

Using digital touch in the process of improvising and the implications for kinaesthesia

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Abstract

The Digital Touch Project took place between 2019 and 2020 and is part of wider research considering wearable technology in dance-making. In questioning the use of body-worn digital tools/aids in the dance-making process, the project aimed to discover more about how technology-assisted creativity operates and its influence. Six experienced dancers/choreographers utilized the prototypes in their choreographic practices. The workshops enabled data collection via a mixed-method approach of semi-structured interviews, embodied participation (researcher as a participant), fieldnotes and movement analysis from video footage. The coded data and thematic analysis have been collated with the transcribed movement and provide evidence towards two different forms of digital touch and its promotion of heightened attentional focus, greater fluidity of interoceptive and exteroceptive abilities within improvisation and varied working relationships with the prototypes.

Keywords: wearable technology, improvisation, interoception, exteroception, multimodality, somatosense, selective entrainment, choreography

Research investigating how we move with the addition of body-worn technology can reveal the potential of future creative technological opportunities and provide a much-needed addition to work critically considering movement with computers. 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, cited in [Choinière et al. 2019: 10.5](#)). The existing literature on technology and kinaesthesia fall mainly into three categories: 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](#)), including the outward-in logic promoted by [Karreman \(2017\)](#), and the restrictions and new ways of moving by [Bisig and Palacio \(2016\)](#). Second, a group for the sensory reorganization invited by technology use ([Davidson 2013](#); [Sweeny 2017](#); [Choinière 2019](#); [Pitozzi 2019](#); [Giomi 2020](#)) and lastly, discussing the destabilization or disruption to kinaesthetic awareness resulting from technologies ([Jochum et al. 2018](#); [Moore 2017](#); [Malinowska 2021](#)).

Academic-practitioners using somatic practices as a research method have and continue to enrich the ontological and epistemological debate of the body and technology and evidence an ability to adopt and shift between different phenomenological perspectives of lived experience in data capture and documentation ([Schiphorst 2007](#)). Through practice they have evidenced links between movement sonification, kinaesthesia and a developed ability to listen to the body ([Kapsali 2017](#)); promote the process of listening, attunement and conscious awareness of technology with wearable sensors and body data ([Morland 2019](#)). This project furthers the work of [Davidson \(2013\)](#) and her discussion on how the physical/technological interface enables multiple states of presence during the creative process. According to the later work of Davidson, in the co-authored book with [Choinière and Pitozzi \(2019\)](#), 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.

Whilst this literature provides a context, it is evident that most research is based on technology in a performance setting and within interactive environments. Further research focusing on the *process* of making dance and with emerging technologies considering broader forms of sensory appreciation would contribute to the field. In using the term ‘digital touch’, this research adopts an extended definition of [Jewitt et al. \(2020\)](#), moving beyond the sociocultural element of touch through digital means ([Jewitt et al. 2020](#): 24) and instead

applying the term to explore artistic movement creation. This research does not seek to emulate realistic versions of touch through digital means, and it has been an intentional decision to move beyond the commercially influenced term of *haptics*. Haptics development is limited mainly to hand-based interactions, this research highlights the importance of the *whole, moving* body and its role in this practice.

The Digital Touch Project emerged from research questions focusing on how forms of digital touch stimuli impact the dancers'/choreographers' kinaesthesia and how this might inform the creative process of choreography. Additionally, it grew out of the second project within the researcher's Ph.D. research which incorporated the creation of new prototypes with different forms of digital touch. The pump prototype was designed and made with the advice and use of the facilities of the Digital Anthropology Lab, London College of Fashion. Inspired by soft robotic structures, the prototype is worn around the waist, with a silicone inflatable waistband and the batteries, micro-processor and pumps, with tubes inflating and deflating the silicone structure, inducing an 'on and off' effect of pressure on the skin of the participant. The workshops also utilized an additional prototype developed for an earlier project: the vibration prototype used at the wrists (bracelets) includes a haptic motor controller, a micro-processor, a battery and a small motor to create ten distinct types of vibration on a loop, and the second bracelet contains over one hundred vibration patterns.

Figure 1: Circuit for the pump prototype.

A colour photograph showing the circuit within white casing for the pump prototype. The electronics and parts include: two small motors, two electronic prototyping boards, Adafruit feather micro-processor and different colour wires connecting the circuit.

Figure 2: Inflatable waistbands for the pump prototype.

A colour photograph showing two white waistbands lying on a board. Each band has Velcro attached either end of a thick elastic band. In the middle of the band there is a rectangular silicone structure, with chambers inside. Tubes are attached to the silicone chambers.

