

Rees, K. (2022). Improvising with digital touch. *Multimodality & Society*, 2(3), 247–260. <https://doi.org/10.1177/26349795221111279>

**Title:** Improvising with digital touch

### **Abstract**

This research is concerned with the use of wearable technology in the process of improvising and how the partnership of the body and technology influences the kinaesthetic awareness of the dancer/choreographer. The project sought to produce a prototype that made touch contact with the skin via patterns of vibration effects. This was achieved by creating a circuit with a haptic motor controller, microprocessor, vibration motor and battery. Contained in two bracelets, the technology was used in a series of workshops enabling participants to explore passive digital touch as stimuli for creative movement. By implementing embodied methods to gather qualitative data, I was able to combine my own embodied participation with movement analysis (Laban Movement Analysis) and the participants' perceptions of the experience. Codes identified from the transcribed interviews and fieldnotes were collated into a matrix with the movement analysis and then thematically analysed, revealing that the experience of repeated touch stimuli marked the continuum of consciousness and facilitated a reference point, creating a heightened awareness or foci for the moving body. I propose that this process disrupts the boundary of the body and plays a significant role in recalibrating the dancers' kinaesthesia.

### **Key Words:**

Digital touch, Vibration, Kinaesthetic awareness, Wearable technology, Improvisation

### **Introduction**

This research explores the complexities of vibration as a form of digital touch and how it is understood and interpreted by dancers within the process of improvisation. In this context, improvisation was used as an activity to generate movement material. Additionally, participants were asked to structure movement ideas into a repeatable phrase of movement. As Blom and Chaplin explain,

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: 6)

By analysing qualitative data from dancers' use of digital touch prototypes, this work provides an argument for digital touch enabling greater awareness of the body in process. In the context of western contemporary dance, the cultivation of an awareness of sensation related to the moving body is part of a dancer's expressive, creative, and technical development. Consequently, I was motivated to understand more about the dancers' kinaesthetic awareness with the addition of body-worn technology and to further conversations surrounding technologically assisted creativity.

An inductive approach to the research was selected to enable flexibility in a creative context and allow the participants' experience/movement to explain the phenomena of working creatively with digital touch. This reflective piece presents the patterns and thematic observations that arose from the qualitative data collection and considers these in relation to creative tool use, perspectives on space and time in technology use and research on touch. As a result, knitting together the micro perspective of the project to the interdisciplinary terrain that is involved with physical computing and creative movement.

To aid the navigation of the existing literature and the research findings, the terms somatoperception, interoception and exteroception will be clarified. Whereby interoception refers to internal sensing of the body, including organs and tissues, whilst exteroception encompasses the use of the senses to gain and process external information. Somatoperception involves the concurrent perception of the body and touch contact with an object. Within this research, kinaesthetic awareness and somatosense have been aligned to consider the sense of movement with that of touch and to further understand the connections between senses in the creative response to stimuli.

### **Kinaesthetic awareness**

Kinaesthetic awareness is the sense of the body and an awareness of its movements, but it encompasses a wide remit under the umbrella of the 'moving sense' within dance,

[including]... 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... (Farnell and Wood, 2017: 74)

As Farnell and Wood describe, kinaesthetic awareness usually refers to the body moving in space and is, therefore, not necessarily about an external object-body relation (omitting the body-as-an-object perspective). In this research, the prototype is worn on the body and has a double dimension of being part of the body, but also regularly felt via the skin as touch. Consequently, the duality involved in digital touch and body-worn technology necessitates the inclusion of somatosense and somatoperception.

### **Somatosense**

This afferent system is considered to be mostly influenced by skin receptors and, to a lesser extent, muscle, organs, and tendons that utilise information from across the body and forms part of the nervous system. It is involved with our sense of touch but also our perception of pain, temperature, proprioception (body position) and kinesthesia (body movement) (Jacobs, 2011:171). By grouping somatosense with kinaesthetic awareness, there is an opportunity to consider connections between how we use information from contact with the skin receptors and the internal muscle spindles associated with proprioception. Whilst it may be logical to separate the elements of somatosense from a biological perspective, this

work 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.

Furthermore, to understand what impact digital touch has on the moving body and the perception of this experience, there needs to be a consideration of how this information is combined. Recent literature suggests that the brain uses this information collectively 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., 2017:11). Therefore, when looking at how the body is influenced by vibrotactile stimulation, it must also be considered in tandem with the participants' awareness of their bodies and the environmental affordances.

