Negotiating Control and Agency: Somaesthetics and Feminist Perspectives on a Wearable E-Textile Instrument

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Figure 1: Performance view of the e-textile interface and selected frames of the interaction process of four participants.

Abstract

Control and agency in digital musical instruments are commonly framed through paradigms of mastery and precision in interaction or seamless integration. This study reconsiders these assumptions through feminist and somaesthetics perspectives, examining how control and agency emerge through embodied negotiation. Using a deformable, wearable e-textile interface designed for whole-body engagement, we conducted an exploratory study with four female participants. Multimodal data, including movement recordings and semi-structured interviews, were analysed using reflexive thematic analysis. The findings show participants' situated experiences with material affordance and open-ended interaction that reconfigure bodily perception and movement strategies. Rather than striving for proficiency or mastery, participants developed a co-agential relationship with the instrument through ongoing negotiation among bodily movement, auditory feedback, and material response. With a feminist and somaesthetics perspective, this work contributes to design opportunities for wearable musical interfaces that encourage affective and exploratory engagement as interaction.

Keywords

E-textile musical interface, Embodied interaction, Feminist HCI, Somaesthetics

1 Introduction

Mastery over musical interfaces and precision in control have long been central values in music technology and instrumental practice. From developing virtuosity on conventional instruments to manipulating knobs and sliders on synthesisers, performers are encouraged to refine bodily techniques to achieve seamless proficiency in control. Both traditional training and digital musical interface (DMI) design pursue this ideal through different means: repeated bodily discipline on one hand [21], and intuitive interfaces on the other [29]. The merging of body and instrument positions the body itself as the musical instrument [29].

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However, both routes presuppose a predefined and deterministic control relationship between body and instrument that does not dissolve the dichotomy between control and being-controlled. From feminist perspectives, the emphasis on mastery reflects the cultural tendencies toward masculinity and industrial aesthetics that aggravate the ambient belonging, which further marginalise the minor group from participating in the practices [3, 23, 31].

In contrast to mastery-oriented paradigms, this paper presents a wearable e-textile instrument foregrounds a negotiated relationship between performer and instrument (Figure 1). The system consists of a deformable wearable textile interface in which sound is generated through audification and manipulated through parameter mapping sonification of sensor data produced by bodily interaction. The material properties of the textile sensor result in a responsive but open-ended mapping relationship between bodily movement and sound. Repeating the same gesture does not guarantee intended sonic outcomes, while different movements may produce similar sounds. This many-to-one and one-to-many mapping resists precise interactions and destabilises linear responses. As a result, control is continually negotiated and invites exploration with different interactions.

To investigate how performers engage with such conditions, we conducted a study with four female participants. They were invited to freely interact with the interface under minimal instruction and procedural restriction. Video recordings and semi-structured interviews were collected and analysed using reflexive thematic analysis, focusing on situated bodily strategies and perceptual experience during interaction [2].

This study addresses the following research question: How do performers negotiate control and agency when interacting with a wearable e-textile musical interface? By examining participants' embodied adaptation, material affordances, and exploratory interactions, this study offers a situated account of how participants negotiate control and agency with the interface from feminist and somaesthetics perspectives.

2 Background

Within the NIME community, numerous projects have explored bodily engagement with musical interfaces through biofeedback[5, 6, 30], motion-based interaction captured via cameras [4, 33] or wearable sensing interfaces [1, 19], as well as unconventional materials such as textiles [18, 22]. These systems commonly foreground embodied interaction and multisensory feedback, reflecting somaesthetics concerns by extending bodily capabilities and enhancing perceptual awareness through sound. Somaesthetics emphasises bodily awareness and perception in interaction [26]. In DMI contexts, somaesthetics highlight how auditory feedback can augment bodily perception through continuous coupling between movement and sound. Such perspectives resonate with longstanding aspirations toward bodily integration with instruments, whether achieved through prolonged training and virtuosity [21]or through embodied interface design for intuitive interaction [29]. However, it is often referenced for seamless integration with interface, positioning body as a site for optimisation rather than a source of generative ambiguity or affective knowledge. Feminist theory offers a critical lens for interrogating these paradigms of control. Haraway's cyborg reframes the relationship between body and technology as entangled rather than organised around a binary of control and being controlled [10]. This reimagining of embodiment is further developed with Kristeva's concept of chora, which describes a pre-linguistic rhythmic space rooted in the maternal body that foregrounds affect, texture, and movement as carriers of meaning [12]. These frameworks challenge hierarchical models of interaction by emphasising fluidity, openness, and relationality, calling for musical interfaces that move beyond mastery toward affectively-driven and perceptually-grounded engagement.

