Bodily Interaction in the Dark

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ABSTRACT

In light of the growing interest in designing for new body-movement based interfaces through somaesthetics and somatic awareness, we created a sound-based interaction using the Microsoft Kinect device, which is performed in the dark. The absence of visual feedback led participants to deeply focus on the movement of their bodies, and to have a different awareness of their bodies and the space around them. The notable difference between performing this interaction in light and dark suggests that non-visual based interfaces are a fruitful area to explore in somaesthetic interaction.

Author Keywords

Body; movement; awareness; dark; vision; somaesthetics.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design.

INTRODUCTION

With the adoption of phenomenology and somaesthetics as tools for investigation and design, HCI is demonstrating a move toward a more body-centric focus [2]. A number of researchers in HCI have begun to more explicitly bring our bodily experiences into the design of interactions [e.g. 4, 5, 6, 7, 9, 13] that help highlight the fundamental relationship between our social, emotional, and bodily experiences. Central to this work is a commitment to the phenomenological ideas that our perception and understanding of the world are bound up in our moving and embodied experiences that cannot be fully understood without recognizing the context in which we act out these experiences [3, 12]. Adopting such a perspective has highlighted the importance of considering body-centric interaction not simply as a means of input to a system but rather in terms of the first-person felt experiences of movement and the body [7, 9, 15]. This in turn has led to greater consideration of somaesthetic concerns within HCI and the design of body-based interactions [e.g. 5, 6, 13]. Drawing on phenomenological concerns, somaesthetics [14] focuses in particular on the relationship between our bodily and conscious experiences and how our mindful and aesthetic experiences are bound up in corporeal practices.

Building on these arguments, we explore a particular way of designing these felt bodily experiences that exploits a shift in the context in which our bodily interactions are enacted and experienced: *darkness*. The context of darkness brings a rich set of physical, social and cultural factors to bear on our felt experiences of movement. On the one hand there is the lack of visual stimuli with which to orient and understand our bodily movements. This can constrain the particular ways we might move through lack of visual reference points or uncertainty about what is in the environment. Removal of the visual sense (e.g. through shutting your eyes) is a well established practice in somatics for heightening senses and focusing on an internal awareness of body movement that can encourage contemplation and reflection [e.g. 9]. Imagination, fear and danger can come into play in the way we experience movement in the context of the dark. Darkness can also create a sense of anonymity and freedom to move without the consequences arising from being observed. How then, might our orientation towards these experiential properties of the dark allow us to design meaningful somaesthetic experiences?

In this respect we build on HCI's shift in orientation to darkness and lack of visual stimuli from a problem to be *solved*, (e.g. assistive technologies for blind people [1]) to a resource for interaction design [11]. In part this shift has related to our social and emotional orientation to the dark and how we might take advantage, for example, of heightened feelings of loneliness or solitude at night [18] or the aspects of risk, fear, danger and the erotic in darkness [17] in our interaction design. Those who have designed interactive experiences for the darkness often still involve some minimal visual stimuli (e.g. [8]). More recently though, there have been more explicit attempts to create interaction in contexts of full visual deprivation. Notable here is the Haptic Lotus, an immersive theatre experience in which a handheld tactile device is used to navigate through a dark space [16].

In this paper we present a body-centric experience in the dark using Microsoft Kinect. The system exploits the Kinect's use of infrared light as the basis for body tracking that allows the user's body and movement to be tracked in

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Figure 1: A user following the shape of a virtual object

the dark. We begin with a description of the system and then move on to present a study of the system in use. We discuss our findings on the difference in participants' overall interpretation and attitude towards a bodily experience in the dark and how designers can purposefully use this relationship to create or enhance somaesthetic experiences.

SYSTEM DESIGN

This project focuses on providing an experience for a user based on the use of sound, rather than visual, feedback. The user, wearing headphones, moves within a space constrained only by the physical limits of a room that contains a virtual, invisible object, such as a two-dimensional circle or line, or a three-dimensional sphere. When the user's left hand 'touches' the virtual object, music plays in the left ear. Similarly, if the user's right hand 'touches' the object, music plays in the right ear. Headphones were used to easily associate the separate channels to the separate hands. Because users turn and move as they interact, recreating this mapping in stereo sound would have made it more difficult for users to distinguish which hand was touching the object and generating the sound. The user's goal is to feel along the entire outline of the shape in order to identify it.

