SoniSpace: Expressive Movement Interaction to Encourage Taking Up Space with the Body

Ruojia Sun
ATLAS Institute, University of Colorado Boulder
Boulder, CO, USA
ruojia.sun@colorado.edu

Althea V. Wallop
ATLAS Institute, University of Colorado Boulder
Boulder, CO, USA
althea.wallop@colorado.edu

Grace Leslie
ATLAS Institute & College of Music, University of Colorado Boulder
Boulder, CO, USA
grace@colorado.edu

Ellen Yi-Luen Do
ATLAS Institute, University of Colorado Boulder
Boulder, CO, USA
ellen.do@colorado.edu

Figure 1: User interacting with SoniSpace, an expressive movement interaction experience with motion-reactive sound and visuals to encourage taking up space with the body

ABSTRACT

Movement forms the basis of our thoughts, emotions, and ways of being in the world. Informed by somaesthetics, we design for "taking up space" (e.g. encouraging expansive body movements), which may in turn alter our emotional experience. We demonstrate SoniSpace, an expressive movement interaction experience that uses movement sonification and visualization to encourage users to take up space with their body. We apply a first-person design approach to embed qualities of awareness, exploration, and comfort into the sound and visual design to promote authentic and enjoyable movement expression regardless of prior movement experience. Preliminary results from 20 user experiences with the system show that users felt more comfortable with taking up space and with movement in general following the interaction. We discuss our findings about designing for somatically-focused movement interactions and directions for future work.

CCS CONCEPTS

• **Human-centered computing** → **User interface design**.

KEYWORDS

movement-based interaction, soma design, sonification, interactive visuals, sensory feedback

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1 INTRODUCTION

Our experience in the world arises in movement. Whether our posture is open or slumped, our stride light or heavy–our movements not only reveal our cognition and emotion, but in turn, shape our ways of thinking, feeling, and being [10]. Influenced by somaesthetics, the study of cultivating somatic appreciation to improve quality of life [11], we are witnessing an increase of interaction designs

that center the bodily experience. We were inspired to design for the experience of "taking up space," an expression used colloquially to describe asserting that one's physical presence, thoughts, and feelings belong and matter in a particular setting. In this work, we define taking up space as expanding the physical reach of our body, as well as expanding the space we feel comfortable inhabiting. Through a first-person soma design practice, we identified this theme for its potential to transform emotion and self-perception. These somatic intuitions are supported by studies that reveal that open, expansive postures improve mood and self-esteem compared to closed, contractive postures [3].

We created SoniSpace, an expressive movement interaction experience that uses real-time movement-reactive sound and visuals to encourage taking up space with the body. We design for body awareness, open-ended exploration, and comfort in movement to reduce psychological barriers to movement such as self-consciousness and promote enjoyable interactions with SoniSpace regardless of prior movement experience. Preliminary results demonstrate that movement exploration augmented with sensory feedback can empower users to both physically take up more space and feel more comfortable with taking up space. We present a demonstration of SoniSpace, our system design, results from initial user experiences, and discussion of findings and opportunities for future work.

2 RELATED WORK

Somaesthetics recognizes the importance of movement in shaping our experiences and is driven by extending somatic awareness and capabilities to create richer experiences and improve well-being [11]. Building on somaesthetics theory, soma design calls for leveraging first-person somatic engagement in the design process in order to center the user's felt experience in the interaction design [6]. Exemplar works have employed interactive technology to enhance body awareness and expand movement repertoires; for example, the "Slow Floor," a pressure sensitive sound-generating surface, was designed to support a reflective engagement with the act of walking [4].

Real-time movement feedback has been applied to improve execution and awareness in a variety of contexts from sports training to rehabilitation [9]. In expressive and somatic movement practices, interactive visuals accompanying movement have been shown to support learning, creativity, and exploration [1, 7], while movement sonification affords awareness, expressivity, and subtle guidance [4, 5, 8]. Furthermore, one line of research studies how sonifications can alter body perception and emotions during movement, for example, making a movement feel lighter or heavier [8].

We apply soma design approaches and findings about effects of movement feedback in the design of SoniSpace and contribute the demonstration of a novel movement interaction to enhance the physical and emotional experience of the body in space.

3 SYSTEM OVERVIEW

Our system tracks body joints from a live mobile phone camera feed using MediaPipe Pose[1], a machine learning solution for body pose detection from images and videos. We send the real-time body joint data at around 20 frames per second through Open Sound Control (OSC) messages into TouchDesigner and Max/MSP to generate motion-reactive visuals and sound respectively. We created an immersive experience through visuals projected in front of the user and sound via noise-canceling headphones (Figure 2).

