Soma Express Kit: Understanding the Somaesthetic Experience of People with Visual Impairment

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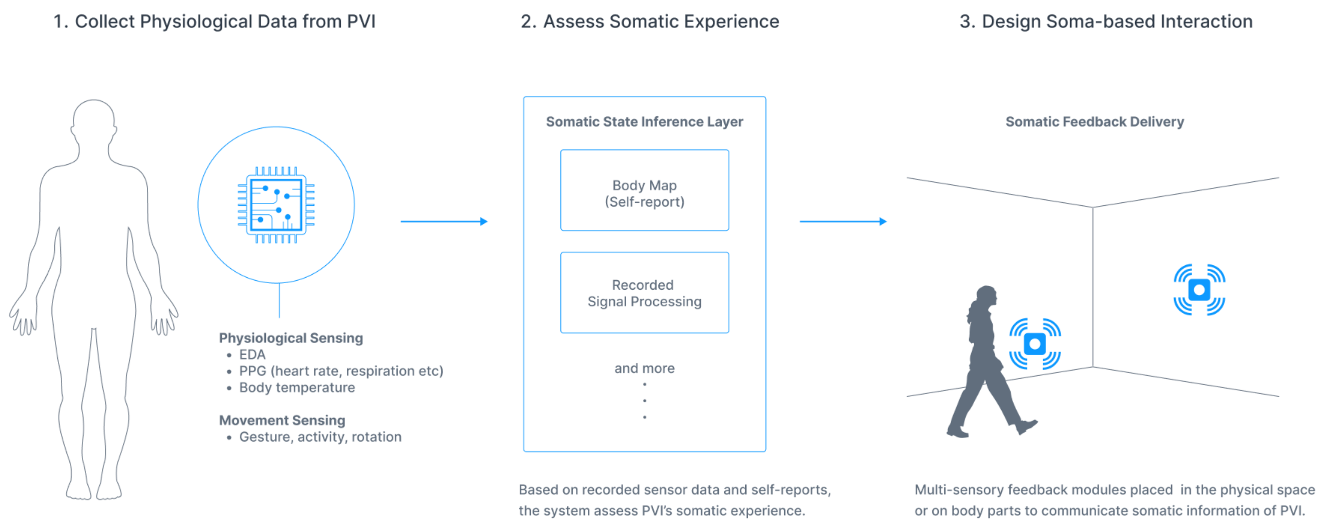

Figure 1: The System Concept for Soma Express Kit

ABSTRACT

This paper introduces the concept of Soma Express Kit, a novel toolkit that capitalises on heightened somatosensory capacities of people with visual impairments (PVI). Rooted in somaesthetic interaction design, it aims to create collaborative experiences that transcend traditional sensory limitations. By combining somaesthetic experiences, multimodal feedback, and physiological sensing, the kit offers a deeper understanding of how PVIs perceive and interact with their physical environment. The kit integrates wearable physiological sensors and multi-sensory modules such as haptics and sound to communicate PVI's somaesthetic experiences. It also explores the potential for real-time, non-visual interaction between PVIs and sighted individuals, fostering empathy and inclusivity. By embracing the somaesthetic potential of PVIs, this research seeks to enrich collaborative cross-ability interactions, offering embodied and immersive experiences for all participants.

CCS CONCEPTS

• **Human-centered computing** → **Collaborative and social computing**; **User interface toolkits**.

KEYWORDS

soma design, somaesthetic experiences, cross-ability collaborations, visually impaired, blind, accessibility, physiological sensing, affective computing

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1 INTRODUCTION

Collaboration between visually impaired and sighted individuals is a topic of interest across multiple fields. In the context of assistive technology, remote sighted assistance (RSA) has emerged as a conversational technology that allows sighted agents to provide real-time navigational assistance to people with visual impairments (PVI) via live video calls [2, 8]. In the design field, efforts have been made to develop tools that offer audio and haptic guidance for exploring tactile graphics to support blind and visually impaired designers [16]. While these works highlight the importance of addressing accessibility barriers for PVI to support cross-ability collaboration, few have explored approaches that capitalise on the abilities of PVI [7]. This is directly in contrast with the analysis of interdependent dynamics in collaborative navigation documented by Vincenzi et al [17] which illustrates how the specific skills of PVI and their sighted companions are both needed to co-construct shared spaces and practices.

PVI have been found to develop higher somatosensory abilities in their remaining senses, which enable them to achieve greater accuracy in tasks such as vibrotactile discrimination and auditory environment mapping compared to sighted individuals [13, 18]. Despite these findings, most prior works in cross-ability collaboration aim to support PVI by supplementing or replacing visual information with alternative sensory information (e.g. sound and touch). Such methods often see PVI only through the lens of limitations in information access and prioritise visual modalities over other sensory experiences, missing the opportunity to explore the somaesthetic potential and experiences of PVI.