To determine when the user is touching the virtual object, we use the skeletal tracking of the Kinect device. We modelled a virtual space containing the object, and superimpose the user's hands into that space. As a hand approaches the object, a piece of classical music begins to play quietly and increases in volume as the hand gets closer to the object. By paying attention to the correspondence between the music playing and the location of their hands, a user can locate the object within the virtual space. The sound communicates only distance to the shape, not the nature of the shape or where on the shape a user has touched. The user determines what the shape is through exploration of where sound does and does not play. When a person has outlined the entire object, a new object replaces it.

DATA COLLECTION AND ANALYSIS

We conducted a user study with seven participants to investigate how people used the system, and how their experience differed when they were in a light versus dark environment. Participants interacted with the system in an empty room in the light for ten minutes and in the dark for ten minutes, the order of which we counter-balanced.

Following each participant's interaction, we performed a semi-structured interview lasting approximately 30 minutes. Our questions were aimed at exposing the difference in experience between the light and dark environments ("Did you enjoy performing the task more in one environment?" and "Did you feel more comfortable in light or dark?"). Participants' interactions and interviews were videotaped and the skeletal data captured by the Kinect, consisting of the three-dimensional positions of 20 joints, was stored.

Analysis of the interview data consisted of an open-reading of the experiences the participants reported between the light and dark contexts. Themes of interest emerged including: what participants were focused on during the experience; how they conceived of the virtual objects; the person's self-consciousness throughout the experience; awareness of their own body; and how the person perceived the space surrounding them. From these themes, we extracted those that further elucidated our question on bodily movement and somatic experience. From there, we returned to the skeletal and video data to further investigate the difference in experience and use. For instance, from the skeletal data, success between the two conditions was determined by the proportion of time that a participant's hands encountered an object as well as how much of an object they were able to discover within the space. In addition, from the video data we were able to assess the character of movement evident in the two conditions.

FINDINGS

Whether in the light or in the dark, outlining the contours of a virtual shape was not easy. While all participants were able to initially locate the virtual objects in both conditions, they found it difficult to complete an object. In objective performance measures, there was no discernible difference in terms of time to locate shapes and number of successfully completed shapes. However, in terms of their perceived performance, participants felt they had performed better and felt less frustrated in the second block of interaction irrespective of whether it was the light or dark condition, suggesting that learning played a role in feelings of success.

Performance metrics, though, were not central to our motivations with the system. Indeed our concerns were much more with the felt experiences with the system and the relationship of this experience to the dark. In terms of these, participants expressed how their experiences with the system were enhanced when performing in the dark, describing it as "more peaceful", "intuitive", "natural", "organic", "calming", "relaxing", "less artificial", "less frustrating", "soothing", and "coherent". In the following sections we review some of the reasons for this perception and how the darkness context facilitated a sense of ownership over one's movements, body, and space that allows us to consider the opportunities for interacting and reflecting on the body.

Proprioceptive Focus

Strategies for interaction with the shapes were markedly different between the two conditions. In the light condition the participants spoke of their reliance on visual cues to locate themselves in relation to the virtual object. Most participants used visual references to remember where their bodies had been previously, and to keep track of the location and shape of the virtual object. Participants would identify the position of their hands, as well as their whole body, almost exclusively by what they could see.

> *You have your hand here, and you use your eye to remember spatially where that was rather than where your hand would go, so that was where I was using my eyes, probably, like, marking areas of the room, that kind of thing. So say that was where the pen holder was, so I know that above that it stops. That kind of thing. [Participant 01, Light first]*

In contrast, in the dark, the participants discussed their focus on body orientation and the movement of their hands and arms. Participants in the dark paid more attention not just to sound, and small changes in the sound, but also to the location and position of their bodies within the space. Success depended on knowing where their body was, and where it had been in the most recent past.

> *In the dark, you have to remember where your body is at. So rather than taking cues from the environment, you're taking cues from yourself. So the space becomes less important. [Participant 03, Light first].*

The lack of a visual reference forced them to be both more aware of their body and more thoughtful about their movements. Some participants said that the lack of visual feedback facilitated this focus. Because they could not see, they tended to use a strategy of being more careful and aware of their movements. They spoke of the heightening of other senses and we observed the markedly slow, methodical movements of their limbs from location to location. Once they found the object in space, some participants would simply stand still with only a small, almost imperceptible change in hand movement divulging their continuing interaction with the edges of the virtual shape.

