Making an interactive dance piece: tensions in integrating technology in art

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ABSTRACT

I describe the research and creation journey of a choreographic dance piece called SKIN that I made with another choreographer, 3 dancers, 1 musician and 1 developer. The performance integrates interactive technologies mapping inner movement to sound and video on stage. We followed a research though practice method that includes iterative cycles of choreographic practice and interaction design. This generated a set of research questions that I address through experience explicitation interviews of both audience and creative team members. The interviews allow me to investigate the lived experience of making and attending the performance and the emergent relationships between dance, media and interaction as well as the tensions and negotiations that emerged from integrating technology in art. I discuss my approach as anti-solutionist and argue for more openness in HCI to allow artists to contribute to knowledge by embracing the messiness of their practice.

Author Keywords

Dance, Embodied interaction, Research through Practice, Anti-solutionism

CCS Concepts

•Human-centered computing → HCI theory, concepts and models;

INTRODUCTION

Third wave Human Computer Interaction (HCI) embraces the notions of experience, emotion, expression, meaning-making and aesthetics [5]. We witnessed the emergence of a body of work that builds upon artistic and movement based practices, pragmatic, somatic and embodied theories, in order to capture and design for human bodily experiences and expressions.

My work builds upon my artistic practice and phenomenological [29] and embodied philosophies [48]. I will illustrate it in this paper by describing my journey of research and creation of an interactive dance performance called SKIN. In a team of 2 multi-disciplinary artists (myself choreographer/researcher, my partner choreographer/videographer), 3 dancers, 1 musician and 1 developer, we created a large-scale 50 minute dance performance that incorporates movement-based technologies capturing physiological data and mapping them to alter video and sound on stage. The motivation to use technologies is to make what is inside of the body accessible to the outside viewer by mapping sensations "under the skin" to sound and videos. SKIN is within the scope of third wave HCI: it is personal, expressive, exploratory, interactive and experiential.

The research creation has dual aims: first to create a show that is touring and second to generate academic knowledge on interactive performances in HCI. Using the notion of practitioners' trajectories developed by [14], I describe our research though practice that includes iterative cycles of choreographic practice and interaction design. These cycles generated a set of research questions: (1) How much does the technology serve or subjugate the dance? (2) Augment or limit the body? (3) How does hiding or revealing the interaction affect the art?

I address these research questions through interviews of both audience and creative team members inspired by experience explicitation technique, after the premiere of the piece. My interviews allow me to investigate how the dance, the interaction, and the media are perceived and experienced by the audience and team members. Finally I discuss my findings in terms of the tensions and negotiations that emerge from intersecting art and technologies and place my contribution in anti-solutionist HCI literature as well as HCI research interested in pluridisciplinary creative endeavours and embodied interaction.

RELATED WORKS

The Living Body in HCI

Theories in embodied cognition describe how we gain knowledge about the world through experiencing it with our body. These theories echo earlier phenomenological accounts of experience [46, 29] and "enactivist" approaches that challenge traditional Cartesian mind-body duality [66]. The mind is no longer only processing information but is extended by the body in the perception and interaction with the world. Heidegger describes when tools are "present-at-hand" i.e. present to the perception and when they become "ready-to-hand", i.e. transparent, embodied and integrated in the motor schema. Along this line, embodied cognition scholar David Kirch argues that tools when manipulated are absorbed into the body schema, and this absorption affects the the way we perceive our environments [40]. Such theories behind tools integration have fundamentally changed HCI, where it is widely acknowledged that important research efforts must be devoted towards paradigms that extend our cognitive, motor, experiential and

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emotional skills [5]. In particular, Paul Dourish, in his seminal work “Where the Action Is" (2001) [13], established the basis of embodied interaction in HCI as interaction design for and with the lived body. Inspired by these embodied views, my aim in SKIN is to extend the body with interactive sensorial and aesthetic artifacts that alter its perception.

There is a number of approaches that design technologies that interact with the experiential body, such as Move to get Moved [33], Moving and Making strange [43], Embodied Sketching [45], Kinesthetic awareness [21], Defamiliarization [7], Estrangement [70]. As argued by Wilde et al., designing for movement can enhance self-awareness and quality of attention [69]. Similarly, somaesthetics recognizes the primacy of bodily movements for existing in the world [60], as well as the human ability to train their bodily and somatic capacities [60]. Schiphorst introduced somaesthetics in HCI as an approach to embodied interaction design [56]. She puts the quality of the attention to experience at the centre of the design. Somaesthetic Appreciation Design, proposed by Hook et al. [31] is a design approach that proposes four main qualities: subtle guidance, making space, intimate correspondence, and the notion of articulating experience. I am inspired by Hook’s notion of intimacy as a key element in crafting SKIN and designing for internal sensations. My aim is to create a dance that emerges from the interaction between the body and the technology that is both performative and soma-aesthetic and supports awareness of movement experience. While acknowledging the challenge, I attempt to articulate such inner lived experience through explicitation interviews [19].

Interactive performance

In Entangled, Christopher Salter shows that technologies have been entangled with performance from early works such as Diaghilev’s Ballets Russes in 1917 to current digital and interactive art [54]. One of the most prominent collaboration between artists and engineers date back to 1966, with the 9 Evenings interactive performances [47]. Subsequently, choreographer Merce Cunningham is the best-known figure to have explored motion capture and computer-based visualization since the 1990s [57]. Since then, multiple experiments linking dance and technology are based on capturing the body movement and generating an effect that represents the signal. For example, [41] propose an interactive dance performance in which projected visualizations reflect the dancers’ movements in real-time. More recent works visualizing dance movement on stage have been popularized by Troika Ranch[1] or Chunky Move[2] dance companies. In SKIN, we explore a more embodied account of interaction and capture and represent what is underneath the skin, the inner physiological sensations that are involved in dance. By using physiological sensing, our approach echoes some earlier use of biometric data in interactive performance by researchers and performers such as Atau Tanaka [63] and Marco Donaruma [12]. SKIN transforms the invisible physiological sensations into an aesthetic digital media.