Several studies in musical instrument design have reflected such feminist and somaesthetics perspectives. Wolloshin and Abas [32] describe instrument de/reconstruction as a feminist practice that subverts conventional materials and interaction logics to enable new forms of self-expression through intimate negotiation during interaction with bespoke instruments. Similarly, Essl [7] discussed *Cutaneous Grooves* [9], highlighting the inverted controlling logic when the interaction decision is influenced by the interface's haptic feedback. These projects emphasise analysing interaction processes and perceptual experience, offering a foundation for understanding how bodily engagement and material response shape musical interaction other than efficiency-driven control.

E-Textiles, with the wearability, deformability, accessibility, and cultural relationships with the human body, have been widely explored in NIME [24, 27, 28]. Prior work on textile musical interfaces highlights how material properties shape embodied interaction, influencing gestural exploration, perception, and sonic interpretation [8, 16, 27]. Recent works further foreground material agency and bodily engagement. For instance, *Pain Creature* [17] explores a wearable textile interface that materialises pain as an embodied and parasitic presence, where deformation not only enables sensing but also mediates an affective and bodily negotiation between performer and interface. Similarly, *Soft(n)* [25] creates responsive textile environments that emphasise distributed touch, movement, and relational interaction between bodies and materials. While these approaches foreground textile responsiveness and embodied interaction, they primarily position the textile as an expressive or affective mediator. However, while these works engage embodied interaction and material agency, relatively limited attention has been given to examining the possibilities of interactions through somaesthetics and feminist perspectives, particularly in terms of how material agency may reconfigure bodily perception, affect, and interaction strategies in practice. Building on these works, this study explores an approach in which the wearable textile itself functions as the primary sensing substrate through knitted structures, aiming for closer communication between body and interface. Informed by somaesthetics and feminist perspectives, interaction is understood not only as control but as a relational and distributed process, where sound emerges through the ongoing negotiation.

3 Methods

3.1 The Interface

This interface builds on the design and concepts established in our previous work [15]. Informed by feminist and somaesthetic perspectives that foreground the body as a site of perception and meaning-making, the interface is designed for interaction through whole-body engagement (Figure 1)[1].

Feminist textile artworks have explored how textiles can intimately relate to, represent, and exaggerate the body [13, 14, 20]. Building on this perspective, this interface adopts textile materiality as both an extension and distortion of body. Its form,

