almost like a prompts or cues for movement.” “It makes you more aware of the forces applied externally to the body.” [talking about both prototypes]
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	wrist. This leads the head to move in different directions. The shoulders and staggered contraction into the torso, which then leads back into flow and ripples of the arms. Step out and across, on middle level, judder and drop in height through bent knees, L arm in front gesturing like something is being mixed. The bigger movements in the judder movement back and head forward over the legs, then R leg is lifted with bent knee and then a big step to stage R. The movement become more locking, wrist rotate and then lock forward and then again behind. Knee comes up on right angle and placed down. Then there is a flicker of the R finger up to the ceiling. Points, unfolding of the arms in front of the body, steps across. 'Guns' pose and then lock down, ripple through the body and knee lift, hop. Back to pointing, rotating of wrists and locking. Participant 13 faces upstage L corner and holds hands together and just moves the torso and legs, so it shifts from side to side, moving the body up and down. This the goes into the elbows. The arms rotate and lock up, then this is repeated behind, then to close with arms extended at the front, palms together. Knee comes up and replaces with the other, knee and a jump to the other leg, leg gestures out to the R side and like a pendulum, swings through.	
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	Then he goes back through some of the moves with the, pointing, rotating, and locking elbows and wrists, with different pauses and emphasis. He also brings back the snap – like crocodile jaws with arms. He walks towards upstage R corner, with bend knees (funk), pumping the arm out. Then round in a small circular pathway and then he grabs hold of the r ankle. Then he repeats a movement of grasps the ankle and then drop down with R hand on top of the head. Pointing, arms rotating and locking. Legs in a pendulum and jump. Windmill arms and turn, facing downstage. Shoulder shimmy, up and down facing stage R. This becomes more into the torso and a step forward, continuing the shimmy. Then the arm rotates down and lock and various combinations of this and point. Then there is a juddery movement with the elbows, out to the side and dropping on knees down. Mini movement of the wrist (R) rotating round and forward and then back, this is located over the head and back. Then both wrists. Improvising with two bracelets:	
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	Participant 13 starts facing stage L in the upstage. His left arm feeds through the gap (he is ½ kneeling) and then his R hand flickers and then wraps around the head. It's like he is scooping space with his arms, and this is shifting him round in a circle on himself. His R arm is swimming up and then more scooping gestures and inter-dispersed with angular movements of the L arm. The facing changes to upstage and then stage right, there is a repeat of the swimming/flicking hand gesture and then stirring the pot gesture. Cross with forearms and replace, angular movements. Straight right arm swings down to the floor and to the side. L leg moves, so he is facing downstage. The R elbow up and left arm straight, a bit like holding a bow and arrow. Steady pace, most of the time on one level (middle) His leg pushes him around to upstage and he is crouched over – L arm is underneath the other leg. R arm swims/flickers. Head focus goes up and its like it is being pushed down by the hand. Then both arms go to the side of the body. R arm higher than the L. Then they both scoop under and brings 13 to standing. Then a reach out with the L arm and turn, forearms parallel and then flicker behind with right and ripple through the body. Big dive ripple down with the body and up, weight transfers into the L	
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	(side lunge), arms on a table plane. Step back and body is sent down to the legs and back up (rotation). Threading the needle arm gestures, body rotates down to the legs and back up gain. Participant 13 steps back and bigger side steps, again use of archer arm. Then more isolated movement knee bend, angular arms actions. Then he hunches and it's like he is in a smaller space, like a box, trying to get out. L hand is placed on the chin. Then more flow through the arms and the energy changes to turns on the spot, the R arm flicking out and then coming to join back in (kathak movement) -quicker turns. The hands scoop back, but they become bit harder and faster, clapping and slapping as they come back to the body or other arm. Back bend (focus at the hands framing him) and then a drop of the knees to the floor. R forearm changes front and up and on the head, adjusting to low level. Then headstand, with opposite arm to leg gesturing. Body rolls to the floor and he grabs L leg with L arm and the weight of that flops him downstage. Then he crosses the legs at the knees and grabs foot and should stand threading the other leg through. (Break dancing). Participant 13 rolls on his stomach, pushing /walking legs backwards, taking him round in a circle on the floor. Then a push into a shoulder stand facing upstage. He repeats this x 3 and then on the third this pushes his body to face downstage.	
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	Then into cross legged position facing stage R, both arms rise up and down, with juddery palms. A roll on the back takes him to the same sitting position facing stage L. The upper body swings from side to side, palms are up by the face. He rolls on his back to kneeling upstage. Bound and angular. Head is in the crease of the R elbow and then angular movements with arms. Then it's like his head is attached to the L hand and there is pushing down and rising head repeated. Palm to forehead – arms slap and the right arm wraps around the head. R arm swings to the side and then almost a cartwheel to stand up. Then a turn down to the floor. Heavy, bound. Weight in balls of feet, crossed legs. Torso curved over. Then head lifts up and looks at the R hand and the L hand is weight bearing too, as he leans and look up. The hands shake, and as the leg extends along the floor and back to cross underneath, it looks almost attached to the hand. Participant 13 then does a break dance move, where the hips twist to side back and knee flicks out x2. Quick movement in flick and back to steady pace. Then he pushes the hips up and heels down and has arms crossed and the hands are attached to the opposite knees, so the actions look restrictive- like he is tied up (facing upstage). The facing changes to stage L and he grabs the back leg, kneeling and it's a rocking motion; forward and back. Then turn to upstage R	
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	corner and then a return to standing with the R wrist attached to the forehead. He steps to stage L in an arabesque, standing on his R leg and R arm is still stuck to the forehead. He rocks back to both legs and winds down to the floor, with his R wrist and head leading the curved, sway from side to side. He crawls upstage with the same relationship with arm and head. Then the L leg is thrown behind. Participant 13 walks backwards but adds the connection of the L knee to the R wrist and forehead (bound). He slaps the right arm away from head, it returns, but then he replaces the arm, with geometric gestures and turns to downstage. Arms outstretch to the side and then the forearms layer, and slide on top of one another, they meet and fold out. The hands flicker to the ceiling. Contained, more kinesphere reach but still not using much general space. He holds up both wrists up either side of his head, they drop down and return several times, as there are shifts in direction. Then there is side to side action of the same arm position (almost like beating a drum). The this goes into rotation of the wrists and then point. Change in energy and bit looser. Two bracelets and music – Participant 13 wanting to focus on popping and locking (KR is sat out)	
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	Popping and locking- quick changes which reflect the speed of the music. Changing between bound and free flow as expected in popping and locking. Mostly on a middle level with some on the floor kneeling. Locking of elbows (r, then l) and wrists, step across L leg and then back chest down and then twist to the side. L arm frames face and goes around head and then out to the side, leg to variation of moon walk around on spot to face downstage. Arms go out to the side and L arm goes up and down and then L foot steps across and back to the side. Arms alternate up and down gestures and weight transfers underneath the body, with gesturing leg coordinating with arms. Stepping and then arms make movements into space and then over head with a ripple This goes into a popping section facing stage L. The hands are carving out space, but it is a small to medium kinesphere reach, so quite underneath himself. Hands are placed behind head and then on the knee, and this initiates the next move, down to a small lunge. Forearms and into the back continue to constantly react, placing in different positions in space. Then the L leg comes to kneeling and the R leg	
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	slots out to the other lunge. The R arm is placed through the legs. The R leg shoots out to the side, hand goes on the knee and it's like a winding gesture with R hand. The left hand takes the lead and then a ripple through the body. To the other side, R arm wraps around overhead. The upper body pumps forward in a pop, this is repeated and Participant 13 steps up to standing. The moonwalk sliding steps take Participant 13 around in a turn on himself. The elbows come up and hands to the head bringing the body forward. Then he changes his hips and comes up the other side. Elbows shoot out and he steps backwards and the arms unfold forward and out to the side. R arm pumps up and down. Then left initiates and places arm and then it moves the feet around and the facing downstage. R leg steps across and back and then the knees move from side to side. This moves into a small jump side to side. R knee goes in and out. L arm goes across the body and then popping of the arms and torso. The arms curve over, and the knees bend and it's like a series of small curves and waves. Then the arms move into locking, and it becomes more geometric (on the spot, facing downstage, transferring weight between legs). L arm comes up and pushes down and across the body, this is then repeated on the other arm. Legs rotate out into wide second and then both arm gesture out and then a lean of the body to the left and arms ripple. Step anticlockwise $\frac{1}{4}$ turn and arms come in front of the head in. parallel. They bring the head down and 13 steps back and R leg	
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	comes up (right angle). Arms extend up and out to the side. Arms weave in towards the body and then 13 pushes them down to the hips and this initiates a body ripple. This exploration continues facing the upstage L corner and the arms ripple and then the body slumps and knees knock together. There is a further play with each arm and ripples through the body. The L arm leads and does a wind-up finger point and stepping across and further ripples through the body, ball of the feet walks and then drop of the weight with bent legs, shifting from side to side. More locking, and angular in this section. Change of music. Elbows initiate, R and then L, then lean to the L, knees bend, and the weight drops in stages. R hand pushes face across to the left. Parallel arms and geometric shapes and weaves of layering arms bring body to normal middle level. Hands come up like they are grabbing onto something. Then R leg swings through and stops at R angle. Step out to L side, facing downstage. Elbows go out and ripple through the back. Weight into L leg and twisted towards ceiling. Hands do little circles out away from the body. Then both pretend to grab up to the ceiling and pull the body up. L arm wiggles out to the left and then he threads the R to meet it, facing stage L. Arms meet in a reverse bra barre position and they spiral the torso back and forth and then ¼ turn to downstage. Kick out, then moves into the R foot wrapping around behind the back of the L knee and twist at the waist. Step out the R and different flickers and grabs of the hands,	
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	punctuating the beats in the music. There is a lean into the left side and then arms take the body up and over. The hands cross at the wrists and there is flapping up and down which coincides with the walk forward and gesturing of legs out. The right arm leads the movement down to the ground the shoulder roll forward. L leg held by toe (b-boy moves) and then brought behind (almost like a quad stretch), then brought in. front as the back lowers to the floor. R leg is fed over the top and the body rocks to upright. The R elbow pumps up and down. Then Participant 13 does a reverse roll (backwards shoulder roll) into a shoulder stand/freeze. He pushes into his L hand on the floor and judders his arm. His R arm flickers up and then both forearms hard into the floor. He plays with palms together and isolated movement of the hands. Next track of music comes on. R wrist rotates, round and round. This goes into a step forward and step back. The L wrist does this and the extends the whole arm out and the R does this same with a point of the finger. This is repeated with the addition of the leg bent and knee gestured. Feet come together closed and ripple through the body. Shoulder shrug isolations, then 2 x more points and roll wrists and close at the back and roll and clap in front of the body.	
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	Step out to face stage right, with variations of roll of wrists and extensions of arm. One arm at a time and then little kick, scoop, hop underneath the body. L arm sweeps across the body figure of 8 and then kneeling to the floor. Wrist action with R hand: rolling and point, rolling and in, this is repeated with hip rocks back and forth. Geometric shapes, and more robotic moves to standing upright. Pointing fingers to the side and then forearms back, box shape which shifts as 13 walks backwards. Horizontal parallel arms, open and close and send the head backwards. Then the arms weave and in and out of each other and then open forward and down, in front of the body. The body pitches forward, elbows held up behind body and slow walks forward. This then turns into backwards walks led by the hands which are waving from side to side and this motion travels into the back. There is a lunge on the L leg, step behind and the this is taken into a turn to the floor. Participant 13 plays with weight into L forearm and elbow, a shoulder stand, with foot hold and then comes down to face downstage L corner in cross legs. Arms and legs work in unison and go out into second on the floor and back together. The R hand pushes the L. knee to the floor, crawling of fingers along the floor and then up the r arm by left hand.	
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	2 x shoulder stands, with the last experimenting with one leg bent and coming in towards the body and out again. L hand connect to left foot and different positions. Next track of music comes on. The music is bouncier, and the movement reflects this. Participant 13 rolls around upper back (half circle and sweep round- b-boy move). He stands up. Popping moves in chest and through ribcage. The rotated wrists come back in, then move into elbows tucking into the body, up and down. As he steps towards upstage (facing stage R) There is a walk back to the left, but it's more a reaction of different body parts (elbows, head, torso, knees etc). Matrix backbend around. Stepping across to the L and almost a grab and pull of the arms moving the body and legs downstage. Step half turn to face stage L. Gestures of hands including L arm rotating behind, pushing the chest over R leg (ball of foot). R finger winds downwards and then ripple bringing the centre of gravity down. Leaning to the stage R and facing upstage R corner, Participant 13's hands come to the floor, they replace the other and wrap around the legs, they take the weight, and the legs swing behind (b-boy move), then half turn on toes, weight drops into L hand and wraps and flicks of legs, cossacks, then turn and shoulder roll. Foot hold and then walking on the side around in a big circle.	
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	Crawling fingers, then rock backwards and come up in half splits, six step around on floor, then shoulder stand on r shoulder. Free arm and leg gestures, then a roll out of it upstage to on the back. Participant 13 plays with hands bound, moving in unison in front of the body. Backwards roll to stand up. Wave through the arm. Leg bend and weight drops down. Step turn to stage L. Elbows take in turn to gesture and see-saw the body slightly. Elbows pump up and down as he walks upstage. More geometric framing with the arms. R arm sends ripple through the body and then L takes over and directs the head up and down. The L arm comes up and over slowly and then Participant 13 goes onto hands and one-handed helicopter (b-boy move) then a barrel jump. Pirouette, then freeze L arm down, R leg out and up. Back down to floor. Step down to floor and swap legs, then shoulder stand, legs swap back and forth. Participant 13 comes back to kneeling, and the ripple through the back, L arm and left leg grab. The grab with opposite arm to leg, turn from the floor to standing. R arm unfolds and then there is a series of tapping different body parts and stepping back down to the floor. Lunge R leg and L foot tucks into the knee. Changing weight to different hands and turning to face downstage. Weight into L elbow and r arm framing the head. Participant 13 with 2 x bracelets, by himself and trying breaking moves with music, improvisation	Participant 13: "It felt like, rather than be a slave to waiting for this vibration, I was able to choose more...it was part of what I was doing...I could tune in or out, if it's not what I'm looking for. For my style of movement and how I free-style that was much more comfortable. I sort of created new movement pathways that I don't normally do."
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	Step, tap in front and side steps in different directions, then cross leg turn on the spot. This continues roughly in a clockwise circular pathway. Then one arm handstand with R arm and then back to standing. Walking and jogging round the circle. These movements start getting bigger and using more space and quicker pace. Step, tap in front and step tap to the side and shift weight, turns on the spot. L knee gestured up (right angle). Step back. Torso spirals to the left and right and down towards thighs- bent over and another leg gesture with R leg. The body comes upright, and arms are in parallel at head height. 2 x big jumps moving diagonally backwards (facing downstage L). Bouncier in quality. Step, tap in front and step tap to the side and shift weight, Turning with change of leg down to the floor. R leg sweeps to join both legs together, hips lift x 2 (in time with music) and r leg shoots out, weight in R arm (breaking move). L arm is extended to the ceiling, then it flickers down and Participant 13 lowers body down to the floor. R leg flicks out and in and then Participant 13 comes up to kneeling and then into 6 step around on feet and hands. Frenetic, flicks of hands and legs.	Participant 13 said that “it was only when I really physically stopped or really slowed down that I could feel either.” “...having to slow down the movement with the popping, and with popping it is about slow mo and visualisation. And it led to coming up with new movements. “ “...you don’t have to disrupt the principles of the style, but you can find new movements within those.”
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	Head stand, Participant 13 changes legs, wrapping them into different shapes, he then takes R arm off floor, which shoots out to the side. Then initiates the ripple through the space into an almost martial art flat palm punch x 2 (both arms), then turn on balls of feet and Cossack move (kick r leg) and then ½ windmill legs. Roll on floor over stomach and then foot grab and free leg pushes through. Turn on both legs and push up through to one handstand and freeze (r arm supporting). Participant 13 recovers and R arm scoops through space taking him around in a stepping turn. Both arms come up to chest and then are pushed down and there is a ripple through the body then. Back down to the floor. Participant 13 swaps weight between arm and the legs kick out, changing which one is gesturing each time. The foot hold L arm and L leg. Turning on balls of feet and just arms windmill, till he is back facing stage L. Forearm stand, both legs join in parallel up to the ceiling. Then Participant 13's body comes up and L arm shoots straight to the ceiling (right arm tucked in but up to the ceiling too). Then elbows come out and martial palm hand punch x 2.	"Like with breaking, I mean, you can obviously do slow motion but because its high impact sprinting, again it would be trickier to freestyle using this, improvise using this, but it would be easier for popping." "If I put my hand, the weight in the floor, it gets lost, so then it is about the free hand" Then KR asks Participant 13 to explain what he was talking about in terms of bi-lateral movement. He explains that movements across the body (opposite arms to legs etc) improve the processing parts of your brain and keep it active.
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	Six step, swapping arm and hands, and then turning on balls of feet, weight into both hands and small freeze. Step through and into head stand, foot hold and then swapped legs then unassisted, no arms. Forearms come down and there is a shifting of how they are placed on the floor. Jump with wide legs and then in together.	
Combination of both prototypes together		
Structuring phrase		
Editing	Participant 13 puts specs on with the pump prototype. He has music on while he is adapting the phrase. This is movement analysis of his final adapted movement phrase. Left foot (flexed) steps across body. R elbow comes up and R hand near ear. Step L leg out to the L side and curve back over R leg. L arm down in front of the body. Turn body to other side and transfer weight. R Hand in front of body bounces up and down.	"...again, when I did my choreography at speed, the sensation was just lost, but I do think it was a really good choreographic device when you have created a sequence, going through each thing slowly and what can be developed from there. Because the phrase I created was very different, but similar at the same time. It had a similar structure, but the movement qualities were very different. It also meant that, I chose not to go on the floor, I found a representation of the floor work that I was doing, which was nice, and it looked better in the