[1] http://troikaranch.org

[2] http://chunkymove.com.au/our-works/production-touring-history/production-history/

Research through practice

Research through practice is an investigation undertaken in order to gain new knowledge through practice. An overview that summarizes a large literature arguing for HCI research to meet interaction design practices can be found in [26]. Along with a team of dance, video and music artists and a developer, we conducted a research through practice method in making SKIN. The art includes an interactive system that did not emerge from users’ needs but rather from personal desires, inspirations and artist-led explorations [65]. Our methodologies and insights also come from our studio practice. In Edmonds and Candy’s framework, they described a model of practice-based research that links theory, practice and evaluation through the notion of trajectories taken by the practitioner and influenced by their individual goals and intentions [14]. I describe the trajectory we undertook as an iterative cycle of choreographic practice, interaction design and system development. These cycles generated a set of research questions that I address through experience explicitation interviews of the audience and team members.

Designing for experience

In designing for the spectator experience, Reeves et. al propose a taxonomy for public interaction design that reveal or hide manipulations and effects [53]. They coined these systems secretive, expressive, magical or suspensive. In their formalization [11], Dix et al. extract salient features of performative interaction such as direct and indirect effects of actions performed by a (human) agent and perceptions of those effects. Revealing or hiding the interaction orient the audience’s experiential engagement with the piece. Indeed ambiguity [24] and openness to interpreting [59] hidden relationships between performers and artefacts encourages the audience to invent their own meanings.

I am also inspired by the approach to aesthetics and experience centred design expressed by Wright et. al where they recognize the need to consider not only the cognitive or rational, but also the emotional, the sensual, the compositional and the spatio-temporal aspects of our experience [71]. This approach correlates with pragmatic aesthetics [50] and embodied interaction in HCI [13]. Routed in this experiential pragmatic view, I seek to provide in SKIN an interactive dance both for the dancers and the audience members to experience, sense, feel, with their bodies in the digital environment.

No solution to no problem

Unlike usual HCI methods and productions that call for reproducibility, generalizability and applicability, art making has a different set of political agenda, goals, singular methods, and unique results, all constantly reinvented. This is similar to other communities of practice in HCI such as the makers or the DIY communities, where practitioners resist corporate agendas [28] and the underlying hegemonic structures of production in HCI [64]. Echoing various critical design approaches, among them slow interaction [49], sustainability [3], undesign [52], making art in HCI challenges the fast and productivist focus. Moreover, I inscribe my work in a lineage of previous HCI approaches that go beyond the usual artificial problem solving. For example, Feminist HCI

[2] where Shaowen Bardzell reveals unspoken values within HCI's dominant paradigms and proposes pluralism, participation, advocacy, ecology, embodiment and self disclosure as design qualities. In anti-solutionism through design fiction [4], Mark Blythe reveals the most influential scenarios in HCI that addresses the "monsters" of work in the twentieth century supported by technology. According to him, this is due to the fact that HCI is an applied discipline funded according to the impact and relevance of the work to industry. He argues that there are many monsters worth fighting and one can see a variation on this plot in critical design where the "monster" is the lack of informed debate. Indeed critical design argues for more reflective and critical practice in design [1]. This discourse applies naturally to art making. Instead of proving that SKIN is a worthy interactive artefact solving a problem (such as making people more aware of their bodies or making people move more), my efforts are towards reflecting on the process of making it. The plot here is about the trade-offs, the decisions, the tensions and the negotiations that emerged from integrating technology in art.

THE PERFORMANCE SKIN

Skin is a dance performance with interactive video and sound by 2 choreographers for 3 dancers and 1 musician. The piece appears as a film that unfolds with 3 different scenes and the transitions between them (see Figure 1).

Aesthetic intentions and motivation

The artistic motivation for the piece is to show and share the felt sensations and experiences "underneath the skin" of the dancers with the audience members. This is grounded in previous approaches such as pragmatic aesthetics [50], somaethetics [31], embodied and kinesthetic interactions [20, 21]. To do so, we map physiological data to digital media (sound and video). The interaction and the media are designed to be aesthetic, sensorial and felt kinesthetically by the audience members.

The dancers interact in real time with projected digital video and sound. The videos displays the choreography staged in a remote house in the south of France. It is a place of family stories and lived experiences where the dancers perform with a poetic detachment, just on the edge of strangeness. The house is also seen as a metaphor of the dancers' skin, surrounding their bodies. It is a shield and an interface, the home where they live, sleep, dream and play.

In each scene, the dancers are equipped with sensors that capture respectively the muscle activity, heart beat and touch data and these are used respectively to trigger, control the frequency or freeze the video and the sound. These mappings reveal the dancers' inner sensations through "the behaviour" of the video and sound on stage. While SKIN is a technologically augmented performance, we (the choreographers) propose an aesthetic that challenges the cold and neutral one that we experience in typical digital art festivals such as Ars electronica[3] or Mutek[4]. We made a cinematographic piece that conveys a sense of fragility, intimacy and nostalgia.

[3]https://ars.electronica.art/news/

[4]https://www.mutek.org/en/

Team members

SKIN is a collaboration between two choreographers and multidisciplinary artists. My partner is a choreographer, filmmaker and inter-disciplinary artist. I am a choreographer, HCI researcher and Laban movement analyst. I designed the technology while my partner captured the video material of the piece. The team is composed of 3 dancers. The first and second dancers participated to the rehearsals and performed on stage. The third dancer was only present on the videos and did not use the technology. The team also includes a developer that prototyped the sensors and a musician and sound designer that composed the music and contributed to the sonic interaction design.