[1]Performance documentation: https://youtu.be/7o3KL1jBKdY?si=Jyn4noCSEf5bPsY1

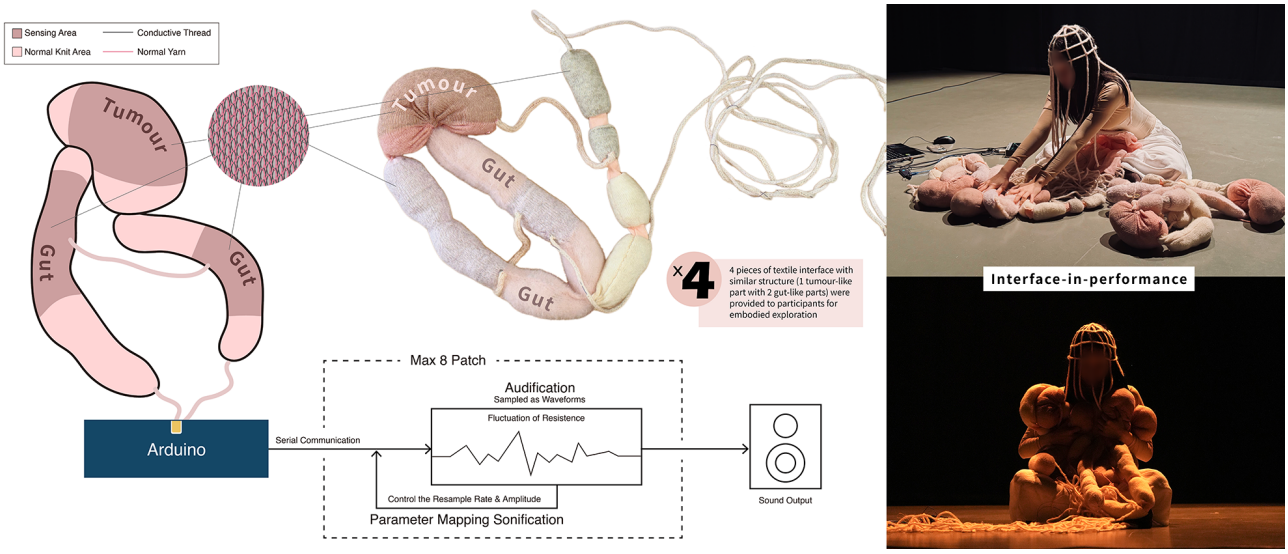

Figure 2: Interface structure, sound synthesis, and performance setting.

colour, and soft materiality draw on exaggerated and redundant body parts, evolving into intestines and tumour-like structures. This prosthetic redundancy destabilises the perceived boundary of the body, while the interface's responsiveness to distributed bodily pressure further disrupts stable and controlled interaction. Each interface piece consists of two gut-like forms and one tumour-like form, with unevenly distributed sensing areas knitted from conductive and non-conductive yarns. Deformation of these areas produces variations in resistance, which are transmitted from Arduino to Max and generate sound through minimally processed audification, where fluctuations are directly sampled as waveforms and rendered in a low-frequency range (Figure 2). Non-sensing knitted regions also contribute by mechanically pulling on sensing areas during deformation, thereby influencing the output. Different qualities of movement, such as sustained pressure, release, or abrupt contact, result in dynamic changes in amplitude and sonic texture. The system consists of four similar interface pieces, each producing sound within a slightly different frequency range based on resistive variation. Contact between conductive areas and mutual deformation across pieces further influence the sound. This tight coupling between movement and sound foregrounds subtle variations in bodily action, positioning interaction as an ongoing negotiation rather than discrete control.

3.2 Participants and recruitment

All participants recruited are identified as female and had prior experience in music-related or body-centred artistic practices, such as music or dance (Table 1). Except for P1, the rest of the participants have no previous knowledge or experience within the NIME area. This recruitment aims to focus on how bodily interaction emerges through exploratory and improvisational engagement with an unfamiliar e-textile interface. The exclusive focus on female participants reflects the project's feminist and somaesthetics orientation, treating embodied interaction as situated rather than universal.

Table 1: Participants' Background.

Participant	Musical Background	Body-centred Artistic Practices
P1	Synthesiser, Keyboard, Guitar	None reported
P2	Vocal Performance, Guitar	None reported
P3	Drumming	Street Dance
P4	Guqin (Chinese Zither)	Zen Dance (Meditative Movement Practice)

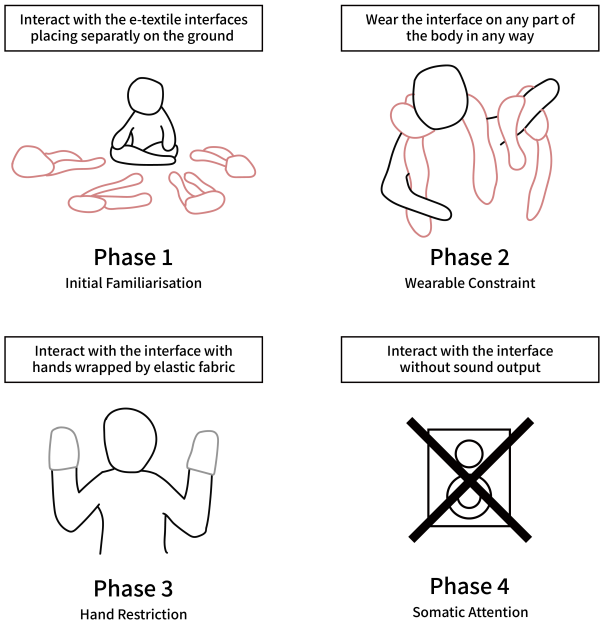

Figure 3: Experiment Procedures

3.3 Study procedure

The experimental session is structured in four phases to explore different modes of embodied interaction (Figure 3). Participants decided when to start and stop each phases, varied between 3-10 minutes. The constraints were introduced progressively to guide a transition from intuitive, hand-centred interaction toward whole-body engagement. Video and audio recordings were taken upon consent to document the process for analysis. Semi-structured interviews were conducted afterwards to reflect on experiences during the session. The interview topics focus on participants' reflections on the embodied experience and bodily perceptions. Questions are adapted to different practices from different participants.