Alternatively, embracing the somaesthetic potential of PVI in designing collaborative experiences could uncover more embodied and immersive experiences for all participants involved. To expand this idea, this paper presents Soma Express Kit, a soma exploratory toolkit for understanding and communicating the somaesthetic experience of PVI to sighted or non-sighted peers. Soma Express Kit builds on recent literature in somaesthetic interaction design, which places body and sensory perception at the centre of interactive experience [9]. Soma Express Kit is introduced as an exploratory concept to investigate a somaesthetic design opportunity for collaborative interactions between PVI and sighted individuals. It brings together somaesthetic experiences, multimodal feedback, and physiological sensing to gain a more nuanced understanding of how PVI perceive and interact with the physical environment.

In the following section, we present the results of the semi-structured interviews with 17 PVI that served as the basis for the development of the Soma Express Kit concept. Further, we then outline the conceptual design of the kit and discuss its potential design implications.

2 RELATED WORK

We begin this section with a brief overview of the technologies developed to assist PVI in collaboration. We then draw on the literature from somaesthetic design and affective computing to describe ideas that seem promising as a combined alternative to the existing disability-focused approach.

2.1 Assisting PVI in Collaboration

In recent years, HCI research on assisting cross-ability collaboration between PVI and sighted people has gained traction. Prior work has focused on providing access to digital information via the use of real-time auditory feedback [12, 19] or digital tactile graphics [4]. These technologies aim to provide PVI with alternative ways of perceiving and interacting with their environment, enabling them to contribute effectively in group settings. However, they tend to focus on compensating for the lack of vision rather than on appreciating and incorporating the unique sensory abilities of PVI into interactive experiences.

In the area of navigation and orientation, while there has been a significant number of research on supporting PVI's independent navigation [1, 11], there is now a growing literature that focuses on supporting social participation [10, 17] and ability-oriented design [15], highlighting the importance of interdependence between PVI and sighted individuals. Our work draws on this literature in developing the proposed Soma Express Kit concept.

2.2 Somaesthetic Design

Somaesthetic design is a design approach that explores the potential of incorporating the first-person account of bodily sensations and movements into interactive experiences, allowing users to engage with their experiences in a more holistic and immersive manner. In the context of cross-ability interaction, somaesthetic design takes on a unique significance for both PVI and sighted individuals. Leveraging this approach could not only provide interactive experiences that respect PVI's capabilities rather than emphasise their disabilities [20], but it could also enhance the somaesthetic appreciation for sighted individuals, promoting a deeper connection with their inner experiences. Thus, there is an opportunity to explore how somaesthetic design can establish common ground for PVI and sighted individuals to engage in meaningful cross-ability interactions.

2.3 Affect Detection via Physiological Signals

There is considerable literature on affect detection that employs physiological-sensing technologies [6]. These technologies often utilise machine learning to infer an individual's emotional state from various physiological signals such as heart rate, skin conductance, and electrodermal activity. Affect detection through physiological signals is closely related to somaesthetic experience, as it allows for capturing affective states that are closely coupled with certain somatic states and bodily sensations. In addition, by visualising and sharing inferred somatic states, the data can be used to promote empathy and synchrony, thereby enhancing cross-ability interactions [3, 14]. However, there is limited research on incorporating physiological sensing to understand the somatosensory experiences of PVI. This research aims to bridge this gap and propose a new tool to uncover and communicate PVI's somaesthetic experiences for cross-ability collaborations.

3 UNDERSTANDING THE SOMATIC EXPERIENCE OF PVI

In this section, we first present the findings from the interviews with PVI. We then introduce the concept of Soma Express Kit.

3.1 Methods

The primary goal of the interviews was to gain insights into the unique somatosensory experiences of PVI and to understand how they navigate and interact with their environment. We conducted a series of semi-structured interviews with 17 PVI (12 blind individuals and 5 low-vision individuals). Participants were recruited via snowball sampling. The interviews were carried out in Japanese, audio-recorded with the consent of the participants, and subsequently transcribed for analysis. The transcripts were analysed using an open coding thematic approach [5] with the goal of understanding the multi-sensory approach that underpins individual strategies that allow PVI to make sense of the surrounding environment.

3.2 Findings

With regard to day-to-day navigational experience, the common frames of reference the interviewees adopted were sound reverberation, the spread of wind on their faces, and vibrotactile sensations from their feet during navigation. All interviewees stated that they paid high attention to somatosensory experiences to interpret spatial relationships, textures, and objects - such as the presence of walls or obstacles - in their surroundings. Additionally, interviewees mentioned relying on auditory cues, such as echoes and sounds of footsteps, to determine the layout and dimensions of the environment they were navigating through. These findings highlight the importance of multi-sensory integration in PVI's ability to understand and navigate their surroundings effectively.