[1]MediaPipe Pose: https://google.github.io/mediapipe/solutions/pose

4 DESIGN

4.1 Process

We were driven to design an open-ended movement feedback experience that centers emotional expression through movement. Using a soma design practice, the first-two authors leveraged their first-person somatic experiences and movement backgrounds in dance and yoga as design material in several "slowstorming" sessions [6], identifying "taking up space" as a physically and emotionally impactful experience that they were inspired to transfer into interaction. During the development of SoniSpace, we cycled between sketching interactions between the body, sound, and visuals and tuning into our somatic experiences of the prototypes. We designed with both sound and visual modalities as we found they supported different aspects of the interaction. For example, the visuals afforded a direct representation of the physical space taken up by the body, while the sound augmented the expressive capabilities of the body to encourage movement exploration. Since the perception of sound and visuals varies between individuals, we also shared videos of an initial prototype with a group of potential users and received feedback that helped shape our final design.

4.2 Experiential Qualities

We designed for three experiential qualities to cultivate somatic appreciation and authentic movement expression in the practice of taking up space for users with varying experience with movement:

- **Awareness.** We intentionally designed sensory feedback to aid awareness of the body's extensions through changes in the sound and visuals based on arm extension from the center. To further promote body awareness, we incorporate original instructions for attuning to the body for the first 3 minutes of the interaction, which includes guidance such as "Allow yourself to take up space... How does it feel to move this way?"
- **Exploration.** We designed the interaction to be exploratory rather than prescriptive. Our system includes guided instructions to help the user orient with the system, but avoids instructing the user to move in any particular fashion. Earlier in the design process, we explored the employment of "poses," however, we chose to develop continuous feedback without movement constraints to encourage participants to move freely.
- **Comfort.** We aimed to create an experience where users felt safe and comfortable in movement. Based on the observation that water sounds elicit feelings of calmness, we employed a water motif throughout the SoniSpace interaction. In the sonification aspect, we utilized wave sounds and synthesized ambient music with water-like qualities. We gave the visual colors and motion that mimics water.

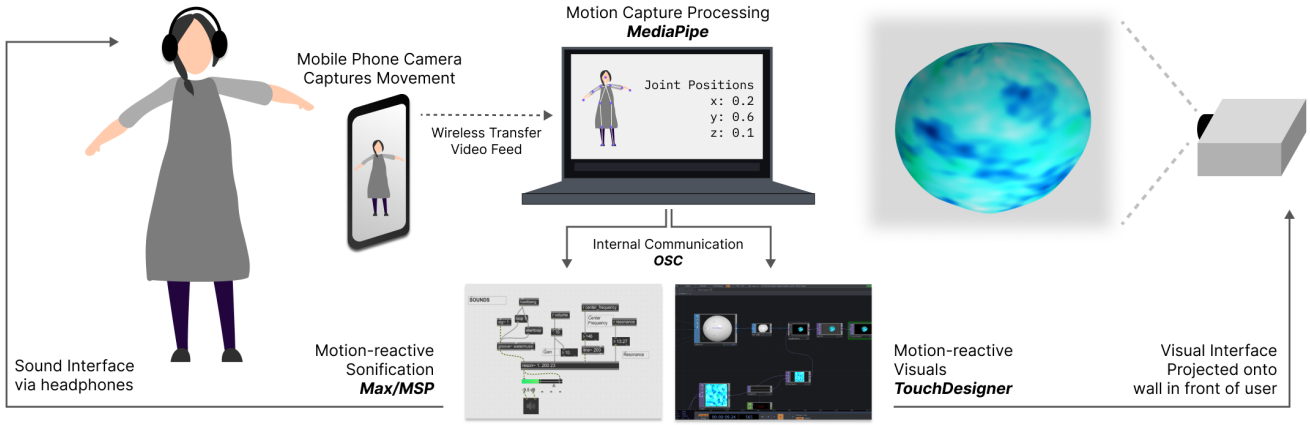

Figure 2: The SoniSpace system includes a mobile camera feed of user movement processed with MediaPipe, movement sonification through Max/MSP, and projected visuals generated in TouchDesigner

4.3 Sonification Design

For the sonification, we generated an ambient soundscape that changes pitch and timbre with movement. We initially experimented with changing the pitch of oscillators and note sequences and panning between different sound samples; however, we found they did not invoke the emotional qualities or feedback characteristics we were looking for. From our observations that changes in pitch were most easily perceptible, in our final sound design, we used a resonance bandpass filter to change the center frequency of an ambient track with water-like qualities, William Basinski's "Watermusic," based on the distance between the wrists to the center of the hips. The center frequency of the audio track increased as the arms extended away from the center to create a "lifting" effect. The distance in between the feet determined the sharpness of the resonance, resulting in a more complex timbre when the feet were further apart. To make it feel more empowering and enjoyable to move the body, we increased the volume of an ocean wave sound audio track the faster the user moved their arms to invoke the metaphor that the user was creating waves with their movement. Finally, we controlled the volume of audio based on the user's vertical level. We used envelope following in order to generate smooth, yet responsive changes in audio.