This research took a reflexive thematic analysis [2]grounded in multimodal video annotations and semi-structured interviews. Video and audio data were annotated using ELAN to segment interaction into meaningful action episodes. Each episode was described at a parent tier, capturing the overall bodily action, its perceived intention, and sonic response. Child tiers were used to document bodily involvement, movement qualities, spatial orientation, and interface engagement (parts and numbers). These annotations support the later thematic interpretation. Analysis focused on participants' perception of bodily movement, control, and sonic feedback during interaction. The following section presents the three main themes and analytic findings by detailing participants' embodied experiences, interaction strategies, and authors' interpretations.

4 Result

4.1 From Hand-Centric Control to Somaesthetics Coordination

The experiment introduced several constraints to disrupt intuitive, hand-centred control to encourage whole body engagement and enhance perception (Figure 3). Although constraints were initially experienced as disruptive or limiting, all participants reported heightened bodily perception and transition to reconfigure different body parts for interaction and control, instead of relying on hands. In interviews, P1, P2 and P4 noted that the hands are usually the primary control in conventional musical instruments and are their intuitive engagement with this interface. In Phase 2, when the interface was worn on the body, participants began to involve the torso, arms, and legs. Phase 3 further prompts feelings of restriction of hands for P2, P3, and P4. P2 described a sense of incapability due to the reduced precision and force, compared to hand-centred interaction. In response, her body becomes a substitute for the hands, reproducing previous hand-interaction patterns with shoulders, arms, and torso. Over time, P2 and P4 reported the awareness of non-hand body parts increased, and the sense of constraint gradually diminished. The sound, as several participants noted, strengthened bodily perception to experience unfamiliar or new perceptions.

With the interface worn on the body, participants increasingly engaged the whole body in interaction (Figure 4). P1 tried different postures of lying down, sitting, or kneeling on the interface. P2 developed movement strategies where the body initiates motion, then the interface follows, generating rhythmic dynamics through swinging, jumping, squatting, and rotation. P3 employed exaggerated full-body movements by lying on the floor, stretching and rotating the body to activate different interface parts. P4 drew on Zen dance postures, noting strong perception around

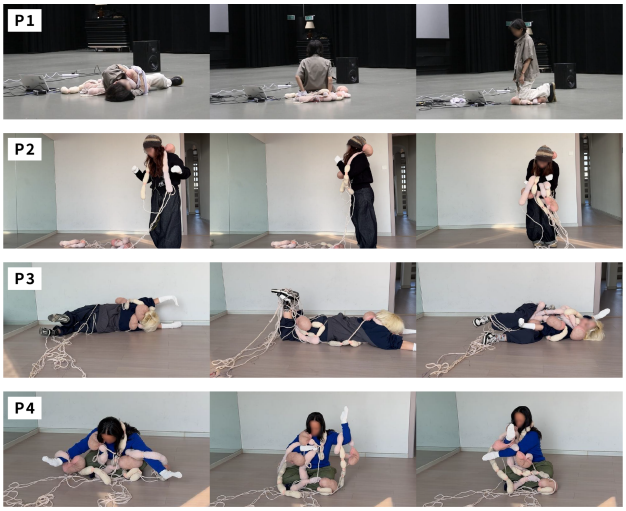

Figure 4: Participants' whole body interactions.

the head, neck, and shoulders when skin contacted the interface. These interactions extended beyond hand-centric squeezing or pressing, foregrounding bodily movement in interaction.

For some participants (P2, P3), bodily perception gradually became central to interaction decision-making. For others (P1, P4), the softness and haptic qualities of the textile reduced feelings of constraint and fostered bodily comfort, which inspired movements distinct from conventional gestures. Notably, in Phase 4, when constraints were removed, all participants spontaneously chose to wear the interface (Figure 5). Although some returned to hand-centred strategies, they continued to involve other body parts, reflecting a lasting reconfiguration of interaction habits. This suggests that temporary constraints and the wearability of interface destabilised habitual hand-based control and support whole-body engagement. In line with somaesthetics [26], participants expanded their initial assumptions about instrument interaction, gaining heightened bodily awareness mediated by auditory feedback. As interaction shifted towards bodily control, sound evolved from intermittent and tentative triggering at lower amplitudes to more sustained and continuous textures. Participants began to modulate sound within sustained states through subtle movement to attune, or increased bodily contact and deformation to produce louder, more intense, and dynamically varied sonic responses across the interface.