Participants spoke of their movements in the dark in terms such as Tai Chi, Yoga, and Karate. One participant referenced the Star Wars films and mentioned he occasionally felt like he was using the Force. Another said he felt like he was doing pantomime. In essence, doing things in the dark seems to be a more reflective and bodily aware experience: participants described their actions with reference to their bodies rather than their surroundings, and were concerned more with the feeling rather than the visual appearance of their actions. This reflection on the body's sensations and feedback created by the dark perhaps added to the "feelings of naturalness", "relaxation", and "enjoyment" related.

The Imagined Space

The dark did not only allow for a focus and reimagining of one's corporeal body, but it also redefined how one thought about their space for interaction. There were mixed reactions to being required to move in the dark. Three out of seven of the participants reported that they were less inclined to move blindly through the space. One participant [Participant 03, Light first] mentioned that she would have done more 'groping around' had there been padded walls, suggesting that either the lack of feedback from empty space, or the perceived danger of running into a hard object, increased her reluctance to move. In these cases, the participants reported exploring the space less in the dark.

However, others preferred the space in the dark, and felt less physically constrained. One reported that the lack of visual reminders that there was furniture and technology in the room made the space feel different, less distracting [Participant 03, Light first]. Two participants said it felt more like an open space in the dark, which made them more willing to move their hands.

> *Because I couldn't see the walls…I didn't have any concern that my hands were going to hit the wall. [Participant 04, Dark first].*

Some participants felt like the room was bigger, and the walls did not exist because they could not see them. It was as if, without a visual reference tethering them to reality, the cares of the world were removed and the space existed as a place that was just there for them and their movements. Participants even remarked upon how large the space felt when they were interacting. This was particularly evident in the participants' orientation of their bodies in the dark. In the majority of other movement-based technical interactions, especially in video games, feedback is given on a screen. As a result, participants orient themselves facing the screen. In the dark, there is no screen to orient towards and no indication of a sensor waiting to capture movements. This freed the participant's movements, both to move around the room and to face sideways and backwards.

Freedom of movement was also constrained or enabled by one's own sense of self-consciousness. Some participants felt more pressure to perform the task "correctly" in the light situation, and felt that the study conductors could see them less clearly or were less aware of the tasks being recorded in the darkness.

> *[I felt self-conscious] more in the [light] because I felt…more observed and in the dark, in the dark it felt like there was nobody who can see me." [Participant 06, Light first]*

DISCUSSION

In this paper, we have presented a system designed to create a particular somaesthetic experience within the particular context of darkness. By exploiting the infrared sensing capabilities of the Kinect, the system is able track the body movements of the user in the dark. In orienting to this property, and building on existing phenomenological perspectives in body-based interaction, the focus of our design was on influencing the felt experiences of movements with interactive technology. Through our study, we have begun to articulate key ways these felt experiences are played out.

In some instances, these experiences built on understood relationships between sensory experiences and bodily understanding. For example, when performing the interactions in the darkness, the lack of visual stimuli encouraged a more contemplative inner awareness of the body and its movements. The aim here is not to highlight this as a novel phenomenon in itself. Rather, and following arguments in [7, 9, 10], the aim has been to been to treat such phenomena as a valid point of departure and demonstrate a particular design instantiation that achieves this. More generally this points to ways that we might consider such darkness-centric and non-visual forms interaction for other forms of contemplative and reflective interactive experiences.

Related to this were observations that body movements in darkness were markedly slower and methodical, at times leading to stillness. What is shown here is how the design of the system can slow people down with associated feelings of calm and relaxation – again highlighting how we can deliberately exploit these concerns in design. In part this can be attributed to a lack of awareness of things in the environment and the adjustment of movement to avoid potential hazards. Aside from the specific consequences of our own design here, this suggests how we might orient to these uncertainties about the environment that derive from the context of darkness. This is further suggested in the notions of imagined space seen in the study. It is this imagined space that gives context to the felt experiences of movement, and the darkness provides the context for this imagination to play out. Although the experiences in the study pertained only to the perceived size of the imagined space, we would argue that further system design might consider other ways to play with the imagined space of movement through richer forms of sensory suggestion in the dark.

Finally, the study also highlights how designing for movement in the context of darkness can also free up possibilities for movement. First of all, by deliberately avoiding screen based interactions, there is less dependency for body movements to be oriented in the direction of a screen – the body is more free to move around. Secondly, movements in the dark are not open to observation by others, which again lends a different meaning to the movements being performed. Movements can be performed freely without self consciousness and the constraints of social judgement. This would seem an interesting area to consider in other body centric systems and applications in which movements might be judged (e.g. exercise, dance).

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