Collaboration and economical agenda

From the beginning, there was a common desire with the other choreographer to make a piece where we explore an experiential relationship between the dancers' internal sensations and video and sound. We received an art and science grant that required us to show the premiere at a festival. The schedule was tight: the production was planned over 1 year period and the premiere was irrevocable. We were also booked to perform 3 additional gigs. The budget of the piece allowed to pay the artists and cover the travels.

Making the piece was a collaboration between the choreographers, the dancers and the musician. The roles were defined but the boundaries were loose: choreographers took artistic decisions based on propositions of the dancers and the musician. My creative collaborators had no computer science or HCI skills. I was in charge of designing the interactions and hired a developer for 6 months to build the hardware. During the rehearsals, the entire team explored the system to build a common understanding of its potential and limits. While this paper represents my voice (hence the use of the first person), by no means am I aiming to silence that of my collaborators. I am the only HCI researcher in the team. I relate our journey to my academic community, cautious to faithfully include the perspectives of my collaborators and of a sample of the audience members. My collaborators are artists that are not interested in academic reflection, nor are they paid for it. They generously contributed to this paper, beyond making the work with me, by giving an interview at the end.

Design process

We followed an iterative step-by-step research through practice method [58, 44] and let artistic, design and research ideas, opportunities and questions emerge. Our process consists of a number of rehearsals with all the team members, where we iteratively created the choreography and integrated the technological prototypes until the piece took shape.

TRAJECTORY IN DANCE REHEARSALS

We organized 3 phases of rehearsals:

- A first rehearsal period of 2 weeks. All the team members were in the studio and experimented with the sound and visual interactions and generated artistic ideas.

Figure 1. (a) Scene 1: dancers triggering media. (b) Scene 2: sonification of dancers' efforts. (c) Scene 3: dancer freezing the media through touch

Figure 2. The circuits in tennis bracelets with the copper conductive sensor

- A second rehearsal period of 2 weeks. All the team members were in the studio mostly to experiment with the proximity sensors.

- A third rehearsal period. All the team members travelled to the south of France for 3 days to capture the final videos and environmental sounds. We then had a 10 day residency to integrate the media into the piece and prepare the premiere. We had to make pragmatic decisions to minimize the technological risks and insure a reliable show that we can tour with.

Initial sensing platform

The developer designed the initial platform in a non ecological setting (i.e. the lab). He surveyed the state of the art of existing physiological sensors and selected: 1) muscle activity via Myo bracelets, 2) breathing through pressure sensors around the thorax, 3) ear worn pulse oximeter for heat rate, 4) skin temperature, 5) skin humidity, 6) balance of the body through pressure sensors under the sole of the foot, and 6) Proximity and contact through capacitive sensors. I tested the sensors and discarded the breathing and pressure sensors because they were cumbersome. I also discarded the skin temperature and humidity sensors because they had too much inertia to be relevant to my practice. I selected the Myo for muscle activity and accelerometers, the heart pulse and the proximity sensors. The developer integrated these sensors into an Arduino Mini control module and set up a wireless communication between this module and a MaxMSP patch via an Xbee S1 connected to a 9V battery. These two devices have the advantage of being small and not requiring a lot of power to operate. The circuits were put in tennis bracelets with zippers to protects them. The contact zone for the proximity sensor was a copper paper that sticks to the skin as shown in Figure 2.

During a preliminary full day of rehearsal, the 2 choreographers, 1 dancer and the developer collaboratively tested the initial sensing platform. We observed that depending on where the copper was glued, we obtained different range of touch data. Moreover with the sweating the copper paper was not sticky anymore. In order to make the prototype more reliable, we developed a shoulder pad where the electronics have simplified wire links. We designed the pad as a second skin by incorporating the contact zone for the proximity sensor into the fabric through a printed conductive silicone patch following the stretchable user interfaces approach of [68]. We knew that the position of the sensor on the shoulder was a constraint but we were willing to explore it creatively.

Choreography and visual and sonic interaction design

The developer and I prototyped 3 interactions on MaxMSP for the three scenes in the piece as shown in the scores on figure 3. We then iterated on them during the rehearsal periods.

First scene

We initially developed the first interaction based on the muscle activity and the acceleration captured by the Myo and sent to a MaxMSP patch. Data is filtered through a a Bayesian filter [55] and used to train a gesture recognition algorithm developed by [22] on the movement qualities of various dance sequences. When the dancer is performing a sequence, the algorithm would recognize its qualities and trigger a corresponding video.

During the first rehearsal period, We asked each dancer to compose 4 movement sequences (8 in total for the 2 dancers) combining Laban Efforts qualities: 1) sustained and strong, 2) sustained and light, 3) quick and strong, and 4) quick and light. we asked the dancers to improvise using such minimalist movement vocabulary and apply variations such as reversing, ordering, and repeating in order to add complexity. We equipped one of the dancer with a Myo on the arm and the other on the leg. We then trained the movement recognition algorithm on the 8 sequences that we curated to enforce a good recognition quality. We built on findings of [18, 23] that show a good recognition rate of such combinations of Efforts qualities using muscle activity and accelerometer data. We tested the algorithm and computed the recognition rate according to [18]. We found that the recognition had a very low tolerance:

the movements had to be reproduced too faithfully. Moreover, given that the sequences were longer than 10 seconds, the algorithm could not sustain an accurate decision without false detections. To overcome this limitation, we “cheated" and made the machine play the videos until the end when a movement was recognized for more than three seconds. This solution was fairly satisfying when the dancers performed the sequences separately.