4.2 Affective Affordances and Situated Interpretations

Several participants (P2, P3, P4) developed situated affordances associating the tumour-like structure with "*wider, deeper roaring* (P3)", or "*spacious* (P4)" sounds, while the gut-like structures were interpreted as "*sharper* (P3)", "*long and thin* (P4)", or "*quieter* (P2)" ones. These associations suggest that participants formed embodied expectations of sound based on the interface's morphology. Such shape–sound correspondences are less explicitly presented in conventional DMIs. These interpretations subsequently influenced participants' movement intentions and interaction strategies, guiding how they approached different parts of the interface when attempting to elicit particular sonic qualities. As a result, sound often fulfils this alignment.

Participants also reported and enacted diverse perceptive and affective engagements (Figure 6). P1 and P4 repeatedly leaned

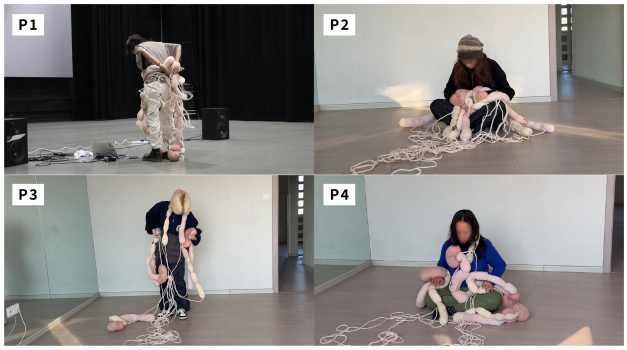

Figure 5: Participant's interaction in phase 4.

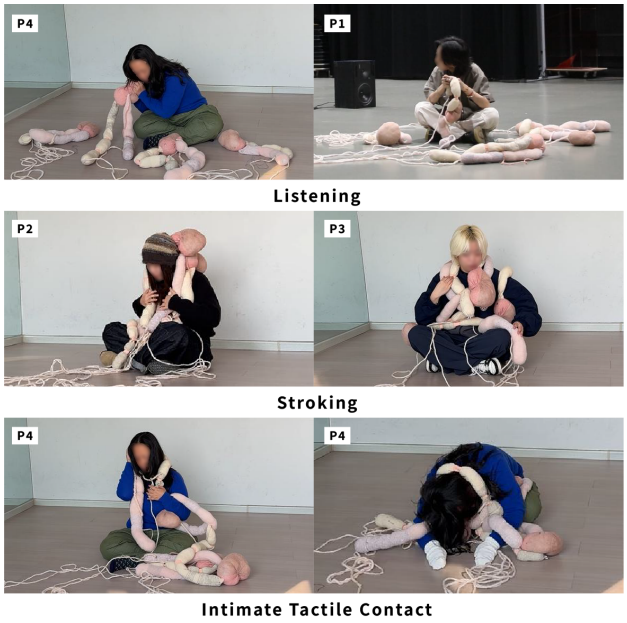

Figure 6: Different perceptive and affective engagements of participants.

in to listen directly to the textile surface, although knowing the speakers as the sound source. P2 described an impulse to smell the scent of the interface during interaction. Such multisensory involvements indicate that the textile interface fostered an affective environment that invited perceptually driven, non-instrumental forms of engagement. P2 and P3 often stroked the surface along the structure. P4 used her face to touch the textile or buried her head into the interface bundle to seek intimate tactile contact. These haptic explorations emerged spontaneously from participants' embodied experiences with the material and were incorporated as meaningful strategies for generating and manipulating sound. Stroking typically produced minimal deformation and subtle sonic variation. However, participants modulated the pressure and speed of these gestures to explore fine-grained fluctuations in sound, in contrast to the sharper, more intense responses generated through stronger bodily interactions. Participants explored thresholds at which sound would be affected, attending simultaneously to tactile and auditory responses.

Participants described these experiences as "emotional", but without articulated discrete emotions. Thereby, these responses

Figure 7: Participants' situated interpretations during interaction.

are better understood as affective, referring to pre-reflective bodily tendencies that foreground perceptual motivation before verbal articulation. In this sense, affect emerged through the interplay of material and sonic feedback, shaping participants' embodied and sensory explorations.