### **Creative movement and technology**

Questions concerning the influence of technology on the creation of movement have been largely addressed within the literature about interactive performance environments. Digital tools and artefacts have been promoted as enabling an extension of the performing body in motion (Broadhurst, 2006), augmenting proprioception (Wilde, 2011), and assisting performers in their multi-sensorial communication (Bisig and Palacio, 2016; Choinière, 2019) and experiences through this conjunction (Parviainen, 2011; Choinière, 2019). Andrea Davidson's (2013) comparison of different choreographers (Brown, Choinière and de Lima) working with technologies and somatic practices<sup>1</sup> concludes that restructuring and re-ordering the body through the physical/technological interface can enable multiple states of presence in performance. Her later work furthers this notion and considers the body as mediated through the necessity of acting upon multiple forms of information via interoception and exteroception (Davidson, 2016:23).

As Johannes Birringer (2008) suggests, there is a necessity to develop methods to study artistic practices with digital and electronic processes and products. Firstly, methods should address the complexities involved in creating art with technology and, secondly, analyse experience in conjunction with the sensorium (2008: xix). Choinière advocates this position, proposing an analytical shift that considers how the senses integrate or are reordered through the multisensorial and multimodal experiences of using technology in choreography (Choinière 2019:9.14). Davidson further notes the lack of research into corporeality and technology use in the creative process and how the body interacts at this juncture (Davidson, 2019: 10.5). Hetty Blades and Sarah Whatley identify the issue as the difficulty in tracking kinaesthesia at this interface (Blades and Whatley, 2019:28). As a consequence, the dancer's feeling of their own body moving in space and the identification of this sense with technology has yet to be fully addressed.

---

<sup>1</sup> Somatic practices or Somatic Movement Education and Therapy is the name for 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 Alexander Technique, Feldenkrais Technique, Bartenieff Fundamentals, and Rolfing.

There is significantly less literature covering the process of improvisation and the structuring of creative movement with body-worn technology than texts focusing on interactive environments, Virtual Reality and Augmented Reality, with the notable exceptions of Schiphorst (2007) and Koziel (2008), whose research has covered touch and wearable devices. This paper attempts to address this epistemological gap at the intersection of moving bodies and technologically assisted creativity, focusing on improvisation in the studio setting and the 'making' of dance using digital touch prototypes.

## **Methods:**

By creating and developing digital touch prototypes, I was able to investigate how coded touch stimuli could be interpreted in improvisation by volunteer undergraduate student dancers. The choreographic workshops were held over two weeks at the Balcony Space at Studio Wayne McGregor, Stratford, London. Each day was split into two - morning and afternoon - with each session involving an individual participant spending approximately 2 hours and 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 the UK and a range of European countries. All were aged between eighteen and twenty-five.

I devised the workshops so that participants could respond to a series of choreographic tasks performed under two different conditions; one requiring the wearing of two bracelets with different programmed vibration loops and the other performed without wearable technology. The bracelets were coded to produce a repeated sequence of vibration effects, which I refer to as a 'loop'. The right bracelet produced a loop of the ten most prominent vibration effects from a pre-programmed library of vibrations. The left bracelet produced a loop of the full library of 123 different vibrations. Aligning the tasks to imagined touch and digital touch stimuli, I suggested three prompts asking the participant to explore either the imagined sensation of touch or the physical sensation on their wrists.

Semi-structured interviews were conducted at the end of each condition and were used to gain the participants' perception of the experience; gathering qualitative data in this manner assisted in explaining and evaluating the participants' experiences (Matthews and Ross, 2010: 223 -224) and helped me to comprehend the choices, influence, and attitudes to working with these tools/aids. In vivo and open coding were used to code the interviews and fieldnotes, and the use of analytic notes enabled a dialogue between the data and coding; by noting occurrences, biases, and thoughts about the events, I was able to adopt a reflexive approach that acknowledged my presence as the researcher within the data (O'Reilly, 2012: 189).