During the second rehearsal period, we tested the movement recognition on the totality of the first scene and no longer on the separated sequences. We observed that the recognition made false detections when the dancers where transitioning from a sequence to another. Moreover, most triggered videos were delayed by approximately one second which compromised the coherence between the dance and the image. We didn't want to make compromises on the dance. Therefore, we decided to change roles: The program no longer recognized the movement but generated the videos and triggered the sound that gave instructions to the dancers. The data captured from the Myo served to influence and weight the generative program. When the activity decreased, the sequences triggered were more demanding for the dancers and vice versa.

During the third rehearsal period, we observed that the generative process that triggered the 8 sequences was not aesthetically convincing because the dancers and the video were never synchronized. We switched to a Wizard of Oz technique where I triggered (using a MIDI controller) the videos and sounds that corresponded to the sequences of the dancers. The video corpus presented a third dancer performing the 8 sequences or their reverse, in the house in the south. The sound was composed for each sequence. Throughout the process of making the first scene, we wondered **how much does the technology serve or subjugate the dance**? Our choice of using a Wizard of Oz was due to an increasing tension that we felt when technology started to affect aesthetic principles that we did not want to jeopardize (synchronicity with media, detection...etc.). The more we delved into making the piece the more it became clear that what mattered was the audience's experience whether that meant to throw away most of the interaction we developed or not. And so we did!

Second scene

We initially developed the second interaction based on the heart rates from the heart pulse sensors that are individually sonified in order to compose an evolutionary sound environment. We mapped different sound parameters such as the frequency, duration, rhythm and spatialization with the frequency of the heartbeat.

During the first rehearsal period, we choreographed repetitive everyday gestures into long dance phrases. We asked each dancer to come up with 15 everyday gestures. Inspired by the making strange method [43], we altered these gestures by changing their dynamics, the body part involved and their scale until they became strange and performative. We composed each 10 gestures into a longer sequence (3 sequences in total). We instructed the dancers to perform using only these 30 gestures or one of the 3 sequences alone or in a duet. The musician programmed a MaxMSP patch that generated an interactive sound environment. He mapped the pulse and BPM information measured on each dancer to a singular sound whose repetition follows the pulsation, and whose frequential composition follows the BPM. The higher the heart rate, the higher the sound, and vice versa. At this point, no video was captured for this scene. We tested the heartbeat sensors and discovered that the modulations of heart rate are very fast and the climax intervenes in times that do not necessarily correspond to the effort phases. It accelerates during rest phases following an intense action.

During the third rehearsal period, we observed that the heart beat sensors did not stick to the ears of the dancers. We switched to a Wizard of Oz where I simulated the heart rate of each dancer and accelerated or decelerated the sound and the video that corresponded to them. We integrated videos where each dancer was evolving in ordinary scenes and using everyday objects in the house. We superimposed these two layers of videos just like we superimposed the sound and controlled their speed similarly. In making this scene, we wondered **how much does the technology augment or limit the body?** The media is simulated and does not reflect the real heart pulse of the dancers. It rather reflects moments of exertion of effort and moments of recuperation as perceived by the Wizard of Oz. The dancers were asked to relate to this external phenomenon that gave them additional information. The media changed their usual apparatus and thus their perception, at times augmenting their expressivity by providing an external stimuli to dance with or against and at times reducing their capacity to be attentive to themselves by simulating a pulsation response.

Third scene

We initially developed the third interaction involving the capacitive proximity sensor worn on the scapula. When the dancers get close or touch the sensor, they produce a zoom and a blur effect on the video. The magnifying effect on the body and the skin is meant to heighten a sens of shared intimacy with the dancers.

During the second rehearsal period. We equipped the dancers with the silicone capacitive sensor on the shoulder pad. We captured the various intensities of contact from a caress to a touch to a press in order to trigger the visual effect of zooming and blurring the video. However due to a heat wave and no AC in the studio, the scale of the proximity data became unreliable and only the touch data was significant. We discarded the proximity and changed the interaction so that the touch was mapped to a freeze of the video. This interaction highlighted the moment of touch but tended to hide the subtleties preceding it. We choreographed 2 solos and a duet for the 2 dancers that included moments of touch specifically on the contact zone.

During the third rehearsal period, we decided to discard the arduino platform because the wires broke too often. We hacked the camera on Android phones that we placed on the dancers' shoulder. When the dancers covered the camera, they froze the video and the sound as shown in figure 4. We integrated the videos that displayed the dance in the remote house. The music was composed of sound recordings from the house. Throughout the making of the third scene, we wondered how we could balance **what was hidden or revealed in the inter-**

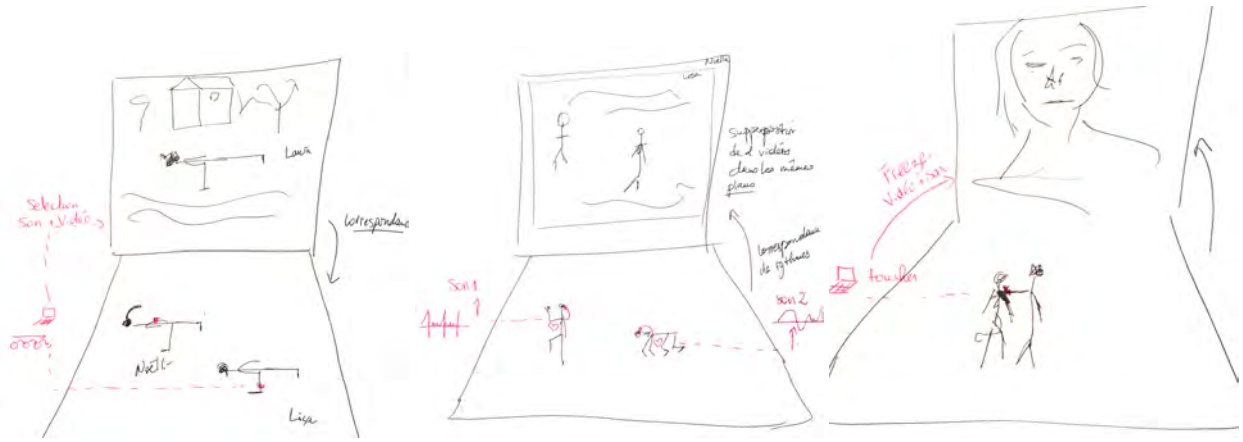

Figure 3. Dance scores (a) Scene 1: Dancers with the Myos triggering sound and videos. (b) Scene 2: The heart rate sensors mapped to the speed of the video and sound. (c) Scene 3: The touch mapped to a freeze of the sound and the video.