Situated interpretations were developed grounded in personal memory and perceptual association (Figure 7). P1 associated holding the interface against her chest with soothing a child, leading to patting and modulating pressure as ways to behave like a mother. During sustained contact, the sound was perceived as buzzing and cry-like, gradually softening, reinforcing this affective association. As she began to pat the interface, variations in force produced rhythmic fluctuations, while adjustments in compressive pressure resulted in more pronounced changes in amplitude and intensity. P2 imagined the interface as four children, "*the shaking motions are like dancing or playing with friends. When I stroke them, I feel like they're my children*". This impression is intensified through stroking and holding, transforming the textile into a relational presence. P3 recalled childhood experiences of playing with toys alone, "*I'm not thinking about making any particular sound, but rather I'm trying to find a state where I feel like I'm playing, like when I was a child*". Both P1 and P4's interactions reflected comfort. P1 lay on the interface in a sleeping mood, rotating and stretching her body as if lying on her bed to explore different sonic textures. P4 described a peaceful, safe sensation that encouraged sustained hugging. She particularly enjoyed the accompaniment of buzzing sounds when sustained.

While the interpretations varied, they shared themes of playfulness, intimacy, and bodily comfort. These affective affordances emerged relationally through the multimodal coupling with material softness and deformability, and participants' embodied memories. Sound both reinforced these affordances by evoking situated, affective qualities and, at other moments, became a focus of exploration, prompting participants to discover gesture–sound mappings. Consequently, interaction formed a situated, exploratory practice that extended beyond instrumental control or choreographic movement.

4.3 Exploratory Interaction beyond Stable Control

Before the experiment, a brief introduction to the interface was provided, including the conductive areas and the principle that deformation, such as squeezing and pressing, would alter resistance and thus affect sound. This introduction was intentionally minimal, leaving space for participants to explore interaction strategies and mapping relationships independently.

All participants began by squeezing and pressing individual parts of the interface, comparing the sound from different sections through repeated gestures (Figure 8). Interaction at this

Figure 8: Different interactions of participants.

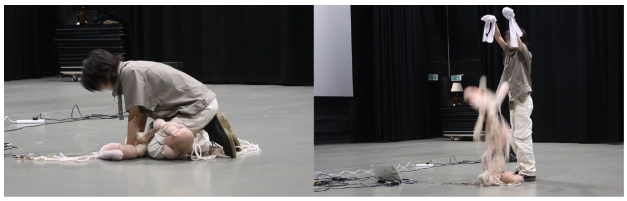

Figure 9: The two interactions of P1 that create a similar sound.

stage remained hand-centred and closely aligned with the demonstrated techniques. In the latter half of Phase 1, P1 and P2 began introducing alternative interactions. They shook, swung, or lightly patted or beat the interface, producing vibrato-like fluctuating sounds. Swinging and shaking became prominent exploratory gestures among participants (P1, P2, P3), particularly with gut-like structures (Figure 8). These interaction strategies emerged through experimentation and were carried forward into later phases.

Participants experimented with spatial displacement and reconfiguration of the interface. P1 and P2 raised or lowered the interface, occasionally triggering sudden and intense sound. Across phases, all participants adjusted the positions of interfaces on their bodies. Bodily movements like shifting posture or repositioning components also generate sonic feedback. Although these actions were not intended as sound-producing gestures, the sound feedback inspired interaction strategies, blurring the boundary between deliberate and unintended interactions.

Moments of surprise became catalysts for further exploration. P1 described discovering a resounding sound that she was unable to reproduce with the same kneeling interaction, only to encounter it again when the interface accidentally fell to the floor (Figure 9). Such experiences illustrate the discrete mapping, where similar sounds may arise from different interactions and identical gestures may have different outcomes. Rather than enabling mastery, this instability continually invites experimentation with different engagement.

These observations indicate that control in this exploratory interaction is not deterministic, but open-ended and negotiable. Instead of fulfilling fixed interaction, control is continually reconfigured through bodily engagement with the interface's material behaviour and auditory feedback. This ongoing negotiation encourages new movements and interaction strategies to emerge over time.