Methods

The workshops embraced the existing practices of the participants and the diversity of their backgrounds, within the naturalistic setting of dance studios and hired community halls. By using a sample of six participants and asking them to adopt the prototypes for timeframes between four and nine hours, this research considers the individual experiences and the trends across the participant group as a whole. The participants primarily came from contemporary dance backgrounds, with two practitioners also having training in urban dance. One choreographer/dancer held 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, reflecting a mix of knowledge and understanding of the making, workings and familiarity with the materials. Where appropriate to the space and participant's practice, the researcher worked alongside the participant in improvisation, experiencing the same prototype and, in some cases, learning small parts of the participant's movement. These exchanges and experiences allowed tacit knowledge acquisition and facilitated richer discussion between tasks and during the interviews.

As the second project into a broader Ph.D. research topic, the aim was to use different forms of digital touch with more experienced choreographers/dancers and focus on how the prototypes would incorporate into the participants' existing practices. Most participants spent time exploring the looped patterns of digital touch as a stimulus for improvisation, with three

spending less time using the prototypes to adapt and edit existing movement material. Some participants used the feeling/sound, and other sensory and imaginary input gained from the environment/body, to initiate their movement response. Others used the sensation alongside their response to their resources (glasses to adapt vision) or structures (timed intervals for specific improvisation tasks). The coded patterns of tactile sensation were created with no specific aesthetic motivation by the researcher, however, combining different strengths, speeds and impulses of digital touch could, in theory, prompt initial dynamic responses. The findings indicate that all those who worked with the prototypes moved through different working relationships/stances during the workshops, and subsequently, their movement responses developed.

The participants' perceptions of the experience were gained by conducting semi-structured interviews. All interviews were transcribed verbatim and then coded. Using field and analytic notes, the researcher considered the dialogue between the data and coding, noting occurrences, biases and thoughts about the events. Finally, movement analysis from the workshops was made possible by viewing video recordings in tandem with embodied knowledge. [Figure 3](#) depicts these different methods for collecting, analyzing and collating the data for both projects.

Figure 3: Chart of methods for collecting and analysing data in the Digital Touch Project.

A blue chart, documenting the methods and analysis. From the left top corner, this includes a box with 'semi-structured interviews', with a line leading to a box with 'transcription'. Below this is a box with 'Researcher's fieldnotes from conversations and observations'. Both the aforementioned boxes have lines to another box labelled 'In vivo and open coding'. Another line leads to a box called 'Matrix (individual and group)', which then leads to the last box on the right side of the chart labelled 'Themes and Trends'. Underneath this section, are two more boxes labelled, 'Video recordings' and 'Embodied memory' that both have lines

leading to a box called 'Movement Analysis'. This joins the box labelled Matrix (individual and group) as previously described.

The amalgamation of sensory/dance ethnography practices and human–computer interaction influenced the data capture and treatment, resulting in a mixed-method approach. Of importance was the consideration of sensory reception, the participants' creative engagement and understanding the experiences and practices of others (human and non-human). The combined data of the researcher's field notes and interviews were considered alongside the researcher's embodied experience and the movement analysis from the videoed workshops.

Ethnographer Sarah Pink (2013) argues for the usefulness of practical experience and how it links to the 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: 121). This research enabled opportunities for understanding the participants' experience through sharing, reviewing the experience in the interview and physically revisiting aspects of improvisation.

Furthermore, research foregrounding the dancer's experience with technology via interview data (Whatley 2015) provides a valuable resource to consider technology use through subjective experience. It also enriches the dialogue and debates across the use of different technologies. Within this domain, Kim Vincs and Stephanie Hutchinson reflect on their practice and adoption of the motion capture suit over several years of research, arguing that 'an openness to admitting movement modalities, qualities, textures and sensations simultaneously from sources inside and outside the dancer [is] integral to the process' (Hutchinson and Vincs 2013: 1).

Findings

Coded themes

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, organizing their improvisation experience. At the beginning of working with the pump prototype, participants felt that they needed to *listen* to what they received from the silicone inflatable. With further practice, this initial response subsided, evolving a different stance or relationship to the technology. This could be described as working alongside or in collaboration with the prototypes, resulting in less direct attention to the sensation and sound.

Participants considered the placement of the prototypes and the localization of the digital touch sensation; this aspect was connected to the theme of *internalized 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. Some participants played with both rhythm and *trajectories*, with their bodily relationship to both visual/auditory stimuli combining the real with the imagined response.

We can connect the themes of *attentional focus* and the inability to actualize the initial creative intention (*'it doesn't feel right'*) to the idea of *entrainment*: synchronizing with the patterns of sensation/rhythm emitted by the sound of the prototypes. 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.