	Body comes upright, left hand to right elbow (backwards L shape), R leg steps forward. Then both legs together, closed parallel. Elbows bent, palms facing the ceiling. Step backwards slump forward with the body, feet in a wider parallel, arms come down, palms towards hips. ½ turn to stage R, legs and then body follows. Head sharp to the upstage. Repeat actions again going clockwise. Slump forward with the body. There is an element of more punctuated movement, with a bounce. Step legs out wide parallel (change of facing to downstage) position. R arm on top of the L shoulder height in front of the body. Both arms straighten to the side. Windmill arms, two full circles of the arms and then kick, right leg sweeps up and out. L arm comes to meet gesturing leg and opens out. Hips change to face stage R, R hand goes to forehead and L leg gestures with bent knee. Quick swap of leg- R leg comes up and R ankle rest on L knee. Arms wrap around body, holding round top of arms. Step, full turn and pop of chest, arms just in front in horizontal parallel.	end. So yeah, it is a worthwhile tool in terms of developing choreography. Participant 13: “I feel, within the way I utilised the inflatable stuff. I thought that was a stronger choreographic tool, but only because I had a chance to feel it with my fingertips, the aesthetic of it and feel the energy that goes through it. So then when it got applied to my body, I could utilise that information to infuse and use that as an impetus.”
Internal and External experiences	“... otherwise, you are spending too much time looking out, feeling out and listening out for it. Which gets in the way of the actual feeling the improvisation and the thought comes into it. “When’s it coming, or when’s it happening?” It can make dance a very intellectualised experience” [Participant 13 talking about improvisation with the pump prototype]. The reliance on paying attention to the external for Participant 13 made it difficult to pay attention to the feeling of the movement and	

	attention to aesthetic realisation of the movement. Participant 13 felt that he had to slow right down to maintain connection to the prototypes, and his usual speed of improvisation was affected. The feeling of the vibration prototype was preferred and seen a more positive light: “I think in terms of actual movement generation it definitely opened up some new pathways. In terms of ways in which my body would not normally typically move. Or in terms of sequencing, my body wouldn’t naturally want to go to. It disrupted that”. It could be the location of this prototype which made it easier to work with for Participant 13; allowing more freedom through it being located on the periphery. Despite the initial reservations, with further time using the prototypes Participant 13 became more accustomed to working with them: “the more I went... the more I flowed with it, the easier it became. I think it would take a hell of a lot of practice with it to become an unconscious experience. Because as well you start pre-empting stuff.” How do the vibration loops work? Projection of movement based on pre-emption, and then adaption or interruption, with a reaction? “...if I wanted to respond deeply to the tech, I had to really slow down and really tune in. It was weird because it was taking me out of my bodily experience and I almost trying to tune into and get inside a piece of tech, rather than inside of my own body.” This description of the vibration bracelets almost adds an added dimension to extended thinking or trying to merge machine and body. The pump and specs were used in the editing of an existing phrase and Participant 13 found more use for the prototype in this instance: “but I do think it was a really good choreographic device when you have created a sequence, going through each thing slowly and what can be developed from there... It had a similar structure, but the movement qualities were very different. It also meant that, I chose not to go on the floor, I found a representation of the floor work that I was doing.” In this way the slowly down to select, consider how and why was favoured. The slowness allowed for questions and space, rather than being a distraction.
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Influences from social cultural background	Participant 13: “To be honest the slowing down process was key because that was what led to more options. There were some movements I definitely amplified more. You know when I did feel a vibration, I would go with it and that did lead my body into um I guess, non-typical positions my body wouldn’t usually get into. So that definitely led to me exploring my movement in a different way. It was funny, it naturally made me call upon my Kung Fu and Tai Chi repertoire.” [vibration prototype]. The slowing down and perhaps the idea of ‘flow through’ [Participant 11] has references to previous experiences of movement with a slower pace and energy perhaps. “I had a chance to feel it with my fingertips, the aesthetic of it and feel the energy that goes through it. So then when it got applied to my body, I could utilise that information to infuse and use that as an impetus”. Participant 13 looked and felt the inflatable section of the prototype to fully understand what it was doing, adding a visual and tactile (more sensitive use of fingers) to gain an understanding, he said this helped him more, which supports the multimodality of the senses and the creative process.
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Participant 14 and 15	Extracts of Movement analysis	Interview Data
Improvisation with pump prototype	Pathway 70, using the pump prototype at the front of the body Pathway 70: Mindful Movement=7, 2nd Choice =4, Mindful Walking =4, 1st Choice contact= 6, Stillness 3 Mindful Movement Participant 14 starts facing upstage, legs wide, she rocks between legs and then brings forearms up and then elbows come closer to the ribs and she changes direction- facing the upstage R corner, with Left arm stretched out in front.	Pump at the front Participant 14: “You really need to stay with it in the ‘mindful moving’ to even be able to understand it. Or be able to take any position to it. I started off by somehow going off on my own journey, but somehow, I felt that I couldn’t be with anything I was doing, so I was like I will have to come back to this. Actually, the sensation of the breathing quality or pulling, I felt it was pulling in on my