5 Discussion

The findings show situated and alternative interaction modes that participants' intentions and the interface's material behaviour constantly shape one another. Participants' interaction evolved over time. Initial engagement often involved exploratory pressing and probing, while later, participants developed personal strategies to navigate the system's responses. Growing reliance on whole-body interaction driven by perception and increased bodily perception was reported. From somaesthetics perspectives, this process prioritises bodily experience and cultivating heightened awareness through movement engagement and sound feedback [11, 26]. Participants interpreted interfaces' deformability and materiality through interactions associated with care, comfort, and intimacy. Sound was not merely the outcome of interaction, but strengthened the perception as auditory feedback or situated reinforcement. This co-agential interaction also resonates with notions of fluidity and ambiguity, as articulated through Kristeva's concept of chora [12]. This situated feedback from participants contrasts with dominant industrial and technological aesthetics in DMIs that privilege precision and efficiency, suggesting alternative values grounded in relational and embodied attentiveness.

The sensory and movement constraints employed in the experiment (Figure 3) functioned as somaesthetics catalysts that actively redirected participants' attention from manipulating the interface to embodied perception. It illustrates how constraint as design strategy can cultivate embodied exploration. The transition from hand-centred to whole-body engagement was not solely due to experimental procedure, but fundamentally supported by the interface's wearability and material properties. The ability to generate sound through different body parts encouraged decentralised bodily engagement, enhancing perception through coupling between movement and auditory feedback. The open-ended mapping produced moments of uncertainty and surprise, fostered expanded movement strategies and highlighted the fluidity in interaction, enabling participants to form affective associations between bodily perception and sound.

Despite the emergence of whole-body movement, all participants identified themselves primarily as instrumental players rather than dancers. Their central intention was to use bodily engagement to activate or manipulate sound. This orientation suggests that, rather than functioning as a movement–sound system, the interface was consistently approached as a musical instrument in which participants built situated and affective associations between sound and movement as embodied expression. In Section 4.3, participants adapted to the open-ended mapping by expanding their movement strategies, treating uncertainty in sound as inspiration for the interaction. Exploratory actions such as shaking, swinging, and repositioning, or following accidental sound events, became ways of negotiating and sharing agency with the interface. The interface is perceived less as a tool for executing predefined mappings but as relational partners that invite performers to discover sound through movement. In the interviews, P1 described the interface as a "*guest performer*," and it "*could not make a mistake*" because "*there was no right or wrong in its sonic output*". P2 characterised the relationship as companionship, noting how it helped sonify the bodily perception. P3

and P4 described the interaction as an exploratory journey rather than mastering an interface. Rather than expressing frustration at the inability to fully control the interface, their reports reveal an affective and generative negotiation with the musical interface, in which agency is distributed across performer and system. Sound was often perceived as both surprising and emergent, as well as an extension of bodily expression.

The study also inspired further development of the interface. Participants' association between forms, sound and gestures indicates that incorporating a wider range of shapes within the textile structure may encourage more varied bodily actions and expand movement to sound associations. In addition, introducing different filling materials with varied levels of softness and elasticity may alter interaction strategies and produce different sonic qualities. Participants' intention of listening directly to the interface inspires the integration of speakers inside. It may support a more spatial and embodied listening experience.

6 Conclusion

This study explored the alternative control as negotiation in a wearable e-textile musical interface. Rather than prioritising precision and mastery in control, the interface invited performers into open-ended interactions, where interaction strategies emerge through the negotiation with material properties and tactile-auditory perceptions. Through reflexive thematic analysis, the findings demonstrate participants' exploratory engagement with this interface that prioritises bodily perception and affective associations.

Rather than aiming for generalisation, this study foregrounds the situated and embodied experiences of musical interaction rooted in somaesthetics and feminist perspectives of these participants. These findings suggest design opportunities for wearable DMIs that balance controllability with negotiability, allowing variation and fluidity to become productive elements of interaction. Future work should involve a more diverse participant group with longer experiment periods, as well as performance-based evaluations to further investigate how such open-ended interaction influences both performers and audiences, and how this alternative control may reshape practice, choreography, and composition.

7 Ethical Standards

Ethical approval for this study was obtained from the relevant institutional ethics committee. This research is conducted as part of the first author's PhD studies funded through a university studentship. The work described in this paper by Ryo Ikeshiro was partially supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project No. CityU 11600523). There are no financial or non-financial conflicts of interest to declare.

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