Movement analysis themes

Improvisation with the pump prototype

The use of the pump prototype during the improvisation process influenced actions. For example, the rippling and undulating from the lower torso through the body and in the upper body curves and hunching over in lower contractions. The researcher observed rocking and playing with the transference of weight; this was also referred to in the experience of Participant 11. Hip isolation occurred, shifting the pelvis forward and back and hula movements rotating around on the horizontal plane. Additionally, there were rolls on the floor and playing with balance and off-balance.

Overall, most participants started with quite a slow and steady pace and then increased speed as the improvisation continued. This is due to the subtlety of the inflatable, as mentioned by Participants 10, 12 and 13, whereby the participants listened and paid attention to the sensations on the skin at the beginning of use. 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 or use of demi-pointe in turns, but this was minimal and unrepresentative of any extensive use of movement on a higher level.

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 then placed in various positions in space. In some instances, the arms

were placed in space, reorientating the body based on that position. For example, the stepping of the legs using stepping patterns – behind, side and back – also indicates a reorientation 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 appearing across the participant group. There was a start-stop quality to the movement, representing the rhythm of the loops of coded tactile stimuli from the prototypes.

Discussion

Attentional focus

The findings suggest that the pump prototype dominated the initial improvisation. The core of the body – where 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 accessible range of the body. 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. Some participants viewed this pull of attention as a favourable implication of collaborating with the technology and described the benefits of working with the vibration prototype. Others found that the focus and localization of the prototypes excessively dominated their improvisation experience.

I think the technology [the sensation of vibration] keeps me thinking more about. [...] 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)

It's just interrupting, and your attention is always drawn to the wearable. [...] I felt like it was always tethered to my wrist or tethered to my waist.

(Participant 13, 2019, Interview 1)

The participants' felt sense of movement (kinaesthesia) adapts by wearing technology that produces tactile sensations. For example, the prototypes cannot be incorporated into the kinaesthesia, as the looped patterns of sensation remind the user of their corporeal existence rather than receding into the background. As such, the dancer/choreographer's use of their own body to create movement and interpret internalized vibration and pressure from the wearable technology is always relational. Consequently, this impacts the dancers'/choreographers' use of sensation and feeling in creating movement through improvisation.

To summarize, 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 internalized perspective, influencing movement initiation, range and, to a lesser extent, dynamic qualities. The heightened awareness of the body from the tactile sensation emitted by the prototype can result in a greater focus through practice.

Observable within Birringer's extensive work into interactive environments and improvisatory exploration, the meaning-making process in this activity was led mainly 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: 214–32). 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 – 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, the project’s findings suggest slightly different repercussions from working with digital touch. The implications of time proved to be a factor when experiencing subjective time and building familiarity with the prototypes over more extended periods. In this research, I observed the direct response discussed by Birringer (2008) but also recorded several other ways an improviser might work with these prototypes as a tool/aid.

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 improvisation.

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 body’s core dominated the observable movement, involving participants moving their backs, hips and torsos. Generally, the even pace of the code and the connected sound/sensation made the prototype predictable and even. By contrast, housing the vibration prototype bracelets at the wrists promoted more significant use of the extremities, and when using both bracelets together created pre-emption, adaption or an

interruption of the movement intention due to the two different looped patterns of sensation.

The location of the prototypes guided where movement emerged from, subsequently influencing the spatial pathway and its relationship to the body. Participant responses to improvising with the vibration bracelets showed wrapping and replacing of hands and the framing of the upper body. 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.

Ravn's (2017) ethnographic fieldwork of thirteen dancers suggests that contemporary dancers use their kinaesthesia and subsequent awareness of space during movement to connect to both the natural 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: 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 internalized 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. The participants connected to sound and sensation, which 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, revealing a multimodal process implicated in an adapted kinaesthesia.

Internalized 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. 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 heightened awareness of the body's exterior against other surfaces (Participant 11, 2019, Interview).

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

[E]xtending 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: 5)

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

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 [...] 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: 2). The participant’s anecdotes suggest that they establish a new sensitivity, and therefore, a heightening or amplification emerges due to, in this case, 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 both placed a greater emphasis on the internal. Participant 11 refers to sensations within the body – vibration going up and down the forearm – influencing the movement’s direction 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 (Participant 11, 2019, Interview 3).

Unfortunately, it is beyond the remit of this research to consider the potential of sound, vibration and pressure on the interoceptive awareness of the body. Nevertheless, speculating about digital touch, its capacity for amplifying the body’s functions and its use as a tool for focusing and changing perspective may present wider implications for future research. During a creative experience, the ability to examine and re-evaluate practice is vital; consequently, an aid for developing somatoperception would prove beneficial.