action? When we hid the mapping, the risk was unclarity and when we revealed it, the risk was obviousness. According to [53], our final design choices are revealing the manipulations (touch) and the effect (freezing the media), unlike in the second scene where both the manipulations and the effect are hidden (the audience does not see the dancers' heartbeat). We wanted the interaction to be visible yet not boring, clear yet not too predictable, expressive yet not too ambiguous. This balance surely affects the audience engagement with the piece, but that we could not know in advance.

Figure 4. The dancers touching the mobile phone to freeze the sound and the video.

We finalized the piece and integrated videos for the opening and the transitions between the scenes, where the house is displayed and where the dancers are in different rooms, sitting and not looking at each other. We carefully curated these videos for their aesthetic qualities so that they conveyed a sense of nostalgia, strangeness and intimacy in the mundane life of the dancers and the poetics of the house. Excerpts of the final piece are available online[5]

AUDIENCE AND TEAM MEMBERS' EXPERIENCE

In order to investigate further the three questions that emerged (the perception of the clarity or intrigue of the technology, its role of serving or subjugating the dance and augmenting or limiting the body), I run a series of interviews following the premiere of SKIN where I solicited the artists and audience members' experience of the dance, the technology and the media.

Participants

I recruited and interviewed 4 audience members (P1-P4) that attended the premiere of the show and 4 members of the team, the musician, the second choreographer and the 2 dancers (T1-T4). Age ranged from 25 to 60 (mean=29,8, STD=4.3), 3 participants were female and 5 were male. Participants were not compensated for their time due to policies in our research institution.

Procedure

Audience members attended the premiere of the show in a theatre. They were seated and the dance took place on the stage in front of them. The members of the team were engaged in the creative process. In particular, the 2 performers had used all the prototypes of the system. I conducted a semi-structured interview of approximately 60-minute with each of the audience and team members approximately 1 month after the premiere.

Experience explicitation technique

My semi-structured interviews were inspired by Pierre Vermersh experience explicitation interviews, also called micro-phenomenological inquiry [67]. This technique was developed to access and articulate subjective singular experiences [51] rather than general statements. It is carried out in various communities such as psychology, ergonomics, health and security. It allows for an evocation of the past and a verbalization of the lived experience. It is ideal for eliciting participants' lived experience of making and attending SKIN. I have followed a certification in the experience explicitation technique and carefully used the set of principles compiled by Nadine Fingold to be as close as possible to the evocation of the experience [16]:

- The interviewer solicits a specific situation and a singular moment to evoke rather than a general one.

[5]http://saralaoui.com/2016/02/skin/

- The interviewer's goal is to bring the interviewee into an evocation of the action itself, avoiding judgments, comments, context, general knowledge and goals.
- The interviewer asks non-inductive questions avoiding perlocutionary effects that could direct the attention of the interviewee to a cognitive act or induce an emotional state.
- The interviewer favours the evocation state through identifying an embodied position rather than a habitual position of verbalization.
- The interviewer respects a contract of communication with the interviewee. We are dealing with a passive memory that requires patience instead of rushing into answers. There are no expectations, no hypothesis, and no pressure. All silences should be welcome, and taken as an opportunity to allow the memory of the experience to emerge. For the interviewer this means humility and not knowing everything in advance but rather accompanying the interviewee into re-evoking the lived experience.

Data collection

The interviews took place individually in calm offices. Both audio and video was recorded. I also gathered first person observations during the iterative process in the form of notes, videos and photographs.

Data analysis

I transcribed, then analyzed the interviews using a thematic analysis approach [27]. Because it is challenging to maintain the interviewees in a state of evocation, some of the responses (usually characterized by the past tense) might "slip" from the evocative state into a more reflective position. I discarded the responses in the past tense except when there was an indication of an evocation state such as slowing speech tempo or pauses. From the selected responses, I defined concepts using the words of the participants (open coding) and grouped them in categories (axial coding). I then verified and discussed my analysis with a second coder that previously red the transcriptions to insure that the analysis captures the data.

FINDINGS FROM INTERVIEWS

In the interviews, the audience members evoked specific moments of the premiere, while the musician dancers and choreographer evoked specific moments of the rehearsals.

Clarity or ambiguity?

The first scene involving triggering videos according to the dance sequences performed, was perceived as obvious. For P3 and P4, such obviousness doesn't let them be immersed.

The second scene involving the heart beat was qualified by P4 as ambiguous and intriguing. Audience members did not try to understand it but rather experienced it sensorily. P3 claimed: "*It is not obvious so I am not taking it for granted [...] I am not trying to understand.*" P4 reported that he "*stops trying to understand [...] I am more into it [...] There is no symbol coming on and breaking the thing. In the third part, I am decoding the symbol and it makes it less intriguing*". P3 mentioned the poetic experience that emerged from the non obvious interaction: "*It was not about intrigue because it's not a puzzle, it's more about poetry that you can experience*" (P3). The musician evoked the second scene: "*It is interesting, while knowing it was a Wizard of Oz was irrelevant. It is the least technological obsessive.*" The ambiguous quality of the interaction made it more immersive, poetic and experiential.