An adapted form of Rudolf Laban's movement analysis, where written descriptions were utilised rather than symbols, enabled the workshop video footage to be categorised into Effort, Space, Shape and Body. The latter section encompasses the 'what' of movement, noting the actions performed; 'effort' associating the 'how' and including further detail on

time, weight, flow, and space; 'space' relating to the 'where' the movement was performed and 'shape' indicating the pathways and the levels of the movement. This type of analysis provided a means to understand what was created in working with the digital touch prototypes. Video recordings were utilised in tandem with my embodied knowledge (gained from learning participants' phrases of movement) to study the participants' movement responses.

[Insert Figure 1]

Figures 1. Digital touch prototypes

My role as the researcher moved from a maker (in the prototyping stages) to a participant-observer in the workshops and included facilitating prompts for improvised exploration and then learning and dancing structured phrases of movement created by participants. Adopting a mix of embodied methods from sensory ethnography, physical computing, and dance ethnography enabled an appreciation for the complexity of human actions, relationships to objects and the production of knowledge through participation. As such, the transfer and merger of these methods provided techniques to interrogate both the means and the data itself.

### **Analysis**

Each participant's movements were analysed in four parts: the improvised task with and without the technology and the structured phrase (again in both conditions). The categories from Laban Movement Analysis were drawn up into a table. The filmed workshops were viewed, and movement was noted and compiled into a matrix for each participant, then subsequently summarised for a whole group matrix. By observing and using my embodied memories, the transcription of movement made use of the movement viewed on the screen and the felt sense of movement that I had previously learned and performed in the workshops. I examined the movement analysis for patterns and, in particular, the frequency, sequence, and similarities/differences of the individual participant responses within both conditions, then compared the data across the whole participant group.

The transcribed and coded interviews and fieldnotes were inserted into the individual and group matrix allowing the participants' voices to be considered next to my observations and embodied reflections on the movement as a participant-observer, enabling connections between the movement and participants' perceptions of the process of working with the prototypes.

### **Findings and Discussion**

The following thematic observations of *Internalised sensation*, *Influence on rhythm*, *Movement initiation – the relationship of a body part to the whole body*, and *Foci* were gathered from data analysis. By exploring these observations, I will consider how meaning is

made in multiple modes, how they influence one another and, more specifically, how vibration is understood by dancers within the process of improvisation.

### **Internalised sensation and multisensorial experience in the creative response**

Participants' responses to improvising with the digital touch prototypes suggest that, in the process of creating, they utilised their combined senses, entwined with imagined translations of tactile sensation.

...that image held quite strongly, the buzzing- travelling, an imagined current going through my bloodstream and nervous system. (Participant 3, 2017)

Participant 5's response also notes the sensation of vibration moving beyond the surface of the skin:

... with the technology, it was all very internal, especially at the beginning....it was in me [laughs] (Participant 5, 2017)

The association of real (vibration waves travelling through the body) and imagined stimuli (images linked with the vibration) were combined in the experience and the interpretation of coded loops of vibration, supporting a multisensorial reception, which in this instance, draws greater attention to an internal perspective of the body. By utilising the vibrotactile sensation in this manner, the participants were able to translate what was felt, both on the skin and internally, into the imagined stimuli associated with the sensation and then physicalised through movement expression.

As suggested by Jonathan Owen Clark and Taku Ando (who consider creative response in working with Virtual Reality), the broader encapsulation of imaginative proposition is involved in dancers' kinaesthesia. For example, the creation of images relates to how the dancer moves in real-time, but the imagined intention is also coupled with the projected feel and look of the movement (Clark and Ando, 2014:12). Moreover, this manner of creating goes beyond external trajectories and geometric forms of visualising and occupying space to that which can be felt and projected from the connection of the tactile body to the external space (Clark and Ando, 2014:14). The findings of this research support a similar experience of internal reference to sensation and how this sensation travels through the body and influences the dancers' use of interoception to promote a different awareness of moving in space.

Whilst the digital touch prototypes were attached to the body, they do not extend the body in the material sense and almost promote the reverse, with participants commenting on their attention to the internal space of the body. The vibration created by the prototypes added a different dimension to interoception and proprioception than perhaps normally

utilised by a dancer<sup>2</sup>. This extra element to kinaesthetic awareness is brought about by the constant physical presence of sensation from the looped vibration effects.

[Insert Figure 2. here]

Figure 2. A participant using the digital touch prototypes in a choreographic workshop at Studio Wayne McGregor, London.