	Participant 15 faces upstage to start. She steps back and r arm and l leg are raised up she steps back to parallel facing the stage R. and then turns to curve forward over the legs facing the window (stage L). Participant 14 steps down to the floor and changes her facing to back on the floor, facing the ceiling. She stays here paused. Her legs tip over to stage R. Participant 15 rolls up and steps back with R arm extended to the side. She bends both knees and curves forward again and shifts weight to the side in a stepping motion and comes to standing and R arm curves overhead. She steps forward towards stage R and then curves over. Participant 14 brings L leg up towards her chest and then opens to the left side, arms are held in front of the torso, then back to flat on her back. Participant 15 rolls down to the floor and on to her side and then rolls on her back – head is towards downstage. Arms are flat to the side and then she rolls to her right side and leaves the L leg behind the body and then it développés through. Participant 15 stretches her R arm and rolls on her front, then the other side and onto her back. She taps her R foot lightly on the floor and then she sits up in a 4th position, and then moves into a relaxed position (palms into floor, leaning back and knees bent and up to the ceiling).	diaphragm, or creating a false breathing. Which was interesting to respond to physically, and produced some interesting responses in terms of expansion and release, but there was only so far I could go with that...Then ‘mindful walking’, gradually came to the place of accepting it, that somehow it was there. This acceptance of, “alright, you are doing that, and I’m doing this, we’re grand and we will get on together”. Participant 15: “I had to really fight against responding to the sound. I had to really zoom in to get the sensation, but then when I had it, it gave me a sense of volume or balloon like” Participant 15: Yeah, it gave me subtle information; in terms of volume, or spherical, under curve visualisation of what I was doing. Participant 14: I found I was much more within myself. Earlier in ‘mindful walking’ I felt I could be and see the space and kind of treat things with equanimity again. But with this, I felt like I was really in on myself.”
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	Participant 14 Lifts R arm opposite eyes (coming into the pump line of the body) and the L leg leans into the centre. Participant 15 lifts both straight legs just off the floor and then settles on the side of the body on the floor. Then across onto her front (but upper body is held away from the floor slightly by leaning on the elbows) and she ends up on her right side of the body. Participant 14 comes up to kneeling facing the upstage L corner. Her torso is on a diagonal pitch forward and her palms have weight into the floor. Participant 15 rolls on to her back and the Left side of her body, both arms are held above her head. She returns to the other side, via her back. Participant 14 leans into the forearm, and weight is on the front of the foot as she is pitched forward over the floor. Participant 15 put weight into her hands and lifts her body into a sort of plank position, but with L knee down on the floor. 2nd Choice Participant 15 comes into a crouched position facing stage R. L arm slides over R knee and upper body is curved over. R knee bends as it lifts and R arm swings behind the body. Participant 14 puts weight into the palms and slightly convex back. She sits back on her heels and arms raise just in front of the torso. Participant 15	Participant 14: “Yeah, because you have the sensation and the bulk of the packs, so there’s lots going on information wise to deal with. Participant 15: And sound. Participant 14: And sounds.” Participant 15: So trying to really feel it and have that information influence my choices, but sometimes I had to go into stillness to really try and feel it and not hear it. Pump at the side of the back KR: Did that feel any different with that one? Participant 14: Totally different. Participant 15: Yeah. Totally different. Participant 14: Not with the...but where it was placed. KR: Ahh, okay.
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	takes a large diagonal step upstage R (towards 14) and then curves the body to the upstage (L arm over) Participant 14 holds left arm behind and down and R forward and up, she hunches her back and then spirals away to her right (and facing downstage). Participant 15 holds L knee as it raises again and spirals her back clockwise, she lets go and steps forward and curves her upper body forward/right. Participant 14 shifts her weight and changes direction to kneel facing stage R. her hands walk a couple of times on her thighs. She clenches her hands in canon, and then spirals round to her R and then her R arm curves up and over. Participant 15's left leg drops back in arabesque and her torso drops forwards and she comes upright as she cuts the other leg behind. Both arms come up and she does a hop travelling across the floor and finishing upstage. She waggles the R foot, and this moves into the hips and turns towards stage R. Participant 14 sits into hips, she lies on her L side of her body on the floor, upper body being held up by her elbows, facing downstage R corner. She then moves onto the front of her body and legs loosely crossed.	Participant 15: Much more information. KR: Really. At the back? Participant 14: It really made me think Katie, about your work and the potential to be in communication with different anatomical systems in the body. The vibration on here as opposed to here, were much more resonant through the bone... different vibrations contacts different tissues. Participant 15: So the stomach and the abdomen. There's so much there in terms of intestines, womb, fat, muscle. Whereas here, there's a thin window. The sounds were being absorbed by my pelvis a bit more, rather than my lower stomach. I wasn't as distracted by the sound as I was the first time. And the way it was surrounded. It felt like two pans a little bit. I found it much more playful as well. Playing with the sound and the feeling of the balloon, this coming and going feeling and or expansion of sound... "vooommm", you know that's coming before the inflatable.
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	Participant 15 steps forward and then leans forward, lifts leg off the floor. Steps back onto two legs in parallel and both arms raised above the head. Spiral round clockwise and the R leg is raised again. Participant 14 flexes the r leg and holds it up and then stretches and rolls and opens the body, facing the piano. Participant 15 cuts the leg behind and changes the gesturing leg and arms held in 4th position. These actions are repeated and then she leans to the L and takes a couple of steps forward, gently falling off the supporting leg. Participant 14 steps up to ½ kneel/lunge. Participant 15 has a grasping action with her R arm outstretched. The she turns back towards the window, and she flings her R arm behind and both hands grasp on a high level. She drops palms and head and there is an upper body curve. Arms stretch out to the sides and with a bit of a swing, she side steps. Participant 14 rolls up in a wide second position, with R arm outstretched. She contracts and then recovers and then faces the widows on a diagonal. Left arm is stretched in front and R arm behind the body. Participant 15 brings R knee up and around towards body, there is a change of weight onto the r leg and then a step forward and lean together left, with R elbow being the body in a turn facing (downstage L) she does the upper body curve.	Participant 14: There was so much there to play with. It felt like a group interaction or constellation rather than somehow the intensity of a duet. I felt like I was constantly shifting between this, and this and you. It was lovely. I had a lovely time. Participant 15: Yeah, I did as well. It didn't feel so overwhelming, but totally different to the first time. Participant 15: I think it was because I wasn't distracted. I wasn't distracted by it. I was using it as a resource. Whereas the first time I had to really focus on feeling it, and then I was hearing the sound rather than feeling it. I was working. Where this time I was using it the same way I might use XXXX and XXXXX as a resource. Participant 14: I think this time I went into it with a bit more of a loose attention towards the equipment within 'first choices' and 'second choices' and I just got on with my thing. Umm, and I think that shaped the way I was able to experience it in 'mindful moving' in
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	Participant 14 picks up one foot then the other very quickly turning to face stage R. 15 steps forward and back with a bit of a rock and then spiralling the torso clockwise. Participant 14 opens both arms wide to the side and walks in a big circular pathway. Participant 15 picks legs up and flexes foot and step into a wide luge forward, arms above and then they come down as she jogs backwards to the upstage. Mindful walking Participant 15 walks downstage R and back upstage in the middle. 14 walks downstage and the upstage in more of a circular pathway. Then 14 does two loose diagonals (crisscross). 15 does a straight pathway downstage, then a diagonal back upstage L. Then they both heading circular pathways anticlockwise. 14 does side steps across on a diagonal pathway from the upstage R corner to the downstage L. 14 creates a curved pathway. 15 walks a diagonal pathway from upstage L to downstage R and then straight pathway upstage again. 15 creates a small circular pathway and then a bigger circular pathway. Then they both head in straight pathways downstage (in parallel to each other). They both curve round to the stage L and head upstage. 1st choice contact	terms of being comfortable and easy with it being there already. Because I had gone in a more casual way, it was a partner, as opposed to something I had to work to find out or discover. It was running alongside me. Yeah, it felt more like I was in collaboration with it, this time. Participant 15: I think it's also a difference of whether you can see it or not, so with the bracelet, there were a few times where I was looking at it, and in doing so, I thought I can touch it, interact with it. With the other one, with it being under the shirt and being at the back, and black, as you say, it was just part of me. And getting information in a different way, and something about not seeing it. And this looks a bit medical, umm so many layers, you have got so much to write about.
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	15 and 14 walk towards each other and stand facing each other. 14 has her arms wide out to the sides (facing downstage), 15 has her r hand just gently touching 14's forehead and left hand draped over her elbow. 15 does to her left side and then 14 guides 15 anticlockwise around in a ½ circle walking by her waist. 14 brings her R knee up and then leans forward and 15 changes round to the other side of 14's body (further downstage). 15 gestures her L leg back and then it swings forward in between 14's legs and then changes her weight onto her L leg and 14 moves and stands in front of and then touches the R leg by the knee. 14 bends forward and 15 allows her weight to be taken by 14, leaning into her back and then it becomes more like an embrace. 14 walks to the upstage and presses against 15's L palm. 14 moves her arm so that it moves up and around and down and then guides 15 around (15 has outstretched arms). 15 takes a few steps and then pitches forward on her L leg. 14 bends forward and places her L hand on the floor. There is a pause here. 14 puts both arms with weight on the floor and 15 stands up and keeps R hand resting on 14's back. 14 brings her hips down to the ground and she is in a half kneeling position, and she holds onto L leg of 15 and turns her head to the windows. 14 contracts her upper back and her L elbow rises, 15 takes hold of this elbow and guides the body forward and down into a lunge. 14 comes up and to kneeling and she holds 15's hand in a counterbalance (15 is standing facing upstage). They pull away and from each other and then 14 stops pulling and stands up behind. They are both	
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	in parallel with R arms up and in contact. Arms fold down and twist round and forward. 15 steps to the r side and then around to stage L. 14 hits her foot of the ground and lifts it to the side, so she is positioned behind 15. 14's R arm hits the side of her body and 15 curves her arm behind her towards 14's upper arm. 14 hits foot on floor again and they faced each other with 15 's hand holding 14's R wrist. 14 shuffle jumps downstage and then just a small jump on the spot and steps forward towards the windows. They swap where they are in relation to each other, moving either side of each other and then 15 jogs backwards and brings 14 with her towards stage L. Then they both hold hands held at shoulder height and flexed elbows. And 14 guides then both more into the centre stage. 15 picks up her L leg and 14 guides her side to side. 14 let's go and wraps arm underneath and then turns on one leg (like a pencil turn), then drops her upper body forward. 15 puts her L arm on her back and raises her R leg (they are both facing the piano). There is a pause here. Participant 14 undulates the body up. 15 puts pressure of the L hand between 14's shoulder blades and then puts her head underneath 14's arm pit. 14 turns ½ turn clockwise holding 15's hand and then steps forward to her knees and then in a lunge on her L leg (downstage). 14 moves onto kneeling (R leg is towards upstage). and then 15 moves to stand behind 14 and again this is more like a hug. This is released and 15 holds onto 14's elbow as she steps to face the windows. 14 rolls to the lie on the floor (on	
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	her back, and L leg gestured). She flexes it and it drops to the floor and 15's R arm is held to the side high. They remain in contact with fingertips and then folding onto 15's foot. 15 walks over 14's feet and 14 rolls up on her R side to 4th position on the floor. 15 stays in contact via her R leg is in contact with 14's R arm. 14 stretches back almost in cobra position, she then puts weight into her hands to come back to kneeling and then she walks backwards until she has rolled up to standing, arms are in a high V shape. 15's elbow is in contact with 14's shoulder and they walk. 15 slides her arm along 14's and hops and walks past her. 14 rises up and R leg gestures up to the ceiling, then there is another rise on to the balls of the feet. They hook round each other's waists. 15 rond de jambe en l'air the L leg and then it is in an arabesque behind. 14 holds onto her and then guides her walking round in a circle. They hold hands facing stage right, arm's length apart. 14 turns in and stops 15 with her L arm. 15 sends the L leg back into a fondu arabesque. Then 14 steps across and turns till she gets to the other side of 15 (Upstage). 14 curves forward and then they link arms and 15 wraps her spare hand around both joined hands. 15 rises up onto demi pointé. 14 gestures L leg (flexed), 15 jumps and then 14 takes two jumps and steps across and then pulls 15 around. This starts to become a bit more frenetic and then the buzzer goes. Stillness	
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	Participant 14 goes to kneel, by the window facing stage R and 15 is standing facing stage L. Pathway 71- Both 14 and 15 using the pump prototype, but the electronics pack is worn more to the side on the hip Pathway 71: 1st Choice= 5, 2nd Choice =4, Mindful Moving contact=6, Wild Card= 3, Stillness =7 1st choice 15 faces stage R to start and lifts her R arm up to ceiling and behind the body and then back again, rotates in the shoulder blade (inward and outward) brings R leg in a rotation forward. 14 faces upstage and lifts both shoulders and then the shoulder blades drop down and the elbows rise up (on a table plane) and then the arms stretch outwards to the side of the body and then the shoulder blades isolate one at a time from side to side. 15 bring the R leg behind again and both arms are brought into the midline of the body (one slightly above the other). She turns to upstage. R hand grasps and L hand reaches to the side. She steps back and to the side and picks up R leg. Her torso spirals round to the R. and she chassé diagonally towards upstage L.	
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	14's elbows come into the ribcage and then the forearms face up to ceiling and then she steps round to stage R and then downstage. 15 steps forward on a diagonal pathway and then elbows also come nearer to the ribcage and she then walks more quickly backwards on a diagonal pathway (heading downstage R corner). 14 has a small undulation of the back and then she initiates another movement from the ribcage to stage R, a ripple which goes into the elbow and rest of the R arm. The R arm is held high, and the L arm is held to the side. She takes a step anti-clockwise towards the piano and then steps back into a lunge. 15 steps backwards towards the upstage left corner. Both her arms open forward and to the side as she walks. Then she steps and turns on both legs clockwise to finish facing upstage R corner standing on her L leg in a relaxed arabesque. 14 puts L hand on her L knee and then steps into parallel position and arms both go out to the side. She steps to the upstage R corner and her back continues to spiral round so she is looking downstage. 15's R arm comes up and scoops down towards the body, with a little rise. She falls to downstage with quicker walks.	
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	14 looks at her L hand and it takes her into a ½ turn clockwise as it flexes and circles down and then both up, flex up and out. One arm goes in front of the body and the other behind they both straighten up to the ceiling and then out to the sides (on a slant). 15 runs backwards, and then she leans on the window (downstage L corner). She pushes herself from the window and downstage centre and stands on one leg and fists clench and open and then both legs are in parallel and 15 leans into her R hip. 14 rotates the R arm forward and back in the shoulder socket. Palms and fingers stretched on both arms stretched. She walks downstage nearer 15. She bends her knees and there is a ripple through the back and into the arms from L to r side of the body. 15 does a series of 3 small jumps on the spot and then leans to the R. She walks anticlockwise, around in a big circular pathway and comes to meet 14 centre stage. 14 rotates the R arm in the shoulder socket again and walks to centre stage and stretches the L arm up on a high diagonal and right on a low diagonal. She bends forward, steps backwards around herself and both arms swing up above the head and down (almost 5th position). Stepping changing directions and arms change up and down, then a step into a lunge and fists clenched and almost a full stop. Then a rotation of hips (like a hula hoop) and then she reaches down L.	
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	15 scoops her R arm down and up and hops backwards towards downstage and then she changes direction and jogs backwards, anticlockwise all the way to the upstage R corner. 14 steps forwards and backwards and then stands facing upstage. She drops to the floor and puts her weight into her R hand. 15 steps and hops downstage and then enters the floor. On all 4's. She kneels back on the right knee and stretches to the right and back (L leg is stretched on the floor). 14 stretches her L leg and puts weight into her R knee and both hands. 15 puts her head on the floor and holds out her leg and swings to the L side onto her knees and then onto her hip and she then rolls onto her back (centre stage). 15 lowers herself onto her side. 14 rolls to her R side and pushes herself up facing downstage R corner in 4th position on the floor. She swings L leg to the stage R and then scuttles to the right onto both legs and stands up (parallel), R arm wrapped over her head and L arm held behind her back. 15 spirals her back and she rolls to on her front and then crawls on her front and lifts her hips up and is lying on her R side very close to the wall	
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	stage R. She rolls to the upstage and lifts legs high and arms almost meeting the legs like a pike position. 14 stretches her R arm in a high diagonal position. Her elbow flexes and she walks backwards in turn out. Her L. arm stretches out and her R arm comes over the body towards it. 15 puts her legs down and then puts her weight into her arms and stands on one leg and then bends again and jumps her legs underneath her and stands up. She stretches her R arm and then leans and walks in small circular pathway towards downstage and then R. 14 steps forward and to the side on her R leg and then she brings both legs together and then L hand is stretched up to the ceiling and she looks up. She steps around in a turn and looks at the palms and then heads to upstage R side. 15 skips and turns as she passes 14. 14 turns on bent legs and does a wide sidestep. 15 steps on one foot and then then the other and hops and then leans off balance heading generally towards centre stage. She jogs backwards, clockwise, and upstage. 14 crosses and unwraps her arms and then moves towards the centre of the stage turning, she steps down to the floor and crosses her legs. She	
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	shakes her hand and gets out of the floor by walking backwards and then swinging her arms to travelling big steps. 15 turns and finishes facing the piano, she does a full circle of the arm and jumps backwards. Hands clasp and she stands on one leg and plays where the weight of her back leg takes her body (tipping forward). She does a reverse turn with arms in 4th and then steps backwards until she is standing behind 14. 14 's hands do a little scoop she steps out to her R and changes direction to stage L and then tilts and to the L and turns upstage and swings right arm out, then turns again and step outs. She cuts back leg in a step behind and then gesture of R leg up and then turn upstage. 15 bends R elbow and then straightens it and flicks fingers away. She leans backwards still looking up at her hand. Her R arm unfolds behind her and then both arms are held to the side. She steps onto one foot and the other rests just on top of the other and does the same action on the other foot, she turns and walks backwards. The puts her arm down near 14's and then steps around her. 2nd Choice It becomes quite staccato in quality for 15, she jumps upstage (to her L side) facing stage L. She steps behind and crosses her arms and pushes them to her side and down. She bends arms and spirals around to the right and swaps gesturing leg.	
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	14 looks upstage and the walks side, back and side again turning to face stage L. Arms come out to the side (like she is holding something) and then like she is shifting round -object in space to the side, (now facing upstage) She steps on her R leg gestures side and round to the front and steps forward and looks to the ceiling. 15's r leg flicks behind and she step upstage and behind 14. She reaches to the stage L and then walks backwards anticlockwise in a half circle around 14. Her R arm does an arc over 14 and then she stands in a wide stance, arms out to the sides. She curves to stage R and changes her hips to this direction and then stands up with a straight back (R arm gesturing to the ceiling). 14 steps backwards and then jumps backwards and steps out to the stage L away from 15. She sits into hip and inverts the leg and pushes around turning, then her R leg flicking out. R arm swings out and stops by thigh, then her left elbow flexes to the hip and there is a series of steps side and behind. 15 moves weight into a lunge on R leg and sweeps arm horizontally to the R. She straightens both legs and raises both arms up and then leaps from 2 legs to one leg and then walks following 14, with her elbow leading. Step behind and then she reached her arm forward, back leg gesturing behind. She swings R arm back and left leg forward (flexed foot). She steps to the side and then changes direction, coming to stand by 14.	
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	14 kneels to the floor, clenches first, leans to stage right and then puts weight into the floor and rolls on her hip, facing upstage. She pauses here. 15 brings right knee up and over into parallel. She quickly moves both legs to a side lunge. The steps to the side on the R and then into a fondu parallel attitude arabesque. She swings the leg back down and then she does a ½ turn facing upstage. She pushes into the hip and aligns, then changes weight into the R leg and does an upper curve forward. R arm extends out and then at the elbow flexes and isolates from the elbow. She steps around to face stage R and extends R arm high. 14 steps on her L and pushes the hips forward and steps to ½ kneeling. She does a sudden high extension with lunge of the legs and then turns to standing, facing stage R (hand wresting on her ribs) R leg bends and gesture across the body and body forward (like she is crumbling) and extends taking the movement to travel upstage in 2 big steps. 15 hops upstage and the curves forward and hands walk to the floor, she brings pelvis underneath her body and then stands up. She curves over to stage L, arm curving over. 14 goes from crossed legs and jumps down in wide legs and then steps her legs together. Her R leg gestures with bent knee and steps across in front. Her R elbow leads her round in a turn and then her head continues to initiate another turn. She walks around 15 in a ½ circle anti clockwise.	
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	15 Arcs her R arm to stage L and towards 14. The arm rebounds and straightens, she turns towards R arm curves the other way, and 15 walks the arm around 14, coming to stand behind her. Her elbow draws in space, and she follows 14 further in towards centre stage. 14 kicks R leg up and then steps back on L. She readjusts her weight forward and back and then kicks her R leg backwards. She moves weight into a deep pli�� in second and then rebounds out moving towards centre upstage. She curves her upper body forward. She straightens her legs and the torso becomes more upright, with elbows tight to hips. Her arms shift side and down together in unison. She steps to the side. 15 walks backwards and stops with forehead resting on her inside of her arm, and it wraps over her. She step-hops and walks backwards towards downstage R corner. 14 walks in a small circle clockwise and then does reverse turn on the spot, with elbows close to the torso and forearms sticking out. 15 steps forward and holds onto her R foot at the heel. She balances and then falls forward and steps onto her R, with R arm up (facing the piano). 14 walks towards stage R and does a jump (2:2 on the spot) high and then drops her body forward facing downstage. She recovers slowly looking backwards. There are a series of side steps moving downstage.	
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	15 steps to the stage R and then swings arms and legs back and forth, finally dropping the torso forward and hanging down, balancing on the left leg. She slots the other leg behind and turns round toward T. Both arms are held high in the air in parallel. Then the L elbow remains up and the hands unfold slowly down, 15 falls off standing leg and walks toward the downstage R corner. 14 walks and then does a very low balance action, she stands in a wide second and then wobbles her head from side to side. She grabs her R foot brings it towards the body and let's go. She turns towards stage R (towards 15) and stands with palms facing out. 15 extends R arm and drops upper body forward as it follows the swing of the arm. She uses her R arm to draw in space around 14's head and then she swaps to her elbow and then her palm. 14 ducks underneath 15's arm and spirals her back around and then extends her L arm behind her, but her body is folded over her legs. She pivots her legs so her body rotates and she does a turn on this horizontal axis and then comes to standing. 15 continues to swap her weight from on leg to the other and changing directions in space. Mindful moving contact	
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	15 and 14 walk towards each other, in the downstage space. They link R arms and walk around each other. Both drop their heads and 14 curves slowly down to the floor and 15 is being gently pulled to the side and forward. 14 moves from crouching to kneeling and then have contact via the wrists pressing into one another. 14 faces upstage diagonal and 15 stands in parallel facing downstage diagonal. 15 ripples the fingers and then she drops to the floor and 14 puts weight into all 4's, they change direction her to opposite diagonals. 14 pushes hers and 15's R palms down into the floor and she stretches her L leg underneath her, so that she is lying on her front and support by her arms. 15 looks down to the ground, also supported by her forearm and hand. 15 brings her R hand away from the floor and changes her hips to face the ceiling and both legs float above the floor. 14 bends her legs in and raises her hips to kneeling, with head nearer to the floor. 14's head comes up and 15 has her hand on 14's head. Then there is a change to the contact being both their right arms as there is a rotation up and to stage L. 14 sits into her R hip and 15 is sitting with knees up to the ceiling. 14 puts weight into the L leg and lunges forward. 15 turns to her R (stage L). They are both on low level in centre stage. 15 rolls onto her R side and 14 shifts	
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	onto her Left side, 14 places her R hand on 15's leg, then lifts it off. 14 lies down on her side and 15 sits up and has her L leg bent and R leg extended. There is slow movement in contact between the L side of 14 and 15's bodies, moving forward and then into their left arms. 15 steps up to standing and walks behind 14. 14 rolls on her back but stays in contact via her R arm (15's Left). 15 swaps arm and rests her fist on 14's. 14 slightly shifts her weight on the floor, through adjustments in the pelvis. Her R leg comes across the body, and she puts her weight into it to bring herself to kneeling. 15 has curved forward and then uncurled to standing with contact between her R hand and 14's left. This point of contact moves to 14's head as she turns to face downstage L corner and her head moves underneath 14's extended R arm (shoulder height). 14 leans towards upstage R corner and 14 curves over, her head leading towards the Upstage R corner. She sits back down (R leg wrapped over) facing downstage. 15 walks and changes her facing to stage R. Wild card 15 walks to upstage and she strokes her hair. Then extends the arms to the side and down, bringing her focus down, standing in parallel.	
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	14 pushes weight into both hands onto the floor and then slowly moves back into the sitting position, R elbow resting on her R knee and her focus is down. She brings her head back up and then shifts her weight into her L hand and her head falls to stage L. 15 at the same time moves her head and shoulders towards stage L, but she is still facing upstage. 14 recovers the head to upright, but 15 continues to the floor and puts weight into the floor, with downward dog position. 14 puts weight into the hands and brings her hips up and walks her feet in. 15 moves onto all 4's. 14 uncurls up to standing very slowly. 15 changes her facing to downstage L corner and squats, with hands just resting on the floor. 14's hips are thrust forward, and she walks and then balances facing Upstage L corner. She then bends forwards and walks backwards downstage. 15 gently shakes hands upwards to the ceiling and then turns and walks backwards to the windows. 14 lifts R arm and L and brings the R leg forward in a balance. 15 is also balancing on one leg (but R arm up and L leg gestured) she rotates arm and gestures around and behind the torso and she changes her facing to upstage.	
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	14 steps out to stage R in big wide steps (side, behind, side). 15 bends elbow and brings her R hand to her head and then she walks in a curved pathway to stage R and picks up her L arm and R leg. She turns to upstage and then turns on herself again. 14 is in a wide second pli�� and is moving her weight forward (and although I can't see clearly because of her baggy T-shirt) there is a play with the pelvis and the lower back, as the arms and back are articulating and undulating. 15 drops her head forward and over her legs. Stillness 15 lies on her L side on the floor, facing the upstage L corner. 14 stands in parallel facing the same corner	
Improvisation with vibration prototype	With one bracelet (10 loops) on the right One vibrating bracelet worn, 2 participants in the space working simultaneously on Pathway 68,	“Participant 14: I found it interesting as a tool for a meditative stillness practice. After a while it almost became part of my body rhythms; and there was this very interesting overlapping of my breathing, and it became a rhythmic