The obvious touch gesture that triggers the freeze in the third scene was perceived as "*taking a lot of space*" by P4 and not leaving enough for interpretation. It made P3 feel "*uncomfortable*". He evoked the last scene: "*There is something mechanical expected visible and obvious that makes me uncomfortable. Technique is more a barrier than a facilitator in this case. In the other 2 it is more subtle*". The touch gesture was repetitive and predictable. For dancer T4 this is due to the "*on and off effect*" that erased the subtleties of touch. The musician T1 evoked: "*it's more interesting to hide your tools. I don't think it's interesting when your tools are your focus. The dancers are performing with their bodies that should be the centre of it.*"

Beyond decoding the interaction, the 4 audience members emphasized that they mainly aimed at experiencing the performance rather than understanding the underlying system. According to P2, understanding: "*doesn't matter*" .

Serving or subjugating the dance?

Triggering the right effect

There were specific gestures that triggered the digital events in the first and last scenes. P1 mentioned that "*some gestures obviously are related to the Myo and that was a strong statement of the correlation with the technology*". He was troubled by the fact that the touch interaction "*has to be in a particular place, that's a constraint.*" P3 felt uncomfortable to " *see that the dancers are trying to make things work [...] they are really targeting the touch, which is not a dance gesture*". According to P3 and P4, this made the dance at the service the technology and the technology to be "*harming*" for the performance.

The necessity of the technology

For the musician T1 the feeling of the dance serving the technology is related to the tools being unnecessary for the artistic purpose: "*Ideally you are trying to get somewhere aesthetically, your tools should help you get there rather than your art shows [SIC] why your tools are interesting*". The fact that we could perform the first scene with the Wizard of Oz showed that the algorithm was not a necessity: "*It wouldn't have changed the quality of that section*" said T1. In the second scene, according to T1 "*we are approaching some level of expressivity that we can't access without the technology*". The third scene on the other hand was perceived as a "*showcase of the technology*" by P4 because the dancers were systematically using the touch.

Fear of failure

T1 and P1 referred to a moment where the phone fell and the dancer had to put it back on stage. P1 felt empathy with the artists and a "*Paranoia that the Myo might skip away.*" Whereas P2 said: "*I would just assume that I am missing what's going on that it's not broken*". The fear of the system breaking was present during the rehearsals and prevented us

from taking the risk of using our original prototypes during the premiere. Choreographers T2 expressed the anxiety related to making the recognition work "*How can we reproduce the movement precisely without becoming robots. It could be a good constraints, but we are panicked to have something work.*" Indeed, we were pressured by our gigs, agenda and budget to make a dance that the algorithm was able to capture and oftentimes compensated for its errors.

Too strong of a constraint

The choreographer T2 felt that the recognition algorithm required too much precision from the dancers at a point where they became "*executers for the machine while the challenge is to be able to communicate with it while staying free.*" This constraint created a mis-communication where no negotiation was possible, because according to T2 "*We don't bend to the machine, and the machine doesn't bend to us*". The dancers also considered this constraint to be too strong. Dancer T3 mentioned physical and technical constraints about "*the regularity of the movement and where the sensors are positioned.*" She considered that the algorithm "*expects something that is too precise for what humans can do*". She had to isolate movements so that the algorithm can recognize them and was frustrated that it only takes into account "*pre-calculated parameters without the flexibility of the human brain and sensitivity. So nothing new can happen.*" According to choreographer T2: "*Sometimes it has to be too clear, we have to cheat to be captured. It could have been interesting, but it's frustrating. It requires patience*".

Opportunities to create with

P2 considered that "*the technology is used as intended*". Both dancers perceived the technology as a creative constraint but for them "*the body came first*" (T3). Choreographer T2 mentioned that the moments where the algorithm failed us were interesting because "*it requires you to rethink. The goals is to reflect on the failures and not to create something that works. It can happen. But even when it doesn't work you can play with it.*" For dancer T3 the constraints allowed her to "*explore diversity*". Although, dance requires one to reproduce movement faithfully, according to T3 "*there is always some freedom in the moment. The challenge for us to find the space for what is alive, playful and spontaneous beyond the regularity of form*".

Appropriating technologies

P2 mentioned that the dance is appropriating the technology "*in new ways*". None of the sensors used are designed for the purpose of the piece. The Myos are appropriated to recognize dance gesture. The phones are appropriated to use the camera as a proximity sensor. According to dancer T4: "*These sensors are useful for something else. Using them in live performance challenges their engineering [...] because we create situations that wouldn't happen otherwise*". Dancer T3 argued that appropriating the technologies made it inaccurate at times, which is why "*we have to put ourselves at the service of the machine to solve the problems*". When the results were unexpected, T3 found "*other ways to interact with the machine.*" However, according to her, this led the project to move away from what was initially desired "*because of the whimsical machine*".

Augmenting or limiting the body?

The audience and the team members gave different roles to the technology: an instrument to control, a dance partner to improvise with, an additional scenographic layer independent of the dance or a tool to enhance awareness.

Partner

Dancer T4 evoked the heat wave, when the proximity sensor was not reliable and she had to adapt to it: " *It's like when you get to know a new person, or 2 animals that apprehend each other*". She mentioned the technology's constant yet unexpected behaviours: "*I trust the machine. At least there is something that is constant, unlike another dancer. I don't have to be careful [...] I do what I have to do and what I need to live and I know the machine would react, I don't necessarily know how*". She trained with the technology until it went from a simple set to a sensorial partner: "*at first, I consider it as a simple set. It's not something that supports me. I don't look at the video. I live my thing and the video lives its own. But in my feeling, it's a character. It's a third dancer. It influences me sensitively.*" Dancer T3 on the other hand perceived the technology as a "*systematic*" object: "*there is a possibility to play with it but there is not the affect that I feel with a real partner. The technology doesn't have a physical body*".