According to anthropologist Tim Ingold (2011), skilled tool use is involved with sensory participation that relies upon an active awareness of the ever-changing environment and affordances of the material. In subscribing to Ingold's theory, this paper proposes that in the case of this specific form of digital touch, the constant presence of vibration patterns on the body amplifies the processing of information via the senses, particularly in a tactile manner. Therefore, heightened awareness is brought about through expanded sensory participation and attention to both internal and external sensations. However, the ongoing sensory information in the looped vibration makes this process both predictable (in the case of the right bracelet and the repeated pattern of 10 vibration effects) but also an anticipatory act when combined with two bracelets on two different loops.

### **Influence on rhythm**

The constant physical stimulus evoked movement responses matching the rhythm of the tactile sensations on a loop. Movement from the improvisation section showed patterns of moving and then pauses, which reflect the looped effects. Participant 6's comments support the rhythmical influence of the digital touch prototypes, "... 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 bracelet worn on the right dominated the rhythm, with the structure of the loop only being ten repeated vibration effects; the dialogue between the right and left hand complicated the process, with participants often trying to guess or make assumptions about the patterns of the left bracelet and how this might be interpreted through the body. Subsequently, the participants played with adjustment, matching, and diverting away from the dominance of the right wrist loop with the interjection of the left bracelet vibrotactile patterns.

### **Movement Initiation and relationship of 'body-part' to the 'whole body'**

Part of the movement analysis included recording where the movement originated and its sequence through the body. The participants' predominant use of their hands and arms to lead and produce movement, also known as distal initiation of movement, can be expected due to the location of the technology on the wrists. However, what is of interest, is the way the arms were moved back in reference to the body. For example, the participants' movement choices frequently included wrapping, scooping, and folding movements that

---

<sup>2</sup> Research by Christensen, Gaigg, and Calvo-Merino (2018) suggests that dancers have accuracy in interoception. However, this work proposes that vibration effects from the digital touch heighten this perspective.

frame and highlight the body (Appendix A- video footage). Body-part relationships and the thematic observation of relational movement to the whole body can be explained by Frédérique de Vignemont, who considers that “a defining characteristic of peripersonal space is that it is encoded in a body part-centred frame of reference” (De Vignemont, 2018: 177). This can elucidate the findings, explaining how the intimacy of sensation, specifically vibration, is involved with the disposition for body-part orientation based on where the digital touch prototypes are worn. The relational element of considering what the arms are doing with respect to the whole body enables a richer consideration of the moving body, particularly as the movement, shape, or quality has a point of reference.

The reception of internalised sensation, the rhythm of tactile sensation patterns, and relational perspectives to movement are all key to answering questions about how forms of digital touch might influence the choreographer/dancer’s sense of moving in space. However, research considering space in digital interfaces provides a point of comparison, and Royden Hunt’s (2000) deliberation on the use of space on either side of the boundary of the skin is pertinent to the discussion of space experienced in Virtual Reality. He employs Rosmini’s theory, ‘fundamental feeling’ (Hunt, 2000: 147), and uses it to describe an individual’s feeling of space beyond the boundary of the skin, with the touch contact reinstating the surfaces internal and external to the body. Despite Hunt’s proposal that touch sensations re-establish the binary of inside/outside the body, his argument raises important points about how the dancers’ awareness of space (including internal space within the body) might adapt with the assistance of technology. By considering the complexities of vibration as a form of digital touch, one could conceive a different subjective sense of space brought about by internalised perspectives and somatoperception. Certainly, the relationship of the body part to the whole body might be explained by the location of the prototypes and their promotion of peri-personal space. However, the way vibration travels through the body and, in turn, how the dancer/choreographer utilises this and maps it through the body is suggestive of greater fluidity between internal and external perspectives of space.

[Insert Figure 3]

Figure 3. A participant using the digital touch prototypes in a choreographic workshop at Studio Wayne McGregor, London.

### **Foci**

It makes people think less about what they are doing and more about how they are doing it (Participant 1, 2017).

By enabling greater awareness of *how* the body moves, digital touch prototype use might increase participants’ ability to comprehend the body in motion and how the qualitative aspects such as weight, tension, speed, etc. of movement might generate different aesthetic choices as a choreographer. However, to further understand the element of coded vibration loops and the participants’ creative digestion and interpretation of this stimulus, it is useful to consider how phenomenology has explained the pre-reflective experience.