Code and the effects of a loop

Movement analysis of the participants’ improvisations and the themes exposes the aesthetics of the computer code on a loop or the interaction of two or more loops (with the use of two prototypes). However, questions surrounding the influence of the code on the participants’ perception of time and space are relevant to kinaesthesia involving body-worn technology. The unfolding of the temporal event during a loop effect enables a slightly different pre-reflective consciousness within improvisation. The findings suggest an altered

perception of time and space, allowing participants to investigate this within their choreographic 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.

[W]ith 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 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 create marks, with the body's related movements generating new awareness. Maxine Sheets-Johnstone describes sensation as being a 'temporally punctual and spatially pointillist phenomena' (Sheets-Johnstone 2011: 461), which assists in explaining 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 et al. (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 et al. 2015: 3). 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 work efficiently according to this time/movement template. 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 synchronization.

Entrainment

Academics have established that there is a human desire to synchronize 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 extend this to explain the ongoing process of looped patterns of digital touch in improvisation. Discussions relating to entrainment hinge on a precept of ‘reciprocal influence’; this research will not make a case for the prototypes *feeling* the dancer’s/choreographer’s response or willingly adapting, but instead arguing for practical forces demonstrated by physics, and how this may occur between two moving objects.

[I]n 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 et al. 2015: 1)

Entrainment between the dancers/choreographers and the prototypes is part of the readjustment process and concerns the flattening of the dynamics described by participants. We can witness the synchronization 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 (2012) explains how rhythmicality and intention become connected to anticipation and flow and, subsequently, the process of adjustment towards entrainment (Gill 2012: 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 prototypes is that it assists in focusing attention, and if the user chooses, this can lead to ‘selective entrainment’ (Mandanici et al. 2017: 89). 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 wanted to deviate from the direct interaction or interpretation of that rhythmical structure, 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.

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 we interoceptively communicate to understand the influence on the dancers’ kinaesthesia fully. Interviewees commented that listening and attention were required when working with the prototypes.

Participant 14 considered it a collective process:

I think there’s both a simultaneous listening and an awareness that you are giving something. [...] 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: 137). By adopting *listening* in this context, this notion includes the comprehension of the tactile sensation of the prototypes.

Improvisation and the process of listening and hearing with the prototypes occurred in the following ways. Participants followed a passive approach of letting the sound/feeling transpire, 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*. Alternatively, as Participant 14 suggests, this may happen simultaneously, whereby moving creatively with the prototypes requires intention and attention. Subsequently, listening becomes essential to using the prototypes and making sense of the creative experience of collaborating with them.

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 struggled to understand the prototype sensation. 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 in the human–non-human relationship. Participant 13 expresses this changing relationship during his experiences using the pump prototype, finding the attentional elements and the subtlety of the sensation challenging 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 was almost trying to tune into and get inside a piece of tech, rather than inside of my own body.

(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)

Participant 11 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. Participant 10 described *fake movement* at the beginning of improvising with the pump prototype. This involvement can be explained by *moving for the sake of it*, whereby the participant might have felt pressure to move before comprehending the digital touch or the mismatch between the sensation and execution of her intended movement. This adjustment process for unifying intention with tactile stimuli is partially responsible for the changing relationship between prototypes and participants. The attentional association was vital for the prototype use as a creative aid via entrainment or a developed understanding of the looped code by the participant.

Multimodality of experience

According to Kirsh (2011), dancers can transpose elements of sound and images through the moving body via 'modality translation' (Kirsh 2011: 145). Therefore, it is unsurprising to see visual information and sound connected to tactile and kinaesthetic experiences within the project data. Using the vibration prototype containing one bracelet with a ten-effect loop – Participant 15 discussed how the sound induced imagined visuals, projected from an internal

perspective externally into the space (Participant 15, 2019, Interview 1). Participant 14 reiterated this, describing the stimuli as part of a larger recognition of the sensory information processed by the body and brain (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. Concerning multimodality and the communication of choreographic ideas, digital touch patterns inform 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.

Conclusion

The repeated sensation/sound created by looped codes became markers in the dancers' temporality, generating a new type of awareness or 'fulcrum' for the experience. The participants' ability to synchronize with the rhythms or understanding through pre-emption was apparent, particularly as *listening* to the prototypes became a thematic element in their accounts. These findings make a case for selective *entrainment* forming part of the varied and changing relationships witnessed during movement created by the dancers/choreographers and the prototypes.

Attentional demands were perceptible during prototype use, promoting a greater internal focus and use of peri-personal space. However, different movement trajectories, 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 in 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 to respond 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 interoception emerges within the interviews, with accounts of developed sensitivity, feeling sensations within the body and a different bodily awareness during body movement. 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 was 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 consequently, we must acknowledge multimodality as integral to the use of body-worn technology during the dance-making process.

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