Instrument

Two of the audience members considered the dancers to become instrumentalists when they were using obvious gestures to control the technology. "*So at that moment where she is making a gesture she needs to produce a signal, she switches to an instrumentalist*" said P1. For P4, technology, like an instrument, is a constraint that serves the art: "*It's like a guitar. I guess if you use it it's because it serves the dance*".

Set

All team and audience members considered that the 3 elements of media, dance and interaction are 3 "*pillars of the performance*". P1 said: "*These 3 elements are working as an ensemble but in different space and time and apparatus*". P3 related to the the video of the house as "*scenery and it becomes a kind of mirror or a second layer.*" Although all 3 elements were perceived as an ensemble, the 2 dancers and the choreographers felt at times "*detached*" from it. Dancers did not always pay attention to the media while performing, except in the first scene where the sound was giving them instructions. Dancer T3 claimed: "*The technology becomes something for the audience rather than for me, especially that the video is behind, I don't always perceive it.*"

Enhancing awareness

The interaction gave dancer T3 feedback on her movement: "*The recognition makes me confront my problems of memory and adaptation. I realize there are more parameters in play, muscular density for example. I get more aware of my muscular density through the machine's response.*" All team members felt that the technology offered a different perceptual element. Dancer T4 said: "*I realize that technology could be a way to show something not explicit and to create those layers for perceiving dance*". However such technology for T4 did not augment the body, she said: "*through the responses of the machine, I feel like it reduces my movement*".

Conveying intimacy and nostalgia

The videos of SKIN conveyed a feeling of intimacy. Dancer T4 perceived the video as "*an oneiric space, out of time, less concrete than me with my body on stage, a dream somehow.*" Musician T1 "*is less consciously thinking of the technology. The aesthetic is trying to say this is not high tech science fiction stuff, it's intimacy, softness, sensuality.*" P3 described the house as another skin: "*Perhaps because the title is skin. There is something more about intimacy inside. This notion of envelop inside outside.*" P1 also evoked the videos of everyday gestures: "*I am seeing a little window into the mundane things which is a real source of intimacy.*" Intimacy was also conveyed by moments such as the solo in the third scene when a dancer is performing and the other is watching her. For P1, this "*reminds me when a soloist doesn't play the solo until the dress rehearsal, the musicians sit with their instruments and watch it, they enjoy it, they typically clap*". Intimacy was also conveyed by the technology. According to P1: "*We are watching a show in a chateau, a bit like a dream. Everything seems right but then one of them has a Myo on the arm. It's confusing, it's nice*". Similarly, for musician T1, the interaction with the video and sound conveyed a feeling of "*nostalgia, softness, intimacy and technologically slightly distopic a bit out of control*". The piece was considered by P2 to be: "*visually stimulating, engaging, coherent, with a connection between the performance and the technology that is changing. It isn't jarring nor disruptive. It seems to have a real flow.*"

DISCUSSION AND PROVOCATION

I describe in this paper the tensions that emerged in reconciling the technological ruptures that occurred as a result of stage-level robustness and artistic intents. These tensions show the non-suitability of linear problem-solving approaches in HCI for making interactive performances [37]. Indeed art making is not about engineering a solution to a problem. Therefore, I argue that delving into art requires the academic community to tolerate its perceived messiness and open its methods and framing to a plurality of discourses. For that reason, I am not proposing implications for design as a recipe to be followed to make art with technologies. I am proposing a broader shift from the predominant understanding of design in HCI to a plurality of voices retracing singular intentions, pathways, challenges, questions and inspirations that artists have to offer.

Tensions and negotiations

The making process was a succession of implicit negotiations between the artists and the technology. These negotiations resulted in design choices that came from both technological limitations, creative ideas but also real-life production constraints.

I realized (after the fact) that my initial artistic intention was focused on a technological motivation. "To make what is inside of the body accessible by mapping sensations under the skin to sound and videos" means : can I design a movement-based interaction that is sensorial and performative? Such technological focus in artistic intention is predominant in digital performance [35]. Its nature does not delegitimize the artistic statement. According to Simondon, in some cases, there is a beauty of technical objects (that can be everyday or computational objects) when they are inserted into the world [61]. Their aesthetic value is related to their integration into the "singular point of the world" that materializes them. In SKIN, the technology per se does not hold artistic value unless it is materialized by the interaction with the dancers on stage. However, because I cared about the technology in my art, I was frustrated when it did not satisfy my aesthetic views. To overcome the persistant frustration, I simulated the digital responses through Wizard of Oz with a taste of disappointment for not including a fully interactive technology as was my initial artistic idea. Despite that, the audience members' responses indicate that they perceived the artistic result similarly to a fully interactive apparatus. What this suggests is that the interactive technology is only necessary when adding a level of "expressivity" that otherwise cannot be achieved. Such expressivity can be achieved when systems have a perceived agency that [32] coined as "partners to improvise with or against, with behaviors of their own, facilitating a second-person relationship". Example of such interactive partners are those that can improvise [34] or that offer an otherness [15] that affords intercorporeality with the dancers. Other examples of creative partnerships emerge from interacting with technologies that disrupt dancers' ways of moving through defamiliarization [8] or restrict their movement through sensory alterations [39]. Interestingly, the interactive artefacts in SKIN, whether they were simulated or not, were perceived by the dancers as partners, characters or members of the ensemble when they had their own ambiguous behaviours. When they displayed a clear (perhaps obvious) response, dancers perceived them as instruments to control or as a set for the audience that they ignored.