Husserl's phenomenology of time-consciousness and use of 'primal impression, protention and retention' (Husserl, 1964:50 -51) frames the varying stages operating in the moment of consciousness. Primal impression is the now of conscious experience, protention the prior, and retention, the past phase (Drummond, 2007 p. 170-171). As Dan Zahavi (2003) explains, this process of pre-reflection works as an unfolding of the temporal event, enabling recognition of past, present, and future moments of consciousness. In the case of the digital touch prototypes, this continuum of subjective consciousness could have even greater significance due to the looping effect. The digital touch sensation repeatedly felt on the skin is implicated in mark-making, and the repeated coded pattern within the duration of consciousness explains why there is an element of 'don't think-just do' in participants' response to the vibration patterns. Participants' recognition of the vibration pattern through its repetition could actualise participants' movement intentions with less perceived cognitive effort. Digital touch prototype use can provide insight into qualitative aspects of movement, with less emphasis on what action *could* be performed. The repetition of the code enables the dancer to focus on the moment of creation rather than premeditated actions. This work suggests that vibration effects created through coded loops mark the pre-reflective continuum in temporal events.

In Material Engagement Theory, the process of thinking is grounded in the 'doing' or, as Lambros Malafouris likes to call it, 'thingness' (Malafouris, 2013). Pertinent to this research is Material Engagement Theory's appreciation of the interaction between the body, material, and tool in the way we think creatively through the action of making (Malafouris, 2013: 7). Malafouris sees 'thingness' as consciousness, and if we consider the use of a body-worn choreographic tool in improvisation, it is part of the conscious thinking-moving experience with the body, albeit one with no enduring materiality beyond the duration of the dance. By applying Material Engagement Theory, merged with Ingold's consideration of expanded sensory perception and the marking of the pre-reflective experience, we can explain the process of making meaning from coded loops of patterned vibration within improvisation. For example, the body's/mind's responsiveness to the prototype (tool/aid), material (body/passive digital touch stimuli), and environment enables a dynamic relationship, where the rhythm of the vibration influences the spatio-temporal elements of the dancers' movement, and in turn synchronicity of the action/motor influences the aesthetics of the movement and consequently how the choreographer relates to the digital touch prototype. When involved in a looped continuum, the prototype promotes a greater awareness of the body in process. Subsequently, the vibration patterns allow participants to consider the way they perform movements and perceive sensations internally and externally, suggestive of heightened kinaesthetic awareness.

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, vibration informs movement by creating perceived 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

This paper suggests that using a body-worn device that produces passive digital touch influences the process of improvisation in the following ways. Firstly, the looped vibration effects from the prototype disrupted the perception of a boundary between internal and external, with the example of participants often feeling/imagining the sensation travelling internally within the body. This impacts the kinaesthetic awareness of the dancer/choreographer by enabling heightened sensory participation and interoceptive awareness. It also allows for wider consideration of the qualitative dynamics of 'how' the body moves and a greater understanding of the body in relation to itself, both in the manner of 'body-part to the whole body' as well as the internal sensation within the body.

The location of the digital touch prototypes contributed to the movement initiation, but the technology housed at the wrists also enabled a relational stance driven by the body's disposition for body-part use in peri-personal space. Subsequently, participants could consider how their arms moved in relation to the rest of the body, including greater use of movement framing and referencing the whole body. Digital touch prototype use did not show any evidence for extending the body in external space. Still, it enabled a greater awareness of the space internally (bones and joints etc.) and how the vibration waveforms might travel through the body.

Ingold's (2011) sensory participation and Malafouris' (2013) thoughts on the dynamic nature of creating with a tool/aid have been used to explain improvising with the digital touch prototypes and how the creation of movement with a body-worn tool/aid requires responsiveness to the interconnected changing elements of body, material, and environment.

Participants' commentary, along with my own experience of engaging with the vibrotactile stimuli, considered the combined interpretation of the rhythm or pattern of the code and the imaginary associations of sensation. Consequently, the use of digital touch in the choreographic process must be recognised as enabling a multisensorial creative response. Repetition of the coded loops from the vibration bracelets provided a physical reminder, bringing attention to the body and enabling a marked pre-reflective consciousness. As a result, the patterned loops of vibration can inform the meaning-making process of improvisation by heightening the kinaesthetic awareness and enabling further considerations of space and time provided by greater flexibility in exteroception and interoception.