	Pathway 68: Stillness= 6, Mindful Moving =5, Mindful Walking =4, 2nd Choice= 6 Stillness 14 is sitting crossed legged against the wall upstage. 15 is standing in parallel facing stage right. Mindful Moving Movement is slow and sustained. Free flow of energy. 15 raises arms from the side to shoulder height very slowly. The R arm with the tech stays there and the L arm continues to rise slowly, and the body turns very slowly to the right until the body is facing upstage (there is a little sway to the L before turning to r). The weight is put into the r leg and then the arms both come down to almost a 1st position facing each other. 14 places her R wrist (with tech) on top of the left wrist which are placed on top of her L knee. She then puts her weight into the R hand and into half kneeling position (foot tucked underneath seems to tap). 15– weight transfer into L leg and body slightly pitched forward, then the body straightens as the arms go into a 4th position (R up, and L down). Then weight shifts back to R and R arm extends to the side. Weight shifts back to the L leg. Head leans to the R and the body curves forward towards the legs (weight back on R leg and L leg is on demi-pointe).	place of focus and an awareness that was really lovely actually. It was very soothing to have another rhythm, to be able to tune into” Participant 15:” I felt like I could hear the rhythm, or the impulses, and I suppose that gave me quite a visual in terms of the stillness and the breathing. If it was going that way, my breath would visually follow that pattern in space. So, drawing out my kinesphere this way or that way, or towards XXXX” Participant 15: “It gave me a lot of visual, but I didn’t find it distracting. I felt like it supported what I was already doing.” Participant 14: “I was playing with how I can experience that vibration travelling up the bone, and whether it was possible to experience it not as an isolated place here, but what could I do to appreciate it in different ways in my body. So, I was with that for a while, and then also the sound of it. I was playing with that, bringing it close to me and coming close to XXXXX, offering an experience, or drawing upon an experience of hers”
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	14 has moved onto all fours (tabletop) and then shifts weight backwards, R leg stretches backwards, and hands walk x 2 and head becomes closer to the floor and the wrists. 15 walks hands to floor and in a kind of downward dog position, but R leg is low and gestures slightly behind body. Mindful walking 15 rolls up from the floor with her head leading 14 stands up from the floor. 14 walks towards upstage and then turns towards stage R and walks back downstage. 14 walks downstage and then in more of a curved pathway, walks towards the window (stage L) then upstage towards the piano. 2nd Choices 14 contracts a little and changes the direction of her hip which initiates both arms to her L side of the body in a quick gesture. Her R leg steps back into a lunge and the arms rise to a loose 5th position. 15 steps onto her L leg and L arm quickly gestures up by the head. The R leg is bend and comes off the floor and gestures behind the body. The L arms drops down and upper body curves over, R leg rond de jambe forward and	Participant 15: "I felt that although we are always a trio. I felt that it was a duet with the wearable and also with XXXX. So, at first it felt a bit conflicting, as I'm used to be me, on my own, with XXXX and XXXXX, so it was interesting to feel like I was double. It was nice, and interesting. In the mindful moving, with that practice, it's about staying with a noticing. Or staying with something, there's not a lot of choice making or decision making. So sometimes I felt like I was paying a lot of attention to the wearable, and then moving in response to that, which is not the task for us. So, then I would try and come back to stillness, to come back to this practice and then to see how I can play with that." Participant 14: "So for me, it's another piece of physical information, it started to function in the same way as a sensation in my knee, or noticing my breathing, or feeling my heartbeat. It was layering in the same way any of those would, at times." Vibration bracelet worn on the left
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then both arms circle to the R. R leg replaces L leg and both arms are held above the head. L arm curves over and body spirals to the R. L arm in front of the body and R arm behind. 14's arms are held above the head and there is a pause here. She steps forward on the R leg and the R arm covers the eyes (elbow). The R arm flings out and behind sending the body forward and bent over the legs. 15 flexes the R foot (bent leg) and then balances there, she rises on to a demi pointe and pointes her R foot quickly and steps onto the R. R arm extends and then L arm does the same, in a V shape, with L leg coming off the floor. Body curves to the L and then a slight fall and change of facing to upstage. 14's body comes up to standing and arms are wide and stretched out to the side (cont. second). Tilt to R side (upstage) and then back to the L and left leg flicks up (flexed foot, inward rotation) R arm comes above the head, and she looks at the hand. She walks into the centre of the stage where 15 happens to be. Participant 15 has L arm held above head and she steps forward and the body spirals and curves forward and then a little pulse and steps forward and the body comes upright with R arm overhead. R arm pushes down to shoulder height then stretches behind and as she walks forward it circles underneath and she almost stops them with L arm now above head. She slides R leg out into a lunge towards upstage L corner and then as 14 passes	Participant 14: "This is this interesting ...with the regularity with the vibration, it brings a temporality and sense of measurement to my experience. A bit like a clock, it's kind of like a... hmmm... a baseline. Which is interesting when you are working with time and duration to have an experience within that. I found myself definitely aware and kind of moving with, or moving around, the rhythms. Certainly not directly in relation to them, but they were very much supporting the temporality of my movement and my experience. And also, a feeling of it being sometimes a fulcrum for the ways things were organising. So, it would every now and again become the centre of gravity for my perception and awareness" Participant 15:" It gives me quite a visual in terms of movement tracing..." Participant 14: "it gave me a stronger feeling of my locality. Where I was in the space, and yours as well. I had a clear sense of us, as little pockets of sound, or vibrations. Energetically, I
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	her she sends weight back into left hip, with a change of facing to upstage R corner. Whilst walking 14 extends L arm to the side and pauses feet together and focus to the extended arm. 15 turns anticlockwise and curves to the left facing downstage (behind 14). 14's left arm curves in towards ribcage. 15 stays there and then stretches her R arm to the side as 14 lunges forward (L leg behind and spiral to the R).15 stands in parallel arabesque by 14. 15's knee R knee folds in bringing her upright. 14 rocks and then knee bends and brings her to ½ kneel in little slide forward.14's R arm stretches across the body and her L leg straightens of the floor and hugging R leg. 15's L arm extends to the side (downstage) and then weight is dropped into R leg (side lunge). She spirals round to right, upper body curved over. 15's L arm extends to the ceiling bring the body upright to standing on both feet in parallel. 14 lies back onto the floor, with both arms out to ceiling at eye height, fingertips touching. 15 steps onto R leg, which is bent, and she keeps L leg straight, her arms gesture to the R side, almost Tai chi like. She comes back quickly to parallel again, but with R arm shoulder height held to the side of	had a clear sense of us, in relation to each other." Participant 15: "I just feel it doesn't necessarily make me move in a different way, it somehow shines light on a brighter area of my understanding of what I am doing in space with XXXX. It's like if I was in a room and they only followed me with a torch but wearing like six torches." Participant 14: "I think my reaction also changed with my attitude in both pathways. The second time perhaps there was less of a need to really tune into it or find out how I was in relationship to it, in the same way. I was more accepting of it the second time round. It was less dominating or befuddling". Participant 15: "Yeah, in the second time, there were a couple of moments where I thought has it stopped? Oh no, it's because my attention is not entirely focused on it. I did a couple of times completely ignore it."
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	the body. Then 15's R arm drifts backwards, shifting her facing upstage. 14's body rises off the floor and her L arm hovers near 15's R wrist (bracelet), she is sideways resting on her hip. There is a pause and then 15 transfers weight into a bent L knee, with R straight, arms in front of the body in a curve. Then she turns slightly and lowers herself to the floor. 14 spirals the back on the floor, legs over the body. 15 lies on her side with her head near to 14. Pathway 69- 10 loop vibration bracelet worn on the left wrist Mindful walking =6, 1st choice =6, Stillness 3, 2nd Choice contact =4, Mindful Moving =5 Mindful walking 14 starts walking from downstage to upstage. Then turns and walks towards stage L and then walks downstage near the windows and cuts in towards stage R and slows down (this correlates with 14) 15 walks upstage but by the window and then turns to walk downstage again, but further in towards the centre, when she nears the downstage, she turns and walks to stage right and pathway back upstage. She turns round to head back again and then slows down very slow. 15 does a small circular pathway very slowly (around herself) and then heads towards stage L on more of the diagonal. She changes direction at the window and heads towards across the centre from stage L to R. Then in	Participant 14: "It's so interesting, because it's an object. It's an external object, that has been put on me, but it has a deep. It goes in, the vibration goes inside, and it goes inside. And sometimes it feels a part of my body and sometimes it feels very separate." Participant 15: I like that you said XXXX that the vibration goes in. I think that is why I keep having this visual, and this trace, because it's not something that's happening on the surface, but it almost goes through the body. And I suppose, my noticing of it, or my perceptual practice of it, is no different to how I would take in my own breath, or XXXX in my line of sight. Or the floor, so I suppose all the things you get challenged with, in terms of distracting thoughts or slight moments of judgement, or temperature or sensation, the way of shifting through all of that, is the same way I shift through the types of noticing of the vibration." Participant 14: "I think there's both a simultaneous listening and an awareness that you are giving something. Which is the same
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	a diagonal pathway towards upstage L. When she reaches the piano, she turns and then heads in straight pathway down one of the seams of the lino. 14 initially in slow walks was on a straight pathway and then she heads more in a circular pathway upstage. 14 joins 15 and walks along a parallel seam on the lino in similar steady pace. They both turn to the stage L and curve around at the same time. 15 continues back upstage and 14 heads round towards upstage R corner. Both head back downstage, but 14 more in a figure 8 pathway and 15 straight down one of the lino seams on the stage R side and then towards the diagonal heading to the piano. 1st Choice 14's left arm is out to the side and the elbow moves slightly up and down as she walks. She pauses with weight on the R leg and L arms framing the head and then it comes even closer to the head. 15's R leg crosses over the L leg x 2, then rise on demi pointe (opposite arm to leg gestures). And steps backwards and to the side. Both 14 and 15 have the L arm in the air. 15 does a small step to the side facing downstage and then a step backwards, with arm scooping down and then back to almost a 4th position with arms. The L arms swings down and around in a full circle.	with these guys [the vibration prototypes]. I'm listening to the vibration, and I am aware of that, but also I can bring that into the world, I can bring that into space and I can offer that to XXXXX... But it doesn't feel me.
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	14's arm comes to rest on the forehead. She walks and then changes her facing to the corner (upstage right corner) and wrists cross in a kind of 'wonder woman' gesture. She opens the palm, stretches the R arm forward and then out to her right (stage L) 15 turns to the right and leans into the L hip and then picks up the R leg and places in down and then R arm shoots out to the side. She steps behind on the L leg and then changes facing and steps back, R arm stretching forward – facing downstage R corner, to finish in parallel with legs and R arm up to ceiling. She is in the same position as 14 for a second. 15 steps out to R side and into parallel attitude in arabesque. She grabs her L elbow and pulls it across the body. Throws the L arm back, and steps back into a wide position with legs and arms wide and high (like star fish position) 14 steps to her R, and facing the windows (stage L), she stands with her arms above her head, almost like she is holding onto something. She continues to turn more to the corner (downstage L) and pitches forward over legs, arms hanging near her feet. 15's R knee gestures to the ceiling. She scoops the space with the arms in front of the body (like she has a pole at chest height). The foot is put down and weight changes to other foot and the arms go into a hug. R leg sort of	
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	arabesque in parallel fondu behind and step the R leg behind. Both 14 and 15 have pitched forward, heads in reaching distance from each other. 15 places gesturing foot down and then rebound back weight onto it. The R hip pushes to stage R and the Left arm pushes away to stage L. Arms arch down to a kind of bra barre and then rebound up to a V shape and she turns and steps to face the piano. 14 straightens legs and arms widen to the sides and then legs bend again and then L arm bend and stretches forward at shoulder height. Then she steps backwards, and L arm lowers down, and r arm stretches out and 14 ends up facing upstage R corner with arms in shape that they are holding a bow (right arm forward). She keeps that shape and walks clockwise around on herself, still holding the same shape with her arms. 15 shoulders lift and then she stretches arms to upstage. She lifts the R leg up, same bent k nee at right angle. And transfers weight into the R leg, with R arm held above head. She swings the R arm down and, steps behind side back, with and swing gesture of both arms and spiral of torso, left arm behind back and R in front. 14 rolls elbows forward as she steps backwards. And then brings L wrist to forehead. The wrist moves towards the R ear and the head turn to the L.	
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	15 lifts L leg behind, then there is a rise on both legs and both arms float up, L hip pushes out. Then R arm floats around 14's R arm. 15's L leg goes behind and arms in a breath and R elbow up and spiral back anticlockwise, then step and change direction and a small step again, R arm up. The R arm sends the body down to floor facing the window. 14 stretches the left arm and articulates the wrist in a ripple. She turns clockwise and steps turning with L arm outreached. Then the L arm pushes across the body and back open again this is repeat. 15 steps behind and the R leg lifts, and she spirals to her right, and then hooks the arms over (like there is a pole hanging). 14's arms raise to a relaxed V shape and then drop down as she steps behind and to her L (upstage), with elbows flexed as if there is a something supporting them underneath. 15 turns on the spot and then steps backwards (upstage) and right arm gentle reach forward before standing on R leg, L leg in bend parallel attitude. 14 has L arm stretched to side as she drops to the floor on all fours head pointing towards the piano. She stretches the R leg behind and then sits back onto a kneeling position.	
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	There is a pause by both dancers and then 15 brings her L arm up to the ceiling and shifts her weight so that she is standing on her L leg. Then she curves forward and changes her facing to downstage. 14 brings her L wrist towards 15's hands. 15 tips forward and her hands go over 14's. 15 rocks back and 14's L arm moves in a circular pathway. There is almost a 3rd position of arms from 15 and then she spirals and steps back to put hands and feet on the floor and to sitting. 14 has reversed the L arm and come back. She lies on her side on the floor with the L hand up by face and R arm underneath the body. 15's legs float up to the ceiling and then the R arm stretches to the floor and there is a pause here. 15's legs are in parallel and held as she lies on her side (another pause). She folds the legs towards the body and stretches them in a pike position (flexed feet). 14 stretches her legs away and holds her upper body away from the floor. L arm is flung away bring the body facing the ceiling and back on floor. Both arms are at shoulder height and R leg lifted towards ceiling. 15 swings her legs to the other side and leaves arms to her left (towards the centre stage) 14 clenches and stretches fingers and sends her R leg to stretch on the floor. She crosses the wrists in front of the body. Both 14 and 15 move	
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	together: 14 rolling to her R side and foetus position and then siting in a 4th position. 15 towards her L to sit up, she puts her weight into the arms and feet with a bounce and stand up. 14 is in a kneeling position facing stage R. 15 flings both arms away in a V position and then a wrapping 4th position and back in then the L elbow rises forward. The hands unfolds forward and 15 steps behind and side and arms go to the side. 14 brings her hips to the ceiling and stretches her R arm up and L down to the ground. 14's L arm leads her towards the piano corner, and she takes big steps behind 15. 14 bounces into a wide second position and then stretches her arms wide standing on her L leg. Stillness Both 14 and 15 face the upstage L corner. Both are standing in parallel Contact 2nd choice 15's R arm lifts from the elbow. 14 turns towards 15 and L arm is raised shoulder height. 15 walks over to 14 and places her R hand under her L elbow. 14 turns to face 15 and arms are wide and held with bent elbows, palms facing downstage. 15 changes her grip on the elbow and more direct hold, but she looks away to upstage.	
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	14 scoops her right arm underneath 15's R stretched arm. Then 15 folds her arm and touches 14's head with the hand. They both move away from that position and 15 stands on the L leg behind 14. 14 is pitched forward. 15 guides 14's R arm up and they both change facing in small steps around each other (14 is facing downstage and 15 is sideways towards stage right) 15 pushes into 14 with her R arm and body, then 14 guides 15's arm down and 15 holds onto her wrist and steps back in a low arabesque. 14 kicks her R leg high to the side and kneels on her L leg- arms and torso in a tilt to her left. 15 steps in closely to 14 almost leaning into her (her supporting leg directly by 14's knee). 14 twists to the floor and the side of 15's forearm rests on 14's back. There is a pause here and then 14 sits back onto her sitting bones and she has contact with 15's R calf. 15 touches 14's forehead and rests her foot on 14's knee. 14's L arms links round 15's L leg and 15 bends her knees and steps past, with her ankle gently making contact with 14's thigh. 15 walks around 14 and has hand on 14's back as she goes onto all 4's and then ½ kneel. 14 jumps to the stage L and then quickly rebounds to the stage R and grabs 15's R hand and L elbow as she goes into a low arabesque.	
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	15 swings her leg forward and then jumps upstage towards the piano. 14 at the same time turns her leg in and her ankle swings out at the knee height and turns to face the same direction as 15. 15 moves around 14, rolling past her/against her body in a circular pathway. 14 bends and steps away. Then 14 's torso ripples and she steps backwards and links arms with 15. There is a series of steps where they transfer their weight from one foot to the other and the contact is forearm to forearm. 14 's arms rise above her head and the hands touch. 15 is facing her in an fondu arabesque and then she holds onto 14's waist. 14 crumples and collapses down. She scoops under 15's L arm and turns to rest her head on 15's arm. 15 moves away and around to lean across 14's body. They place their arms one at a time in criss-cross and 15 leans into 14. They both come up to standing and make contact with the fingers (like you are grasping for something) 14 rocks back and forth between legs and then leans to the floor (L arm down to the floor). R arm holding 15's R arm (which is high in the air). 14 springs around clockwise and 15 does 2 little jumps around and way from 14. 15 walks upstage on the diagonal towards the piano. Then they touch fingertips and then 15 moves towards 14 with her L elbow. 14 wraps around 15's legs with her R arm. As she unrolls their arms are interlinked. 14 turns underneath 15's left arm. 15 brushes along 14's arm and walks	
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	behind her, then takes 14's hand and holds in her crossed arms, they both release the arms up to the ceiling. Mindful moving They both lift left leg and L arm is raised. 15 swings the L arm down and out and this changes her facing towards 14 (stage R). 15 holds one arm above her head and one out to the side as she arabesques and then steps and repeats this action downstage L corner. 14 steps back and to the side and palms face up in low V shape. The L arm rises to shoulder height and the R arm supports the lifted R leg underneath the thigh. 14 crouches down to the floor like she is looking at something. 15's focus was to the ceiling and now she has curved to her left. She moves her feet and ever so slightly falls off her centre line and then catches herself. Arm is back in the open 4th position. 15 puts her hands on the floor and moves towards 14. 14 is now on all 4's. They both kneel, but more like 'child pose'. 14 sits up and 15 pushes her legs away and lies on her side for a short pause and then rolls on her back to her other side, facing the stage L. Her L leg is held off the floor. She pushes her upper body up off the floor and then settles back lying on her side facing downstage. 14 lowers back to the floor on her back and the L arm held in space – in line with the face. The arm continues to fall to the Left side of the body taking the body to the left side (r leg off the floor behind the body).	
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	15 pushes her hips and walks her legs around on the floor, until she changes her facing the floor (head stage L). 14 brings the R arm back and she is back on her back, facing the ceiling. 15 folds her legs back up to a pike position and spiral of the back to the ceiling. 14 rolls up to kneeling, facing downstage. 15 rolls upstage and stop on her front and then she pushes herself back along the floor. 14 is back in child's pose, but with L arm stretched out behind the body. She rolls the body up and then drops into her R hip and looks upstage. 14 stretches L arm along floor and the 15 brings her legs up to the ceiling.	
Combination of both prototypes together	N/A	N/A
Structuring phrase	N/A	N/A
Editing	N/A	N/A
Internal and External experiences	Participant 14: "You really need to stay with it in the 'mindful moving' to even be able to understand it. Or be able to take any position to it. I started off by somehow going off on my own journey, but somehow, I felt that I couldn't be with anything I was doing, so I was like I will have to come back to this." [pump prototype for improvisation] Experientially, there is a sense that the pump is dominant, and it's hard to not concentrate on what is happening at the core and be influenced by this both through movement initiation and spatially. Which is further explained by Participant 14, "I found I was much more within	