Throughout the making process, a persistant pressure was that of the HCI academic values. Although, I followed a practice based research, I was still seeking for academic validation of my work. While my most urgent endeavour was to create a piece that was not a showcase of the technology, sometimes I felt the need to use the technology because otherwise there was limited academic value in my insights. This tension became particularly high when the dance became about making the technology work. However, little by little, I let go of this pressure and resisted altering the art for the sake of using the technology. Maintaining the technology fully meant taking the risk that videos would trigger with delay or that the recognition would perform false positives. As much as the creative process was enriched by the questions emerging from the experimentations and failures with the technology, I discarded the interactions and the apparatus that did not fulfil the aesthetic demands and the stage robustness required for the dance piece. In terms of robustness, making SKIN showed that there is a difference between a system that one experiments within the lab, and a system that one has to work with for more than a month of rehearsals, 8 hours a day with paid professional dancers sweating, rolling on the floor and fully engaged physically. A prototype is simply not an option. And when the curtain of the theatre opens, the stress is at a climax, one cannot afford to lose a signal. This is what stage-worthy robustness is and it is beyond user experiment-worthy robustness. Such robustness is particularly hard to achieve when we appropriate existing devices for creative uses that

they are not designed for. Honauer et al. reports on such critical requirements for the technology when creating, staging and integrating interactive costumes in the existing structures of traditional theatre [30]. According to them this requires openness in terms of methods, processes and structures beyond existing disciplinary boundaries.

There is no problem here!

There are no needs nor problems to solve for people. Echoing anti-solutionism through design fiction [4], SKIN is not an art and science collaboration where scientists observe the artists with a third person perspective, define (perhaps collaboratively) a problem space or a design opportunity, and develop a technology to support the practice. The HCI literature shows a variety of design approaches that facilitate dance practice by extending the movement vocabulary [17] or enhancing performers awareness [21, 42]. There are also approaches problematizing dance practice in that it is an ephemeral medium that needs a technology to document its process through choreographic writing [9] and to digitally archive the resulting piece [6]. Making SKIN showed that integrating technology in a dance production challenges the view of technology as either solving artistic problems or supporting artists' actions. Instead it is composed of layers of intentions, interactions, meanings, interpretations, desires and aesthetics. For Emmanuel Kant, when there is art, there is free will [38]. An aesthetic idea is a representation of the imagination from which thought emerges, without concept or language to make it intelligible or to express it completely.

When there is no concrete agenda with concrete problems, it is difficult to anticipate or model how the design choices might affect the audience other than intuitively. For example it was difficult to anticipate that the performers would appreciated the clarity of the interaction while the audience members would feel more immersed and more engaged sensorially with a hidden ambiguous mapping [24, 59]. These are design choices that cannot be simulated in the lab. Additionally, artists are confronted to physical and pragmatic constraints from the stage robustness needed to production constraints [65]. Theories in Art and methods in HCI (user centred design for example) do not address these constraints or allow to make "good" design choices, let alone the artistic ones. The practice does. According to Gonzales et al. [25], creating a cohesive union between dance and computing to form the overall gestalt and intent of the piece involves trial and error and a mutual disciplinary understanding. The authors argue for the complexity of practice-based research where HCI meets the arts. However, they simplify this complexity by defining a *recipe* for making interactive dance through five design principles: connected kinetics, augmented expression, aesthetic harmony, interactive build, and integrated process. I argue that there shouldn't be a single linear recipe but rather a plurality of discourses. Post-structuralist philosopher Jacques Derrida avoids a unique discursive theory on art [10]. He deconstructs institutions, traditions, beliefs, and practices by showing that they do not have definable meanings and missions that limit them. Deconstructing art practice stretches it beyond methodological and theoretical boundaries and transgresses these confines. This argument correlates with open-ended methodologies in HCI such as ethnography, feminism [2] as well as makers and DIY approaches [64]. Kang et al. also describes features of improvisation in art (reflexivity, transgression, tension, listening, and interdependence) and show their potential to extend both linear and open-ended methodologies for HCI research and design [37].

Some readers might think: why should HCI deal with the arts? I argue that if integrating technologies in arts breaks the established HCI methods and challenges the existing design techniques, then they should be reinvented. Ignoring technologies in art will not make them disappear. Christopher Salter retraces the extensive history of the adoption of technological practices in performance art [54]. He shows that performance traditions can inform emerging practices such as new media. There is great value in investigating, designing and reflecting on the adoption of technologies in art although that might push HCI research into orthodox lands [36].

Some of the readers might think that this paper draws a dark portrait of technologies in art, how can we fix this? There is no problem here, there is no solution neither. Artists are experimenting with technology, facing its resistances, pushing its limits. Perhaps what artists need is to not artificially attempt to problem-solve in order to contribute to knowledge. Perhaps what HCI needs is to make space for alternative discourses, with a different nature of insights, outside of typical problem-solving approaches and where knowledge comes authentically from the practice.

CONCLUSION

SKIN is an art project with the goal of creating a sensorial interaction between technology and the dancers' embodied inner experiences [31, 62]. I describe the research and creation journey of making the piece using a first-person perspective. In that process, I questioned the ways by which technology serves or subjugates the dance. How it augments or limits the body. And the different ways hidden or revealed interaction are perceived. I addressed these questions through interviews of both audience and creative team members inspired by experience explicitation technique [67]. I found that technology was perceived as an instrument, a dance partner, a scenography and sometimes a tool to enhance awareness. Beyond its clarity or ambiguity, the audience aimed at experiencing its poetics. While we negotiated with it to avoid bending to its constraints, we recognized the creative opportunities that it opened. These findings also revealed the tensions that emerged from integrating technologies in art. This led me to place my contributions within anti-solutionnism in HCI and argue for openness to alternative approaches allowing artists that are experimenting with technologies to embrace the messiness of their practice in order to contribute to the field with their own methods, insights and voices.

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