3.2.1 Affective Experiences and the Perception of Physical Space. Several interviewees highlighted that their affective experiences during navigation were closely linked to how they perceived and interpreted physical space. For example, some participants mentioned feeling more anxious or uncomfortable in crowded or confined areas, whereas others expressed a sense of calmness and relaxation in open and spacious environments. These findings suggest a strong relationship between affective experiences and how PVI perceive and navigate through different spatial settings.

3.2.2 Approaches to Sense-Making of Physical Space. Furthermore, there seem to be two dominant approaches to how PVI use sensory information to make sense of the physical environment: 1) the bird's-eye view and 2) the immersive view.

The group of people who relied on the former mode tended to mentally visualise the layout of the environment from a top-down perspective. For example, they described having mental representations of each navigational point, such as doors, hallways, and staircases. They would then mentally navigate through the space by connecting these points on their mental map. This mode tends to be used for reflective instances, in which individuals take time to carefully plan and strategise their movements within the environment.

By contrast, those who adopt the latter tend to focus more on their own bodily sensations and memories of specific objects or landmarks in their immediate environment. For instance, they would focus on sensory cues, such as sound, smell, texture, and temperature, to navigate through space. This approach seemed to help them adapt well to environmental situations; however, they mentioned that if any of the sensory cues were different from their memories, this could potentially lead to confusion or disorientation.

Lastly, a few interviewees said that they adopted the hybrid mode, where they would make use of each approach depending on the situation. They explained that in familiar environments, they relied more on their memory and mental maps, whereas in unfamiliar places, they would pay closer attention to bodily sensations and sensory cues. This adaptive strategy allows them to navigate effectively in a variety of contexts and maintain a sense of spatial awareness.

These differences imply that there might be a degree of difference in how much body awareness and sensory abilities are exercised, even among PVI. We hope to investigate this aspect further through a series of studies.

3.3 Soma Express Kit: Concept Design

The aim of Soma Express Kit is to explore a somaesthetic design opportunity for collaborative interactions between PVI and sighted individuals. The kit will feature a wearable physiological sensing module and a multi-sensory module such as heat, haptics, and sound to communicate and augment PVI's somaesthetic experience. The physiological sensing module will gather affect-related data using sensors such as electroencephalography (EEG), galvanic skin response (GSR), and heart rate variability, which will provide objective measures of PVI's somatic experience in real time. While effective sensory feedback for this purpose still needs to be investigated, we initially plan to focus on feedback such as haptics, sound, and heat, as these seem to be preferred modes of interaction for PVI based on the interview mentioned in the previous section.

3.3.1 Soma Express Kit: Potential Application. There are two steps in which the kit will be used. The purpose of the first step is to gain both quantitative and qualitative data on PVI's somaesthetic experience during spatial interaction. It involves collecting PVI's soma-related data through the kit's physiological sensors along with the self-reports from PVI to assess their somaesthetic experiences. The data collected from the physiological sensing module will be fed into a machine learning algorithm that will analyse and interpret the PVI's affective state, which will then be cross-referenced with self-reports by PVI. In the second step, the insights and data gathered from the first step will be incorporated into the design process of soma-based interaction via multi-sensory feedback. Multi-sensory modules are designed to respond to physiological signals in real time, providing different feedback according to one's affective state. These multi-sensory modules can be installed in the physical space to communicate PVI's subjective experience in the surrounding space in a way that sighted individuals can understand, offering an interactive map of PVI's somaesthetic information. Alternatively, they can be integrated into a wearable device worn by both sighted individuals and PVI to exchange each other's soma-related information. This integration allows for a more inclusive and empathetic experience, fostering a deeper understanding between sighted individuals and PVI via non-visual means.

4 DISCUSSION

Examining the somaesthetic experience of PVI can offer valuable insights into how to create more inclusive interactive experiences for PVI, as well as how sighted people can re-establish their connections with their bodies and senses to foster a deeper understanding of their inner experiences. It also has the potential to change how both sighted and visually impaired people experience and interact with our surrounding environments, allowing us to move away from heavily relying on visual cues and embrace a more multi-sensory approach. In an attempt to achieving this vision, Soma Express Kit builds on the existing cross-ability research by incorporating the somaesthetic design approach and physiological sensing technologies as a way to uncover and share PVI's rich somatic experience. However, there are areas that still require further consideration, which I would like to discuss in the workshop.

(1) What visualisation and communication approaches best capture the somaesthetic experience of PVI and allow for effective sharing and understanding among individuals?
(2) How might we ensure that the use of certain multi-sensory feedback does not promote misinterpretation or misrepresentation of somatic experiences?

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