	myself. Earlier in 'mindful walking [with the vibration bracelets] I felt I could be and see the space and kind of treat things with equanimity again. But with this, I felt like I was really in on myself." The change of location from the front to the back provided a different experience and the sound was less of an influence, but there was multimodal response to the pump prototype and the experience and relationship changed for both participants: Participant 15: "So the stomach and the abdomen. There's so much there in terms of intestines, womb, fat, muscle. Whereas here, there's a thin window. The sounds were being absorbed by my pelvis a bit more, rather than my lower stomach. I wasn't as distracted by the sound as I was the first time. And the way it was surrounded. It felt like two pans a little bit. I found it much more playful as well. Playing with the sound and the feeling of the balloon, this coming and going feeling and or expansion of sound... 'vooommm', you know that's coming before the inflatable." The relationship changed to one where the pump prototype was used more as a resource and Participant 14 explained: "I think this time I went into it with a bit more of a loose attention towards the equipment within 'first choices' and 'second choices' and I just got on with my thing. Umm, and I think that shaped the way I was able to experience it in 'mindful moving' in terms of being comfortable and easy with it being there already. Because I had gone in a more casual way, it was a partner, as opposed to something I had to work to find out or discover. It was running alongside me. Yeah, it felt more like I was in collaboration with it, this time." Using one bracelet (10 loop) provided a point of focus in the stillness practice- Participant 15:" I felt like I could hear the rhythm, or the impulses, and I suppose that gave me quite a visual in terms of the stillness and the breathing. If it was going that way, my breath would visually follow that pattern in space. So, drawing out my kinesphere this way or that way, or towards XXXX." It also seemed to be incorporated as an internal element, Participant 14 "So for me, it's another piece of physical information, it started to function in the same way as a sensation in my knee, or noticing my breathing, or feeling my heartbeat. It was layering in the same way any of those would, at times."
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	Participant 14: “This is... this interesting ...with the regularity with the vibration, it brings a temporality and sense of measurement to my experience. A bit like a clock, it’s kind of like a... hmmm... a baseline. Which is interesting when you are working with time and duration to have an experience within that. I found myself definitely aware and kind of moving with, or moving around, the rhythms. Certainly not directly in relation to them, but they were very much supporting the temporality of my movement and my experience. And also, a feeling of it being sometimes a fulcrum for the ways things were organising. So, it would every now and again become the centre of gravity for my perception and awareness.” There are several things here with regards to experience of improvisation; if one is completely immersed in the movement intention (or perhaps flow), then there is little recognition of time, therefore the vibration bracelets and the loop might provide measurement and therefore perhaps it is harder to be immersed, or it suspends this by being a point of focus?
Influences from socio-cultural background	The way both prototypes look and where they are worn (not just location for movement initiation, but whether they can visually be seen during moving) does influence the experience as Participant 15 points out: “I think it’s also a difference of whether you can see it or not, so with the bracelet, there were a few times where I was looking at it, and in doing so, I thought I can touch it, interact with it. With the other one, with it being under the shirt and being at the back, and black, as you say, it was just part of me. And getting information in a different way, and something about not seeing it. And this looks a bit medical, umm so many layers, you have got so much to write about”. Thus, connotations can bring about different ideas about what the tech is doing to the body and possibly the type of relationship one has with it. Viewing the arm and deciding about how intrusive it is or not, combined with seeing it or relying on the sensation. Participant 15: “I just feel it doesn’t necessarily make me move in a different way, it somehow shines a light on a brighter area of my understanding of what I am doing in space with XXXX. It’s like if I was in a room and they only followed me with a torch but wearing like six torches.” The idea that the tool can make you see in a different way about your own body is of interest. How does it do this: by heightened sensation? Through being a focus? Through allowing connections to be made in the body (kinaesthetic, tactile, auditory) which reveal different things to the dancer/choreographer? Participant 14 considers what is happening:

	"I think there's both a simultaneous listening and an awareness that you are giving something. Which is the same with these guys [the vibration prototypes]. I'm listening to the vibration, and I am aware of that, but also, I can bring that into the world, I can bring that into space and I can offer that to XXXXX... But it doesn't feel me." By opening the channels of listening to the body and what the inside might say are we then engaging with it externally in a different manner?
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10. Bibliography

Alaoui, S.F. et al. (2015) 'Strategies for Embodied Design: The Value and Challenges of Observing Movement', *Creativity and Cognition '15*, Glasgow, United Kingdom, June 22 – 25. DOI: <http://dx.doi.org/10.1145/2757226.2757238>

Allen, A.P. and Thomas, K.E. (2011) 'A Dual Process Account of Creative Thinking', *Creativity Research Journal*, 23(2), pp. 109-118.

Bacon, M. J. and Midgelow, V. L. (2010) 'Articulating choreographic practices, locating the field: An introduction', *Choreographic Practices*, 1, pp. 3–19.

Bainbridge Cohen, B. (1995) 'Sensing, Feeling, and Action: The Experiential Anatomy of Body-Mind Centering', in D.H. Johnson (ed.) *Bone, Breath, & Gesture: Practices of Embodiment*. Berkeley, California: North Atlantic Books, pp.185- 204.

Baker, C. and Sicchio, K. (n.d) 'Hacking the Body'. Available at: https://www.academia.edu/8838091/HACKING_THE_BODY_Camille_Baker_PhD_and_Kate_Sicchio_PhD (Accessed: 27 October 2016).

Baker, C. and Sicchio, K. (eds.) (2017) *Intersecting Arts and Technology in Practice: Techne/Technique/Technology*. Abingdon, Oxon: Routledge.

Banfield, J. and Burgess, M. (2013) 'A Phenomenology of Artistic Doing: Flow as Embodied Knowing in 2D and 3D Professional Artists', *Journal of Phenomenological Psychology*, 44, DOI: 10.1163/15691624-12341245

Barbieri, D. (2021) 'The Body as the Matter of Costume: a Phenomenological Practice', in S. Pantouvaki and P. McNeil (eds.) *Performance Costume: New Perspectives and Methods*. London: Bloomsbury, pp. 197-212.

Barnard, P. (2013) 'Mind and Movement Essay: Imagery and Mind', in
McGregor, W. et al. (2013) *Mind and Movement*, [resource pack], Studio
Wayne McGregor. Available at:
<http://waynemcgregor.com/learning/resources/>(Accessed: 19 November
2018)

Bastian, H.C. (1887) 'The 'muscular sense'; its nature and cortical localisation',
Brain, 10, pp. 1–137.

Batson, G. (2008) 'Proprioception'. Available at: <http://iadms.org/page/210>
(Accessed: 26 Feb 2019)

Benitez, M. and Vogl, M. (2014) 'S.A.R.A.: synaesthetic augmented reality
application', *Conference Proceedings, Shapeshifting: A Conference on
Transformative Paradigms of Fashion and Textile Design*. Auckland University
of Technology, Auckland, New Zealand, 14-16 April. ISBN: 978-1-927184-27-1

Benjamin, W. (1969) 'The Work of Art in the Age of Mechanical Reproduction',
in H. Arendt (ed.) *ILLUMINATIONS*, New York: Schochen Books, pp. 217-253.

Bermudez, B. et al. (2007) *Capturing Intention*. Emio Greco | PC and
Amsterdam School of the Arts Research Group Art Practice and Development,
ISBN 978-90-810813-3-7

Berntson, G., Gianaros, P., and Tsakiris, M. (2019) 'Interoception and the
automatic nervous system: Bottom-up meets top-down' in M. Tsakiris and H.
De Preester (eds.) *The Interoceptive Mind: From homeostasis to awareness*.
Oxford: Oxford University Press, pp. 3- 23.

Bersin, D. (1995) 'Interview with Gerda Alexander' in D.H. Johnson (ed.) *Bone,
Breath, & Gesture: Practices of Embodiment*. Berkeley, California: North

Atlantic Books, pp. 255-293.

Birringer, J. (2003) 'Dance and Interactivity', *Dance Research Journal*, 35(2), pp. 89- 111.

Birringer, J. (2008) *Performance, Technology and Science*. New York: PAJ Publications.

Birringer J. (2017) 'Metakimospheres' in S. Broadhurst and S. Price (eds.) *Digital Bodies: Palgrave Studies in Performance and Technology*. London: Palgrave Macmillan, pp. 27-49.

Birringer, J. (2018) 'Augmenting virtuality', *International Journal of Performance Arts and Digital Media*, 14(2), pp. 224-228.

Birringer, J. (2022) *Kinetic Atmospheres: Performance and Immersion*. Abingdon: Routledge.

Birringer, J. and Danjoux, M. (2005) 'The Telematic Dress: Evolving garments and distributed proprioception in streaming media and fashion performance', *Design and Performance Lab*. Available from: <http://people.brunel.ac.uk/dap/egarments.html> (Accessed: 15 March 2016).

Birringer, J. and Danjoux, M. (2009) 'Wearable performance', *Digital Creativity*, 20(1-2), pp. 95-113.

Birringer, J. and Danjoux, M. (2013) 'The Sound of Movement Wearables: Performing UKIYO', *Leonardo*, 46(3), pp. 232-240.

Bisig, D. and Palacio, P. (2016) 'Neural Narratives- Dance with Virtual Body Extensions' in *Proceedings of 3rd International Symposium on Movement Computing*, Thessaloniki, Greece, 5-6 July. DOI: 10.1145/2948910.2948925

Blades, H. and Whatley, S. (2019) 'Digital Dance', in S. Dodds (ed.) *Bloomsbury Companion to Dance Studies*. London: Bloomsbury Academic, pp. 357–384.

Bleeker, M. (ed.) (2016) *Transmission in Motion: The technologizing of dance*. Abingdon, Oxon: Routledge.

Blom, L. A. and Chaplin, L. T. (1982) *The intimate act of choreography*. Pittsburgh: University of Pittsburgh Press.

Blom, L. A. and Chaplin, L. T. (1988) *The Moment of Movement: Dance Improvisation*. London: Dance Books.

Botvinick, M. and Cohen, J. (1998) 'Rubber hands "feel" touch that eyes see', *Nature*, 391. DOI: <https://doi.org/10.1038/35784>

Bourdieu, P. (1993) *The Field of Cultural Production: Essays on Art and Literature*, Cambridge: Polity Press.

Braun, V. and Clarke, V. (2006) 'Using thematic analysis in psychology', *Qualitative Research in Psychology*, 3(2), pp. 77-101.

Bresnahan, A. (2014) 'Improvisational Artistry in Live Dance Performance as Embodied and Extended Agency', *Dance Research Journal*, 46(1), pp. 84-94.

Broadhurst, S. (2006) 'Intelligence, Interaction, Reaction, and Performance' in S. Broadhurst and J. Machon (eds.) *Performance and Technology: Practices of Virtual Embodiment and Interactivity*. London: Palgrave Macmillan, pp. 141-152.

Broadhurst, S. (2014) 'Theorising Performance and Technology: Aesthetic and Neuroaesthetic Approaches', *Australasian Drama Studies*, 65, pp. 212 – 236.

Broadhurst, S. and Machon, J. (2012) *Identity, Performance and Technology*:

Practices of Empowerment, Embodiment and Technicity. Hampshire: Palgrave Macmillan.

Brown, C. (2004) 'Arteries and avatars' in M. Brady (ed.) *Choreographic Encounters*: 2, Cork, Ireland: Institute for Choreography and Dance, pp. 39-51.

Bugg, J. (2014) 'Dancing Dress: experiencing and perceiving dress in movement', in S. Bech and R. Hann (eds.), *Scene*, 2 (1+2), pp.67-80.

Bugg, J. (2021) 'The Body as Site: Interdisciplinary Approaches to Dress in/as Performance', in S. Pantouvaki and P. McNeil (eds.) *Performance Costume: New Perspectives and Methods*. London: Bloomsbury, pp 213- 228.

Buckland, T. (ed.) (2006) *Dancing from Past to Present: Nation, Culture, Identities*. Chicago, IL: University of Wisconsin Press.

Buckwalter, M. (2010) *Composing While Dancing: An Improviser's Companion*. Madison: University of Wisconsin Press.

Burrows, J. (2010) *A Choreographer's Handbook*. London: Routledge.

Butterworth, J. (2004) 'Teaching choreography in Higher Education: a process of continuum model', *Research in Dance Education*, 5(1), pp. 45 – 67.

Butterworth, J. and Wildshut, L. (eds.) (2009) *Contemporary Choreography: A Critical Reader*. Oxon: Routledge.

Candy, L. (2006) *Practice Based Research: A Guide*. Available at: <https://www.creativityandcognition.com/research/practice-based-research/differences-between-practice-based-and-practice-led-research/> (Accessed: 24 November 2016).

Cheng, T. and Haggard, P. (2018) 'The Recurrent Model of Bodily Spatial Phenomenology', *Journal of Consciousness Studies*, 25(3-4) pp. 55-70.

Choinière, I., Pitozzi, E. and Davidson, A. (2019) *Through the Prism of the Senses. Mediation & New Realities of the Body in Contemporary Performance. Technology, Cognition & Emergent Research- Creation Methodologies*. Bristol: Intellect.

Chong Kwan, S. (2020). 'Embodied Methods in Qualitative Research', in P. Atkinson, et al. (eds.) *SAGE Research Methods Foundations*. DOI: 10.4135/9781526421036817526

Christensen, J.F., Gaigg, S.B., and Calvo-Merino, B. (2018) 'I can feel my heartbeat: Dancers have increased interoceptive accuracy', *Psychophysiology*, 55, DOI: 10.1111/psyp.13008

Cisneros, R., Whatley, S., and Sabiescu, A. (eds.) (2018) *Digital Echoes: Spaces for Intangible and Performance-based Cultural Heritage*. Cham, Switzerland: Palgrave Macmillan.

Cisneros, R. et al. (2019) 'Virtual Reality and Choreographic Practice: The Potential for New Creative Methods', *Body, Space & Technology*, 18(1), pp. 1–32.

Clark, A. (2008) *Supersizing the Mind: Embodiment, Action, and Cognitive Extension*. Oxford: Oxford University Press.

Clark, A. and Chalmers, D. (1998) 'The Extended Mind', *Analysis*, 58(1), pp. 7–19.