## References

- Birringer J (2008) *Performance, Technology and Science*. New York: PAJ Publications.
- Bisig D and Palacio P (2016) Neural Narratives- Dance with Virtual Body Extensions. In: *Proceedings of 3<sup>rd</sup> International Symposium on Movement Computing*, Thessaloniki, Greece, 5-6 July 2016. DOI: 10.1145/2948910.2948925

Blades H and Whatley S (2019) Digital Dance. In: Dodds S (ed) *Bloomsbury Companion to Dance Studies*. London: Bloomsbury Academic, pp.357–384.

Blom LA and Chaplin LT (1988) *The Moment of Movement: Dance Improvisation*. London: Dance Books.

Broadhurst S (2006) Digital Practices: An aesthetic and neuroesthetic approach to virtuality and embodiment, *Performance Research* 11(4): 137-147.

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.

Christensen JF, Gaigg SB and Calvo-Merino B (2018) I can feel my heartbeat: Dancers have increased interoceptive accuracy. *Psychophysiology*, 55, DOI: 10.1111/psyp.13008

Clark J and Ando T (2014) Geometry, embodied cognition and choreographic praxis. *International Journal of Performance Arts and Digital Media* 10(2):179- 192.

Davidson A (2013) Somatics: An orchid in the land of technology. *Journal of Dance & Somatic Practices* 5(1):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):21 –42.

De Vignemont F (2018) *Mind the Body: An Exploration of Bodily Self-Awareness*. Oxford: Oxford University Press.

Drummond J (2007) *Historical Dictionary of Husserl's Philosophy*, Maryland: Scarecrow Press.

Farnell B and Wood RN (2017) Kinaesthetic intimacy in a choreographic practice. In: Chrysagis E and Karampampas P (eds) *Collaborative Intimacies in Music and Dance: Anthropologies of Sound and Movement*. Oxford: Berghahn Books, pp. 65-95.

Hunt R (2000) Being @ Installations: the space-time of technoetics. In: Hunt R (ed) *Art, Technology, Consciousness: Mind@large*. Bristol: Intellect, pp.144-148.

Husserl E (1964) *Phenomenology of Internal Time Consciousness*. Bloomington: Indiana University Press.

Ingold T (2011) *Being Alive: Essays on Movement, Knowledge and Description*. Abingdon: Routledge.

Jacobs KM (2011) Somatosensory System. In: Kreutzer JS, DeLuca J and Caplan B (eds) *Encyclopedia of Clinical Neuropsychology*. Springer: New York.

Jewitt, C and Leder Mackley K (2019) Methodological dialogues across multimodality and sensory ethnography: digital touch communication. *Qualitative Research* 19(1): 90–110.

Kozel S (2008) *Closer: Performance, Technologies, Phenomenology*. Spain: MIT Press.

Malafouris L (2013) *How Things Shape the Mind: A Theory of Material Engagement*. Cambridge: MIT Press.

Matthews B and Ross L (2010) *Research Methods: A practical guide for the social sciences*. Harlow: Pearson Education Ltd.

O'Reilly K (2012) *Ethnographic Methods*. Abingdon, Oxon: Routledge.

Parviainen J (2011) Dwelling in the Virtual Sonic Environment: A Phenomenological Analysis of Dancers' Learning Processes. *The European Legacy: Toward New Paradigms* 16(5):633-647

Schiphorst, T (2007) *The Varieties of User Experience: Bridging Embodied Methodologies from Somatics and Performance to Human Computer Interaction*, PhD Thesis, Plymouth, CAiiA Star at the University of Plymouth, U.K.

Tyldesly B and Grieve J (2002) *Muscles, Nerves and Movement in Human Occupation*. Malden, MA: Blackwell Publishing.

Valenzuela-Moguillansky C, Reyes-Reyes A and Gaete M (2017) Exteroceptive and Interoceptive Body-Self Awareness in Fibromyalgia Patients. *Frontiers in Human Neuroscience* 11:117. DOI: 10.3389/fnhum.2017.00117

Wilde D (2011) *Swing That Thing: moving to move. The poetics of embodied engagement*. PhD thesis, Monash University, Australia.

Zahavi D (2003) *Husserl's Phenomenology*. Stanford, CA: Stanford University Press.