Clark, J.O. and Ando, T. (2014) 'Geometry, Embodied Cognition and Choreographic Praxis', *International Journal of Performance Arts and Digital Media*, 10(2), pp. 179-192.

Clarke, V. and Braun, V. (2013) 'Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning', *The Psychologist*, 26(2), pp. 120-123. Available at: <https://thepsychologist.bps.org.uk/volume-26/edition-2/methods-teaching-thematic-analysis> (Accessed: 19 November 2018).

Clayton, M., Sager, R., and Will, U. (2005) 'In time with the music: The concept of entrainment and its significance for ethnomusicology', *European Meetings in Ethnomusicology*, 11, pp. 3–142.

Collins, D. F. et al. (2005) 'Cutaneous receptors contribute to kinesthesia at the index finger, elbow, and knee', *Journal of neurophysiology*, 94(3), pp. 1699-1706.

Colombetti, G. (2011) 'Varieties of Pre-Reflective Self-Awareness: Foreground and Background Bodily Feelings in Emotion Experience', *Inquiry*, 54(3), pp. 293-313. DOI: 10.1080/0020174X.2011.575003

Colombo, D. et al. (2017) 'Egocentric and allocentric spatial reference frames in aging: A systematic review', *Neuroscience and Biobehavioral Reviews*, 80, pp. 605–621.

Company In Space (no date) *Introduction*. Available at: http://www.companyinspace.com/front/cis_fs.htm (Accessed: 24 August 2020)

Coniglio, M. (2015) 'Conclusions: Reflections, Interventions, and the Dramaturgy of Interactivity', in S. Popat and N.S. Sutil (eds.) *Digital Movement: Essays in Motion Technology and Performance*. London: Palgrave Macmillan UK, pp. 273- 284.

Coniglio, M. (2017) 'Keynote Presentation', *Movement and Computing*

Conference, Goldsmiths University, London, 28th June, 2017. Available at: <http://moco17.movementcomputing.org/> (Accessed: 31 October 2022)

Corbin, J. and Strauss, A. (eds.) (2008) *Basics of qualitative research Techniques and procedures for developing grounded theory*. Thousand Oaks, CA: Sage.

Cranny-Francis, A. (2013) *Technology and Touch: The Biopolitics of emerging technology*. London: Palgrave Macmillan.

Cseh, G.M. et al. (2016a) 'Mental and perceptual feedback in the development of creative flow', *Consciousness and Cognition*, 42, pp. 150–161.

Cseh, G. M. (2016b) 'Flow in creativity: A review of potential theoretical conflict' in L. Harmat et al. (eds.) *Flow experience: Empirical research and applications*. Berlin: Springer International, pp. 79-94.

Csikszentmihalyi, M. (1997) *Creativity: Flow and Psychology of Discovery and Invention*. New York: Harper Perennial.

Csordas, T.J. (1993) 'Somatic Modes of Attention', *Cultural Anthropology*, 8(2), pp. 135-156.

Cute Circuit (2002) 'Hug T-Shirt', Available at: <https://cutecircuit.com/the-hug-shirt/> (Accessed: 20 August 2020).

Cute Circuit (2012) 'Twitter Dress', Available at: <https://cutecircuit.com/the-twitter-dress/> (Accessed: 20 October 2016).

Cveji, B. (2017) 'Problem as a Choreographic and Philosophical Kind of Thought', in R. J. Kowal and G. Siegmund and R. Martin (eds.) *The Oxford Handbook of Dance and Politics*. New York: Oxford University Press, Chapter 11.

Danjoux, M. (2014) 'Choreography and sounding wearables', *Scene*, 2(1), pp. 197–220.

Danjoux, M. (2019) 'Design-in-Motion: Sculpting Choreosonic Wearables', *Theatre and Performance Design*, 5(1-2), pp. 114-124.

Danjoux, M. and Birringer, J. (2009) 'Wearable technology for the performing arts' in J. McCann and D. Bryson (eds.) *Smart Clothes and Wearable Technology*. Woodhead Publishing, pp. 388-419.

David, A. (2013) 'Ways of moving and thinking: the emplaced body as a tool for ethnographic research' in P. Harrop and D. Njaradi (eds.) *Performance Ethnography: Dance, Drama, Music*. Newcastle Upon Tyne: Cambridge Scholars, pp. 44-66.

Davidson, A. (2013) 'Somatics: An orchid in the land of technology', *Journal of Dance & Somatic Practices*, 5(1), pp. 3–15.

Davidson, A. (2016) 'Ontological shifts: Multi-sensoriality and embodiment in the third wave of digital interfaces', *Journal of Dance & Somatic Practices*, 8(1), pp. 21–42.

Dean, S.E. (2021) '“Aware Wearing” - a Somatic Costume Design Methodology for Performance', in S. Pantouvaki and P. McNeil (eds.) *Performance Costume: New Perspectives and Methods*. London: Bloomsbury, pp. 229- 246.

De Keersmaeker, A. T. and Cvejić, B. (2012) *A Choreographer's Score: Fase, Rosas danst Rosas, Elena's Aria, Bartók*. Brussels: Mercatorfonds/Rosas.

DeLahunta, S. (2002) 'Software for Dancers: Coding Forms', *On Translations: Performance Research*, 7(2), pp. 96-102.

DeLahunta, S. (2010) 'Shifting Interfaces: art research at the intersections of live performance and technology'. PhD Thesis. University of Plymouth, UK.

DeLahunta, S. (2018) 'Dance becoming Data: Version Two' in S. Ellis, H. Blades and C. Waelde (eds.) *A World of Muscles and Bones & Organs: Research and Scholarship in Dance*, C.Dare, Coventry University, pp.333-357. Available at: <https://www.coventry.ac.uk/research/about-us/researchnews/2018/c-dare-e-book/> (Accessed: 21 March 2020).

De Spain, K. (2011) 'Improvisation and intimate technologies', *Choreographic Practices*, 2, pp. 25–42.

De Spain, K. (2012) 'The Sorrow and the Pithy: Six Short Statements on Heidegger and Technology', *The International Journal of Screendance*, 2. Available at: <http://screendancejournal.org/article/view/6891> (Accessed: 9 Feb 2022).

De Spain, K. (2014) *Landscape of the now: a topography of movement improvisation*. Oxford: Oxford University Press.

De Spain, K. and Kaiser, P. (2000) 'Digital Dance: The Computer Artistry of Paul Kaiser', *Dance Research Journal*, 32(1) pp. 18-23.

De Vignemont, F. (2014) 'A Multimodal Conception of Bodily Awareness', *Mind*, 123(492), pp. 989–1020.

De Vignemont, F. (2018) *Mind the Body: An Exploration of Bodily Self-Awareness*. Oxford: Oxford University Press.

Dicks, B. (2014) 'Action, experience, communication: three methodological paradigms for researching multimodal and multisensory settings', *Qual Res*, 14(16), pp. 656-674.

Dietrich, A. (2004) 'The cognitive neuroscience of creativity', *Psychonomic Bulletin & Review*, 11(6), pp. 1011-1026.

Diffus (2014) '100 dancers'. Available from: <http://www.diffus.dk/100-dancers/> (Accessed: 17 October 2016).

Dim, N.K and Ren, X. (2017) 'Investigation of suitable body parts for wearable vibration feedback in walking navigation', *International Journal of Human-Computer Studies*, 97, pp. 34–44.

Dixon, S. (2007) *Digital Performance: A History of New Media in Theater, Dance, Performance Art, and Installation*, Cambridge: MA: MIT Press.

Doruff, S. (2009) 'The Tendency to Trans-: The Political Aesthetics of the Biogrammatic Zone', in J. Jeffries and M. Chatzichristodoulou (eds.) *Interfaces of Performance*, London: Routledge, pp. 121 -140.

Dourish, P. (2001) *Where the Action Is: Foundations of Embodied Interaction*, Cambridge, MA: MIT Press.

Drobny, D. and Borchers, J. (2010) 'Learning basic dance choreographies with different augmented feedback modalities.' *CHI'10 Extended Abstracts on Human Factors in Computing Systems*, Atlanta, USA, April 10-15, pp. 3793-3798. DOI: 10.1145/1753846.1754058

Drummond, J. (2007) *Historical Dictionary of Husserl's Philosophy*. Maryland: Scarecrow Press.

Eccleston, C. (2016) *Embodied: The Psychology of Physical Sensation*. Oxford: Oxford University Press.

Eddy, M. (2009) 'A Brief History of Somatic Practices and Dance: Historical Development of the Field of Somatic Education and Its Relationship to Dance.' *Journal of Dance & Somatic Practices*, 1(1), pp. 5–27.

Ehrenberg, S. (2015) 'A Kinesthetic Mode of Attention in Contemporary Dance Practice', *Dance Research Journal*, 47(2), pp. 43-61.

Farnell, B. and Wood, R. N. (2017) 'Kinaesthetic intimacy in a choreographic practice' in E. Chrysagis and P. Karampampas (eds.) *Collaborative Intimacies in Music and Dance: Anthropologies of Sound and Movement*. Oxford: Berghahn Books, pp. 65-95.

Fernandes, C. (2015) *The Moving Researcher: Laban/Bartenieff Movement Analysis in Performing Arts Education and Creative Arts Therapies*. London: Jessica Kingsley Publishers.

Forsythe, W. (no date) *Choreographic Objects*. Available at: <https://www.williamforsythe.com/essay.html> (Accessed: 24 August 2020).

Forsythe, W. et al. (1999) *Improvisation Technologies: A Tool for the Analytical Dance Eye*. Ostfildern: Hatje Cantz.

Forsythe, W. et al. (2009) *Synchronous Objects*. Available: <https://synchronousobjects.osu.edu/content.html> (Accessed: 24 August 2020).

Fortin, S., Long, W., and Lord, M. (2002) 'Three Voices: Researching How Somatic Education Informs Contemporary Dance Technique Classes', *Research in Dance Education*, 3(2), pp. 155–79.

Foster, S. L. (2010) *Choreographing Empathy: Kinesthesia in Performance*. Oxford: Routledge.

Foucault, M. (1995) *Discipline and Punish: The Birth of the Prison*, Westminister, U.S.A: Vintage.

Fraleigh, S. (2000) 'Consciousness matters', *Dance Research Journal*, 32(1), pp. 54-62.

Francksen, K. (2018) 'The Implications of Technology in Dance: A Dancer's Perspective of Moving in Media -Rich Environments', in S. Whatley, R. Cisneros and A. Sabiescu (eds.) *Digital Echos: Spaces for Intangible and Performance-Based Cultural Heritage*, London: Palgrave MacMillan, pp. 57-79.

Francoise, J. et al. (2017) 'Designing for Kinesthetic Awareness: Revealing User Experiences through Second-Person Inquiry', *CHI 2017*, Denver, CO, USA, May 6-11, pp. 5171-5183. DOI: 10.1145/3025453.3025714

Fuchs, T. (2012) 'The phenomenology and development of social perspectives', *Phenom Cogn Sci*, 12, pp. 655–683. DOI 10.1007/s11097-012-9267-x

Gabora, L. (2000) 'Toward a Theory of Creative Inklings' in R. Ascott (ed.) *Art, Technology, Consciousness: Mind@large*, Bristol: Intellect, pp. 159-164.

Gallagher, S. (2003) 'Phenomenology and Experimental Design Toward a Phenomenologically Enlightened Experimental Science', *Journal of Consciousness Studies*, 10 (9-10), pp. 85-99.

Gallagher, S. (2005) 'Dynamic models of body schematic processes', in H. De Preester and V. Knockaert (eds.) *Body Image and Body Schema*. Amsterdam: John Benjamins Publishers, pp. 233-250.

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

Gallagher, S. (2019) 'Precis: Enactivist Interventions', *Philos Stud*, 176, pp. 803–806, DOI: 10.1007/s11098-018-01230-8

Gallese, V. (2020) 'Brain, Body, Habit and the Performative Quality of Aesthetics', in I. Testa and F. Caurana (eds.) *Habits: Pragmatist Approaches from Cognitive Neuroscience to Social Science*. Cambridge, UK: Cambridge University Press, pp. 376- 394.

Gallese, V. and Lakoff, G. (2005) 'The Brain's concepts: the role of the Sensory-motor system in conceptual knowledge', *Cogn Neuropsychol*, 22(3), pp. 455-479. DOI:10.1080/02643290442000310

Gardner, S. (2007) 'The Dancer, the Choreographer and Modern Dance Scholarship: A Critical Reading.' *Dance Research*, XXV (1), pp. 35–53.

Giaccardi, E. et al. (2016) 'Thing Ethnography: Doing Design Research with Non- Humans', *DIS 2016*, Brisbane, QLD, Australia, June 04-08. DOI: 10.1145/2901790.2901905

Gibson, J. (1986) *The Ecological Approach to Visual Perception*. London: Lawrence Erlbaum Associates Publishers.

Gibson, R. (2019) *Falling Upwards: Somatic Sensing in Virtual Space*, Phd Thesis, RMIT, Melbourne, Australia.

Gill, S.P. (2012) 'Rhythmic Synchrony and Mediated Interaction: towards a framework of rhythm in embodied interaction', *AI & Society*, 27(1), pp. 111-128.

Ginot, I. (2010) 'From Shusterman's Somaesthetics to a Radical Epistemology of Somatics.' *Dance Research Journal*, 42(1) pp. 12-29.

Giomi, A. (2020) 'Somatic Sonification in Dance Performances. From the Artistic to the Perceptual and Back'. *MOCO '20*, Jersey City/ Virtual, NJ, USA, July 15–17. DOI: 10.1145/3401956.3404226

Grant, M. and Hertenberger, A. (2014) 'Lace Sensor Project', Available at: <http://lacesensorproject.com/about-this-project/> (Accessed: 18 October 2016)

Grau, A. (2007) 'Dance Anthropology and Research through practice'. Available at: www.academia.edu/199889/Dance_anthropology_and_research_through_practice (Accessed: 10 November 2016).

Green, J. (2015) 'Somatic sensitivity and reflexivity as validity tools in qualitative research', *Research in Dance Education*, 16(1), pp. 67-79, DOI: 10.1080/14647893.2014.971234

Gtat, Y. et al. (2019) 'Absolute Detection Threshold of Vibrotactile Stimulation Pulse Width and Inter-Pulse Gap', *9th International IEEE EMBS Conference on Neural Engineering*, San Francisco, CA, USA, March 20 - 23. DOI:978-1-5386-7921-0/19

Gunther, E. (2001) *Skinscape: A Tool for Composition in the Tactile Modality*, PhD thesis, Massachusetts Institute of Technology, Massachusetts, U.S.A.

Haagendoorn, I. (2010) 'Dance, choreography and the brain', in D. Melcher and F. Bacci (eds.) *Art and the Senses*. Oxford: Oxford University Press, pp. 499-514.

Haas, C.T. et al. (2006) 'The effects of random whole-body-vibration on motor symptoms in Parkinson's disease', *NeuroRehabilitation*, 21, pp. 29–36.

Hall, E. T. (1984) *The dance of life: The other dimension of time*. Garden City, NY: Anchor Press/Doubleday.

Hamdan, N. et al. (2019) 'Springlets: Expressive, Flexible and Silent On-Skin Tactile Interfaces', *CHI 2019*, Glasgow, Scotland UK, May 4–9. DOI: 10.1145/3290605.3300718

Han, J. et al. (2016) 'Assessing proprioception: A critical review of methods', *Journal of Sport and Health Science*, 5(1), pp. 80-90, DOI: 10.1016/j.jshs.2014.10.004.

Hand, J.F. (2012) 'Within and Beyond the Body: The Perception of Energy', *Repertório*, 18, pp.113-128.

Hanlon Johnson, D. (ed.) (1995) *Bone, Breath, and Gesture*. Berkeley, California: North Atlantic Books.

Hansen, M.B. (2015) *Feed-Forward: On the Future of Twenty-First-Century Media*. Chicago: University of Chicago Press.

Haraway, D. (1991) *Simians, Cyborgs and Women: The Reinvention of Nature*. Abingdon: Routledge.

Hayles, K. (1999) *How we Became Posthuman: Virtual Bodies in Cybernetics, Literature and Informatics*. Chicago: University of Chicago.

Hayles, K. (2012) *How We Think: Digital Media and Contemporary Technogenesis*, Chicago: The University Press of Chicago.

Heidegger, M. (1927) *Being and Time*. Albany, NY: SUNY Press.

Hertenstein, M. J. et al. (2006) 'Touch communicates distinct emotions', *Emotion*, 6(3), pp. 528–33.

Heywood, I. (ed.) (2017) *Sensory Arts and Design*. Abingdon: Routledge.

Himberg, T. and Thompson M. R. (2011) 'Learning and synchronising dance movements in South African songs – cross-cultural motion-capture study', *Dance Res.* 29, pp. 305–328. DOI: 10.3366/drs.2011.0022

<https://choreographiccoding.org/#/> (2022) (Accessed: 30 March 2022).

<http://insidemovementknowledge.net/project/organisation/> (2019) (Accessed: 30 March 2022).

<https://waynemcgregor.com/> (2022) (Accessed: 30 March 2022).

<https://www.deakin.edu.au/about-deakin/news-and-media-releases/articles/2009/dance-project-captures-expert-attention> (2022) (Accessed: 30 March 2022).

<https://www.touchlessai.eu/> (2022) (Accessed: 30 March 2022).

Huisman, G. (2018) 'Social Touch Technology: A Survey of Haptic Technology for Social Touch', *IEEE Trans Haptics*, 10(3). DOI: 10.1109/TOH.2017.2650221

Huisman, G. and Frederiks, A. (2013) 'Towards Tactile Expressions of Emotion through Mediated Touch', in *CHI Extended Abstracts*, Paris, France, 27 April- 2 May, pp. 1575 – 1580.

Humphrey, D. (1991) *The Art of Making Dances*. Princetown, New Jersey: Princeton Book Company.

Hunt, R. (2000) 'Being @ Installations: the space-time of technoetics', in R. Hunt (ed.) *Art, Technology, Consciousness: Mind@large*. Bristol: Intellect, pp. 144-148.

Husserl, E. (1964) *Phenomenology of Internal Time Consciousness*.
Bloomington: Indiana University Press.

Husserl, E. (1997) *Thing and Space: Lectures of 1907*. Berlin, Germany:
Springer Science+Business Media Dordrecht.

Ihde, D. (1990) *Technology and the Lifeworld: From Garden to Earth*.
Bloomington, Indiana: Indiana University Press.

Ihde, D. (2002) *Bodies in Technology*. Minneapolis: University of Minnesota
Press.

Ingold, T. (2011) *Being Alive: Essays on Movement, Knowledge and
Description*. Abingdon: Routledge.

Jacobs K.M. (2011) 'Somatosensory System', in J.S Kreutzer, J. DeLuca and B.
Caplan (eds.) *Encyclopedia of Clinical Neuropsychology*. New York: Springer,
pp. 2320 – 2324.

Järvinen, H. (2006) 'Kinesthesia, Synesthesia and *Le Sacre du Printemps*:
Responses to Dance Modernism', *The Senses and Society*, 1(1), pp. 71-92, DOI:
10.2752/174589206778055718

Jarvis, L. (2019) *Immersive Embodiment Theatres of Mislocalized Sensation*.
London: Palgrave Macmillan.

Jensenius, A. R. (2022) *AMBIENT: Investigating Bodily Entrainment to
Audiovisual Rhythms in Local and Remotely Connected Environments*.
Available at: [https://www.uio.no/ritmo/english/projects/ambient/open-
research/application/](https://www.uio.no/ritmo/english/projects/ambient/open-research/application/) (Accessed: 20 March 2022).

Jewitt, C. (2017) 'A multimodal perspective on touch, communication and learning', in F. Serafini and E. Gee (eds.) *Remixing Multiliteracies: Theory and Practice from New London to New Times*. New York, USA: Teachers College Press, pp. 106-118.

Jewitt, C., Xambo, A. and Price, S. (2016) 'Exploring methodological innovation in the social sciences: the body in digital environments and the arts', *International Journal of Social Research Methodology*. DOI: 10.1080/13645579.2015.1129143

Jewitt, C. et al. (2020) *Interdisciplinary Insights for Digital Touch Communication*. New York: Springer Briefs in Human-Computer Interaction, Springer Open. DOI:10.1007/978-3-030-24564-1

Jöbges, E.M. et al. (2002) 'Vibratory proprioceptive stimulation affects Parkinsonian tremor', *Parkinsonism and Related Disorders*, 8(3), pp. 171-176.

Jochum, E. et al. (2018) 'Becoming Cyborg: Interdisciplinary Approaches for Exoskeleton Research', *Proceedings of EVA*, Copenhagen, Denmark, 15 - 17 May 2018. DOI: 10.14236/ewic/EVAC18.40

Jones, C.A (2007) *Sensorium: Embodied Experience, Technology, and Contemporary Art*. Cambridge, MA: MIT Press.

Juhan, D. (1995) 'Job's Body: A Handbook for Bodywork', in D.H. Johnson (ed.) *Bone, Breath, & Gesture: Practices of Embodiment*. Berkeley, California: North Atlantic Books, pp. 355-378.

Kaeppeler, A. (1972) 'Method and Theory in Analyzing Dance Structure with an Analysis of Tongan Dance', *Ethnomusicology*, XVI (2), pp. 173-217.

Kalampratsidou, V. and Torres, E.B. (2019) 'Bodily Signals Entrainment in the Presence of Music', *Proceedings of the 6th International Conference on*

Movement and Computing (MOCO '19), Tempe AZ USA, October 10 – 12. DOI: 10.1145/3347122.3347125

Kapsali, M. (2017) 'Making the body all ears: Sonolope and a somatic practice of really listening', *International Journal of Performance Arts and Digital Media*, 13(1), pp. 39-54, DOI: 10.1080/14794713.2017.1300446

Karreman, L. (2017) *The Motion Capture Imaginary: Digital renderings of dance knowledge*, PhD Thesis, Ghent University, Belgium.

Khut, G. (2006) *Development and Evaluation of Participant-centred Biofeedback Artworks*, PhD thesis, University of Western Sydney, Australia.

King, L.K. et al. (2009) 'Short-term effects of vibration therapy on motor impairments in Parkinson's disease', *NeuroRehabilitation*, 25, pp. 297–306.

Kirsh, D. (2011) 'Creative Cognition in Choreography', *Proceedings of 2nd International Conference on Computational Creativity*, Mexico City, 27-29 April, Available at: <http://computationalcreativity.net/iccc2011/proceedings/index.html> (Accessed: 19 November 2018)

Kozel, S. (2008) *Closer: Performance, Technologies, Phenomenology*. Spain: MIT Press.

Kuusk, K. (2016) *Crafting sustainable smart textile services*, PhD thesis, Eindhoven University of Technology, Eindhoven, The Netherlands.

Kyrgia, T. and Toeters, M. (2014) *Transforming the dance experience with expressive social wearables*, Available at: www.inter-disciplinary.net/critical-issues/WPS-content/uploads/2014/kyrgiaperpaper.pdf (Accessed: 25 October 2016).

Lamontagne, V. (2012) 'Wearable Technologies : From Performativity to Materiality', *Studies in Material Thinking*, 07(10), pp. 1-9.

Larssen, A.T. et al. (2006) 'The Feel Dimension of Technology Interaction: Exploring Tangibles through Movement and Touch', *Proceedings of TEI*, Louisiana, 15-17 Feb, pp. 271-278.

Leach, J. (2016) 'Making Knowledge from Movement- Some notes on the contextual impetus to transmit knowledge from dance', in M. Bleeker (ed.) *Transmission in motion: the technologizing of dance*. New York: Routledge, pp.141 -154.

Legrand, D. (2007) 'Pre-Reflective Self-Consciousness: On Being Bodily in the World', *Janus Head, Special Issue: The Situated Body*, 9(1), pp. 493–519.

Legrand, D. and Ravn, S. (2009) 'Perceiving subjectivity in bodily movement: The case of dancers', *Phenomenology and the Cognitive Sciences*, 8(3), pp. 389-408.

Lepecki, A. (2010) 'The Body as Archive: Will to Re-Enact and the Afterlives of Dances', *Dance Research Journal*, 42(2), pp. 28-48.

Leuk, J.S.P., Low, L. L. N. and Teo, W.P. (2020) 'An Overview of Acoustic-Based Interventions to Improve Motor Symptoms in Parkinson's Disease', *Frontiers in Aging Neuroscience*, 12. DOI:10.3389/fnagi.2020.00243

Luria, A. R. (1973) *The Working Brain*. Middlesex, England: Penguin Books.

Maguire, M. and Delahunt, B. (2017) 'Doing a Thematic Analysis: A Practical, Step-by-Step Guide for Learning and Teaching Scholars', *All Ireland Journal of Teaching and Learning in Higher Education*, 3, pp. 3351- 33514.

Maidstone, D. and Murrar Browne, T. (2009) *Serendipitchord*, Available at: <http://dimaidstone.com/project/serendipitchord/> (Accessed 24 October 2016)

Malafouris, L. (2010). 'Metaplasticity and the human becoming: Principles of neuroarchaeology', *Journal of Anthropological Sciences*, 88, pp. 49–72.

Malafouris, L. (2013) *How Things Shape the Mind: A Theory of Material Engagement*. Cambridge, MA: MIT Press.

Malafouris, L. (2015) 'Metaplasticity and the primacy of material engagement', *Time and Mind*, 8(4), pp. 351–371.

Malafouris, L. (2018) 'Mind and material engagement', *Phenomenology and the Cognitive Sciences*, 18, pp. 1–17, DOI:/10.1007/s11097-018-9606-7

Malinowska, A. (2021) 'Demonic Interventions', *Performance Research*, 26(1-2), pp. 112-124.

Mandanici, M., Rodà, A. and Canazza, S. (2017) 'Bodily Interactions in Motion-Based Music Applications', *Human Technology*, 13(1), pp. 82–108.

Marks, L. (2001) *Touch: Sensuous Theory and Multisensory Media*. University of Minnesota Press, Available at: <http://ebookcentral.proquest.com/lib/ual/detail.action?docID=310595>. (Accessed: 10 Feb 2022)

Matthews, B. and Ross, L. (2010) *Research Methods: A practical guide for the social sciences*, Harlow: Pearson Education Ltd.

Mauss, M. (2007) 'Techniques of the Body' in M. Lock and J. Farquhar (eds.) *Beyond the Body Proper: Reading the Anthropology of Material Life*, Durham: Duke University Press, pp. 50 – 68.

McCormick, J. (2014) *Responding to human full-body gestures embedded in motion data streams through machine learning and memory*, PhD Thesis, Deakin University, Melbourne, Australia.

McDaniel, T. et al. (2010) 'A Haptic Belt for Vibrotactile Communication', *Proceedings of 2010 IEEE International Symposium on Haptic Audio Visual Environments and Games*, Phoenix, U.S.A, 16-17 October, DOI: 10.1109/HAVE.2010.5623962

McGregor, W. et al. (2013) *Mind and Movement*, [resource pack], Studio Wayne McGregor. Available at: <http://waynemcgregor.com/learning/resources/> (Accessed: 19 November 2018)

McLuhan, M. (1964/2001) *Understanding Media: the extensions of man*. London: Routledge.

Merleau-Ponty, M. (1945/1962) *Phenomenology of Perception*. London: Routledge & Kegan Paul.

Michailidis, T., Polydorou, D. and Bullock, J. (2013) 'A Multimodal integration of sensory feedback modalities for dance performances'. *Proceedings of the 1st Fascinate Conference "Thoughtful Technology and Beautiful Interfaces"*, Falmouth University, Cornwall, UK, 28-30 August, Available at: www.tychonas.com/Tychonas/...files/FASCINATE_Conference_Paper_Michailidis.pdf, (Accessed: 19 November 2018).

Moen, J. (2006) *KinAesthetic Movement Interaction*, PhD Thesis, Stockholm University, Stockholm, Sweden.

Montero, B. (2006) 'Proprioception as an Aesthetic Sense', *The Journal of Aesthetics and Art Criticism*, 64(2), pp. 231- 242.

Moore, L. (2017) 'The Bleeding Self in Digital Performance Practice: A Phenomenology of Self through the Making Process' in C. Baker and K. Sicchio (eds.) *Intersecting Arts and Technology in Practice: Techne/Technique/Technology*. Abingdon, Oxon: Routledge. Chapter 3.

Morland, F. (2019) 'In the intersection of emotion, biosensors and sound: emerging corporealities in Emovere's interaction', *Archée: arts médiatiques & cyberculture*. Available at: <http://archee.qc.ca/wordpress/in-the-intersection-of-emotion-biosensors-and-soundemerging-corporealities-in-emoveres-interaction/> (Accessed: 11 March 2020).

Morrison, A., Knoche, H., and Manresa-Yee, C. (2015) 'Designing a Vibrotactile Language for a Wearable Vest', *Proceedings, Part II, of the 4th International Conference on Design, User Experience, and Usability: Users and Interactions*, Berlin, Heidelberg, 2-7 August 2015, pp. 655-666. DOI: https://doi.org/10.1007/978-3-319-20898-5_62

Morrison A., et al. (2017) 'Interactive Furniture: Bi-directional Interaction with a Vibrotactile Wearable Vest in an Urban Space', in A. Brooks et al. (eds.) *Recent Advances in Technologies for Inclusive Well-Being*. Intelligent Systems Reference Library, vol 119. Cham, Switzerland: Springer, pp. 183-220.

Murray-Browne, T. (2012) *Interactive music: Balancing creative freedom with musical development*, PhD thesis, Queen Mary University of London, London, United Kingdom.

Myers, N. and Dumit, J. (2011) 'Haptic Creativity and the Mid-embodiments of Experimental Life' in F.E. Mascia-Lees (ed.) *A Companion to the Anthropology of the Body and Embodiment*. Oxford: Blackwell Publishing, pp. 239-261.

Naugle, L.M. (1998) 'Technique/Technology/Technique', *Dance Research Journal*, 30 (1), pp. 13-15.

Noë, A. (2004) *Action in Perception*. Cambridge, Massachusetts: The MIT Press.

Noë, A. (2016) 'Newman's note, entanglement and the demands of choreography - Letter to a choreographer', in M. Bleeker (ed.) *Transmission in Motion: The technologizing of dance*, Abingdon, Oxon: Routledge. Chapter 20.

Nunez- Pacheco, C. and Loke, L. (2017a) 'The Body as a Source of Aesthetic Qualities for Design: Explorations and Techniques'. *Proceedings TEI 2017*, Yokohama, Japan, March 20-23. DOI:10.1145/3024969.3025049

Nunez- Pacheco, C. and Loke, L. (2017b) 'Tacit Narratives: Surfacing Aesthetic Meaning by Using Wearable Props and Focusing'. *Proceedings TEI 2017*, Yokohama, Japan, March 20–23. DOI: 10.1145/3024969.3024979

O'Dell, T. and William, R. (2013) 'Transcription and the Senses', *The Senses and Society*, 8(3), pp. 314-334, DOI:10.2752/174589313X13712175020550

O'Reilly, K. (2012) *Ethnographic Methods*. Abingdon, Oxon: Routledge.

Ortiz, M. (n.d) 'A Brief History of Biosignal-Driven Art: From biofeedback to biophysical performance', *Canadian Electroacoustic Community, eContact!*, 14(2), Available at: http://electrocontact.ca/14_2/ortiz_biofeedback.html (Accessed:28 October 2016)

Parisi, D. (2018) *Archaeologies of Touch: Interfacing with Haptics from Electricity to Computing*. Minnesota: University of Minnesota Press.

Parisi, L. and Portanova, S. (2011) 'Soft thought (in architecture and choreography)', *Computational Culture* (1), Available at: <http://computationalculture.net/soft-thought/> (Accessed:13 August 2020).

Parviainen, J. (2010) 'Choreographing Resistances: Spatial-Kinaesthetic Intelligence and Bodily Knowledge as Political Tools in Activist Work', *Mobilities*, 5, pp. 311-329. DOI:10.1080/17450101.2010.494838.

Parviainen, J. (2011) 'Dwelling in the Virtual Sonic Environment: A Phenomenological Analysis of Dancers' Learning Processes', *The European Legacy: Toward New Paradigms*, 16(5), pp. 633-647.

Parviainen, J. et al. (2013) 'Gestures within Human-Technology Choreographies for Interaction Design', *Proceedings of the 10th International Gesture Workshop and the 3rd Gesture and Speech in Interaction Conference*. Tilburg: Tilburg University, June 19-21. Available at: <http://tiger.uvt.nl/pdf/papers/parviainen.pdf> (Accessed: 19 November 2018).

Paterson, M. (2007) *The Senses of Touch: Haptics, Affects and Technologies*. Oxford: Berg.

Phillips-Silver, J., Aktipis, C. A., and Bryant, G. A. (2010) 'The ecology of entrainment: Foundations of coordinated rhythmic movement', *Music Perception*, 28(1), pp. 3–14. DOI: 10.1525/mp.2010.28.1.3

Pink, S. (2013) *Doing Sensory Ethnography*. London: Sage.

Pirhonen, A., Tuuri, E. and Erkut, C. (2017) 'Guest Editors' Introduction, Human–Technology Choreographies: Body, Movement, And Space In Expressive Interactions', *Human Technology*, 13(1), pp. 6-9. DOI: 10.17011/ht/urn.201705272515

Pitozzi, E. (2014) 'The Perception is a Prism: body, presence, and technologies', *Brazilian Journal on Presence Studies*, Porto Alegre, 4 (2), pp. 174-204.

Pohl, C. and Hirsch Hadorn, G. (2008) 'Methodological challenges of transdisciplinary research', *Natures Sciences Sociétés*, 16(2), pp.111-121.

Potter, C. (2008) 'Sense of Motion, Senses of Self: Becoming a Dancer', *Ethnos*, 73(4), pp. 444-465. DOI: 10.1080/00141840802563915

Poutanen, O., Ylirisku, S. and Hoppu, P. (2017) 'Technology Choreography: Studying Interactions in Microsoft's Future Visions Through Dance', *Human Technology*, 13(1), pp. 10–31. DOI: <http://dx.doi.org/10.17011/ht/urn.201705272516>

Priplata, A., et al. (2003) 'Vibrating insoles and balance control in elderly people' *Lancet*, 362, Oct 4th, pp. 1123–24.

Punkanen, M. and Ala-Ruona, E. (2012) 'Contemporary Vibroacoustic Therapy: Perspectives on Clinical Practice, Research, and Training', *Music and Medicine*, 4(3) pp. 128-135. DOI: 10.1177/1943862112445324

Quinn, B. (2012) *Fashion Futures*. London: Merrell.

Rajko, J., et al. (2016) 'Touching Data through Personal Devices: Engaging Somatic Practices and Haptic Design in Felt Experiences of Personal Data', in *Proceedings of 3rd International Symposium on Movement Computing*, Thessaloniki, Greece, 5-6 July. DOI: 10.1145/2948910.2948937

Ravn, S. (2017) 'Dancing Practices: Seeing and Sensing the Moving Body', *Body and Society*, 23(2), pp. 57–82. DOI: 10.1177/1357034X16677738

Ravn, S. and Hansen, H.P. (2013) 'How to explore dancers' sense experiences? A study of how multi-sited fieldwork and phenomenology can be combined', *Qualitative Research in Sport, Exercise and Health*, 5(2), pp. 196-213. DOI: 10.1080/2159676X.2012.712991

Reynolds, W. (1974) 'Foundations for the Analysis of the Structure and Form of Folk Dance: A Syllabus', *Yearbook of the International Folk Music Council*, (6), pp. 115-135. International Council for Traditional Music.

Rhodes, B. (2016) *A brief history of wearable computing*. Available at: www.media.mit.edu/wearables/lizzy/timeline.html (Accessed: 25 April 2017).

Rouhiainen, L. (2003) *Living Transformative Lives. Finish Freelance Dance Artists Brought into Dialogue with Merleau-Ponty's Phenomenology*. Helsinki: Helsinki Theatre Academy.

Rutgeerts, J. et al. (2018) 'Choreographing Research: Interdisciplinarity to the Second Degree', in A. Stefan and M. Sarco-Thomas (eds.) *Interdisciplinarity in the Performing Arts: Contemporary Perspectives*. Malta: University of Malta Press, pp. 23-40.

Ryan, S. E. (2014) *Garments of Paradise: Wearable Discourse in the Digital Age*. Massachusetts: MIT Press.

Saadatian, E. et al. (2014) 'Mediating intimacy in long-distance relationships using kiss messaging', *Int. J. Hum.-Comput. Stud*, 72(10), pp. 736–746. DOI: <https://doi.org/10.1016/j.ijhcs.2014.05.004>

Sagasti, F. (2019) 'Information Technology and the Arts: The Evolution of Computer Choreography during the Last Half Century', *Dance Chronicle*, 42(1), pp. 1-52.

Salazar Sutil, N. (2017) 'Human Movement as Critical Creativity: Basic Questions for Movement Computing', *Computational Culture: a journal of Software Studies*, 6, Available at: <http://computationalculture.net/section-editorial-human-movement-as-critical-creativity-basic-questions-for-movement-computing/> (Accessed: 1 March 2018).

- Salazar Sutil, N. and Popat, S. (eds.) (2015) *Digital Movement: Essays in Motion technology and Performance*. London: Palgrave MacMillan.
- Saldana, J. (2008) *The Coding Manual for Qualitative Research*. London: Sage.
- Salter, C. (2010) *Entangled: Technology and the Transformation of Performance*. Cambridge, MA: MIT Press.
- Savrami, K. (2017) 'A duet between science and art: neural correlates of dance improvisation', *Research in Dance Education*, 18(3), pp. 273-290.
- Schacher, J. (2018) 'What Quality? Performing Research on Movement and Computing' in *Proceedings of 5th International Symposium on Movement Computing*, Genoa, Italy, June 28–30. DOI:/10.1145/3212721.3212834
- Schiller, G. (2003) *The Kinesfield: A Study of Movement-Based Interactive and Choreographic Art*, PhD Thesis, University of Plymouth, Plymouth, United Kingdom.
- Schiller, G. (2008) 'From the Kinesphere to the Kinesfield: Three Choreographic Interactive Artworks', *LEONARDO*, 41(5), pp. 431–437.
- Schiller, G. and Rubidge, S. (eds.) (2014) *Choreographic Dwellings: Practising Place*. London: Palgrave Macmillan.
- Schiphorst, T. (2007) *The Varieties of User Experience: Bridging Embodied Methodologies from Somatics and Performance to Human Computer Interaction*, PhD Thesis, University of Plymouth, Plymouth, United Kingdom.
- Seymour, S. (2009) *Fashionable Technology: the intersection of design, fashion, science and technology*. New York: Springer.

Sharir, Y. (2013) *Beyond the Electronic Connection: The Technologically Manufactured Cyber-Human and Its Physical Human Counterpart in Performance: A Theory Related to Convergence Identities*, PhD Thesis, Plymouth University, Plymouth, United Kingdom.

Sheets- Johnstone, M. (1981) 'Thinking in movement', *Journal of Aesthetics and Art Criticism*, 39(4), pp. 399–407.

Sheets- Johnstone, M. (2006) 'Essential clarifications of 'self-affection' and Husserl's 'sphere of ownness': First steps toward a pure phenomenology of (human) nature', *Continental Philosophy Review*, 39, pp. 361–391. DOI: 10.1007/s11007-006-9039-9

Sheets- Johnstone, M. (2009) *The Corporeal Turn: An Interdisciplinary Reader*. Exeter: Imprint Academic.

Sheets-Johnstone, M. (2011a) *The Primacy of Movement*. Amsterdam: John Benjamins.

Sheets-Johnstone, M. (2011b) 'Embodied minds or mindful bodies? A question of fundamental, inherently inter-related aspects of animation', *Subjectivity*, 4(4), pp. 451–466.

Sheets-Johnstone, M. (2018) 'Why Kinesthesia, Tactility and Affectivity Matter: Critical and Constructive Perspectives', *Body & Society*, pp. 1–29.

Sheets- Johnstone, M. (2019) 'Kinesthesia: An extended critical overview and a beginning phenomenology of learning'. *Cont Philos Rev*, 52, pp. 143–169.

Sherrington, C.S. (1906) *The Integrative Action of the Nervous System*. New Haven, Connecticut: Yale University Press.

Shusterman, R. (1999) 'Somaesthetics: A Disciplinary Proposal'. *The Journal of Aesthetics and Art Criticism*, 57 (3), pp. 299-313.

Sicchio, K., et al. (2016) 'Hacking the Body 2.0: Flutter/Stutter', *Proceedings of the 2016 International Conference on Live Interfaces*, University of Sussex, Brighton, 29 June- 3 July, Available at:
<http://reframe.sussex.ac.uk/reframebooks/archive2016/live-interfaces/>,
(Accessed: 4 March 2019)

Sklar, D. (2000) 'Reprise: On Dance Ethnography', *Dance Research Journal*, 32(1), pp. 70–77.

Sklar, D. (2006) 'Qualities of Memory --Two Dances of the Tortugas Fiesta, New Mexico', in T. Buckland (ed.) *Dancing from Past to Present: Nation, Culture, Identities*. Madison: University of Wisconsin Press, pp. 97-122.

Sklar, D. (2008) 'Remembering Kinaesthesia: An Inquiry into Embodied Cultural Knowledge', in C. Noland and S.A. Ness (eds.) *Migrations of Gesture*. Minneapolis: University of Minnesota Press, pp. 85 – 112.

Smelik, A., Toussaint, L. and Van Dongen, P. (2016) 'Solar Fashion: an embodied approach to wearable technology', *International Journal of Fashion Studies*, 3(2), pp. 287- 303.

Smyth, M. M. (1984) 'Kinesthetic Communication in Dance', *Dance Research Journal*, 16(2), pp. 19-22.

Song, S., et al. (2016) 'An End-to-End Spatial-Temporal Attention Model for Human Action Recognition from Skeleton Data', *Proceedings of the Thirty-First AAAI Conference on Artificial Intelligence (AAAI-17)*, Phoenix, Arizona USA, February 12–17. Available at: <https://arxiv.org/pdf/1611.06067.pdf> (Accessed: 4 March 2019)

Stoppiello, D. (2009) 'Translation: Words < - > Movement < - > Bits', in S. Broadhurst and J. Machon (eds.) *Sensualities/Textualities and Technologies: Writings of the Body in 21st Century Performance*. Palgrave Macmillan UK, pp. 162-176.

Stuart, S. (2009) 'The mindsized mashup mind isn't supersized afterall', *Analysis*, 70(1), pp. 174-183.

Stuart, S. (2011) 'Enkinaesthesia: The Fundamental Challenge For Machine Consciousness', *International Journal of Machine Consciousness*, 3(1), DOI: 10.1142/S1793843011000650

Stuart, S. (2017) 'Enkinaesthesia: Proto-moral value in action-enquiry and interaction', *Phenom Cogn Sci*, 17, pp. 411-431.

Sweeney, R. (2009) *Transferring principles: the role of physical consciousness in Butoh and its application within contemporary performance praxis*, PhD thesis, Middlesex University, London, United Kingdom.

Sweeney, R. (2017) 'Animate Shadows: Exploring synaesthesia and kinesthesia within digitalized dance', *Body, Space and Technology Journal*, 16(0), Available at: <https://www.bstjournal.com/articles/6/> (Accessed: 19 November 2018).

Synectic (2019) *Everything you need to know about nitinol*. Available at: <https://synectic.net/everything-you-need-to-know-about-nitinol/> (Accessed: 2 July 2020).

Thaut, M. H., McIntosh, G. C., and Hoemberg, V. (2015) 'Neurobiological foundations of neurologic music therapy: Rhythmic entrainment and the motor system', *Frontiers in Psychology*, 5, 1185, pp. 1-6. DOI: 10.3389/fpsyg.2014.01185

TheOpenEndedGroup (no date) '*How Long...* (2005)'. Available at: <http://openendedgroup.com/artworks/howlong.html>. (Accessed on 24 August 2020).

Thomas, H. and Ahmed, J. (eds.) (2004) *Cultural bodies: Ethnography and theory*. Malden, MA: Blackwell Publishing.

Thrift, N. (2004) 'Movement-space: The changing domain of thinking resulting from the development of new kinds of spatial awareness', *Economy and Society*. November. DOI: 10.1080/0308514042000285305

Tibbits, S. (2017) *Active Matter*. Cambridge, MA: MIT Press.

Tilbury, N. (2009) 'Digital skins: body atmospheres', *KIOSK* (3), pp. 8-13.

Toeters, M. and Kyrgia, T. (2014) 'Transforming the dance experience with expressive social wearables', *Inter-Disciplinary.Net- A Global Network for Dynamic Research and Publishing: 5th Global Conference*, Prague, Czech Republic, November. Available at: https://www.researchgate.net/publication/305201229_Transforming_the_dance_experience_with_expressive_social_wearables/comments (Accessed: 21 March 2022).

Tognazzi, P. (2011) *WearMe_SuperNow*, Available at: <http://www.wearabledynamics.com/portfolio/aurora-bolear/> (Accessed: 22 October 2016).

Toner, J., Montero, B. G., and Moran, A. (2016) 'Reflective and Prereflective Bodily Awareness in Skilled Action', *Psychology of Consciousness: Theory, Research, and Practice*, 3(4). DOI:/10.1037/cns0000090

Tsakiris, M. and de Preester, H. (eds.) (2019) *The Interoceptive Mind: From homeostasis to awareness*. Oxford: Oxford University Press.

Tuuri, K. and Eerola, T. (2012) 'Formulating a Revised Taxonomy for Modes of Listening', *Journal of New Music Research*, 41(2), pp. 137–152.

Tuuri, K., Parviainen, J. and Pirhonen, A. (2017) 'Who Controls Who? Embodied Control Within Human–Technology Choreographies†', *Interacting with Computers*, 29. DOI:10.1093/iwc/iww040

Tyldesly, B. and Grieve, J. (2002) *Muscles, Nerves and Movement in Human Occupation*. Malden, MA: Blackwell Publishing.

V2_Institute for the Unstable Media (2011) *Performative Wearables*. Available at: www.v2.nl/lab/blog/performativity-wearables/ (Accessed:28 October 2016).

Valenzuela-Moguillansky, C., Reyes-Reyes, A. and Gaete, M. (2017) 'Exteroceptive and Interoceptive Body-Self Awareness in Fibromyalgia Patients', *Frontiers in Human Neuroscience*, 11. DOI: 10.3389/fnhum.2017.00117

Varela, F.J., Thompson, E. and Rosch, E. (2017) *The Embodied Mind: Cognitive Science and Human Experience*, Cambridge, MA: The MIT Press.

Vasileva, B. (2016) 'Dramaturgies of the Gaga Bodies: Kinesthesia of Pleasure/Healing*' *Danza e Ricerca*, 7(8), pp. 77-99. DOI: <https://doi.org/10.6092/issn.2036-1599/6605>

Warburton, E. (2011) 'Of meanings and movements: Re-languaging embodiment in dance phenomenology and cognition', *Dance Research Journal*, 43(2), pp. 65-83.

Warfel, T. Z. (2009) *Prototyping: A Practitioner's Guide*. New York: Rosenfeld Media.

Weiser, M. and Seely Brown, J. (1996) *The Coming Age of Calm Technology*. Available at: www.ubiq.com/hypertext/weiser/acmfuture2endnote.htm (Accessed: 3 January 2017).

Weiss, G. (1999) *Body Images: Embodiment as Intercorporeality*, New York and London: Routledge.

Wensveen, S. and Matthews, B. (2014) 'Prototypes and prototyping in design research', in P. Rodgers and J. Yee (eds.) *Routledge Companion to Design Research*. London: Routledge. pp. 262-276.

Whatley, S., Varney, R. and Bennett, D. (2008) *Siobhan Davies RePlay*. Available at: <http://www.siobhandaviesreplay.com/> (Accessed: 24 August 2020)

Whatley, S. and Sabiescu, A. G. (2016) 'Interdisciplinary Collaborations in the Creation of Digital Dance and Performance: A Critical Examination', in K.J. Borowiecki et al. (eds.) *Cultural Heritage in a Changing World*. Springer Open, pp.17-36.

Wilde, D. (2011) *Swing That Thing: moving to move. The poetics of embodied engagement*, PhD thesis, Monash University, Melbourne, Australia.

Williams, D. (2019) 'Semasiology: A Semantic Anthropologist's View of Human Movements and Actions', *Journal for the Anthropological Study of Human Movement*, 26(2). Available at: <https://jashm.press.uillinois.edu/26.2/williams.html> [Accessed: 8 January 2020]

Wong, H.Y. (2014) 'On the Multimodality of Body Perception in Action', *Journal of Consciousness Studies*, 21 (1–12), pp. 130-139.

Wong, H.Y. (2015) 'On the Significance of Bodily Awareness for Bodily Action',

Philosophical Quarterly, 65(261), pp. 790–812.

Wong, H.Y. (2017) 'On Proprioception in Action: Multimodality versus Deafferentation', *Mind and Language*, 32(3), pp. 259–282.

DOI:10.1111/mila.12142

Wood, K., Cisneros, R. E., and Whatley, S. (2017) 'Motion Capturing Emotions', *Open Cultural Studies*, 1(1), pp. 504-513.

Zahavi, D. (2001) 'Beyond empathy: Phenomenological approaches to intersubjectivity' in E. Thompson (ed.) *Between ourselves: Second-person issues in the study of consciousness*. Imprint Academic, pp. 151–167.

Zahavi, D. (2003) *Husserl's Phenomenology*. Stanford CA: Stanford University Press.

Zahavi, D. (2005) *Subjectivity and Selfhood: Investigating the first-person perspective*. Cambridge, MA: The MIT Press.

Zheng, A. et al. (2009) 'Effects of a low-frequency sound wave therapy programme on functional capacity, blood circulation and bone metabolism in frail old men and women', *Clin Rehabil*, 23(10), pp. 897-908.