4.4 Visualization Design

The visualization creates an abstract representation of the user's body in space throughout the experience and complements the sonic aspect. We refer to the visualization shape as the "blob." The blob shape elicits a mirroring effect to enhance self-perception. Initially, we created the visualization shape as a mirrored humanoid avatar. However, based on preliminary feedback, we found that the humanoid avatars elicited connotations of bodily perception, distracting from the user's own movement awareness. The blob's abstract form allows for movement mimicry akin to mirroring without invoking any additional body perceptions. To control the shape and position of the blob, the blob's radius moved in tandem with the user's wrist points, while the center point of the blob followed the user's nose. Thus, when the user moved their arms closer and farther apart, the blob would grow and shrink accordingly. As the user stretched up, the blob would stretch lengthwise, and so forth. We programmed intentional noise using TouchDesigner into the blob's surface mesh so it would appear in a constant state of fluid motion, which gives the blob living and water-like qualities. It also helps to smooth any noise in the camera data and sudden movements.

5 EXPERIENCE STUDY

To understand the qualitative experience of using SoniSpace, we deployed SoniSpace over two days in public installations, recording a total of 20 user experiences, primarily from university students, faculty, and staff. We gathered anonymized data and took photos and videos with users' consent. Figure 3a shows a participant interacting with SoniSpace.

5.1 Procedure

We introduced the user to SoniSpace with minimal instructions. We played an original guided audio track in the first 3 minutes of the interaction to orient the user towards paying attention to their body and easing into movement. After the guided exploration portion, the user could continue open exploration with the system for as long as they wished. At the end of the experience, we asked users to fill out body maps and answer self-report questions corresponding to before and after using SoniSpace. Body maps are visual documents where somatic experiences can be drawn onto graphical representations of the body, capturing emotions and felt sensations that may be difficult to express in words [2]. We also asked users for written feedback.

6 RESULTS

We observed a variety of movement interactions with SoniSpace. Most participants started more still and introduced a wider range and complexity of movements over the course of the interaction, taking up more space with their bodies, both within their personal sphere of movement, as well as in the environment. We did not record the total time that participants interacted with SoniSpace;

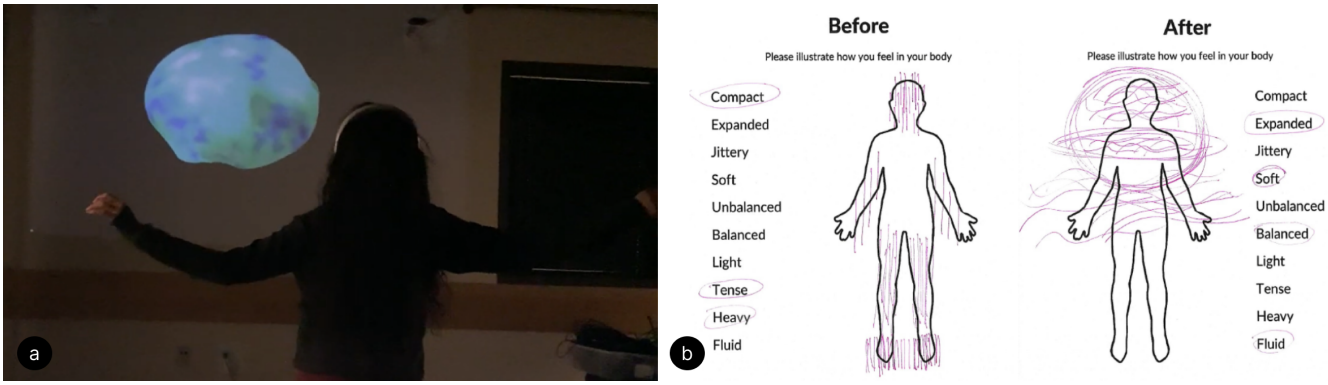

Figure 3: (a) Study participant interacting with SoniSpace, (b) example of completed body map

however, based on our observations, a majority of participants explored for at least several more minutes after the guided track ended.

On how comfortable they felt taking up space, participants reported an average of 2.875 before the interaction and an average of 4 after the interaction on a scale of 1 (not comfortable) to 5 (very comfortable). On comfort with movement, participants reported an average of 3.15 before the interaction and an average of 4 after the interaction on a scale of 1 (not comfortable) to 5 (very comfortable). Although the adjectives that the participants used in their body maps cannot fully capture the information from the body maps, the most commonly used words in the "before" body maps were tense (15/20), heavy (12/20), and compact (12/20), while the most commonly used words in the "after" body maps were expanded (19/20) and fluid (13/20). Figure 3b includes an example of a completed body map .

Users provided feedback that the interaction was "interesting," "amazing," and "calming," and verbally expressed that the experience was fun. They described the sound as "lovely," "beautiful," and "meditative," and the visual as "intriguing and friendly." Users reported feeling that the experience "opened the body," "motivated [them] to move and be more creative with movement," and that they felt "more open and comfortable over time… like [they were] floating or moving underwater and could keep going forever." Suggestions for improvement included better audio balance between the guided instructions and sonification, and generating more visual changes. Some ideas for future exploration included bringing SoniSpace into a fully immersive environment and enabling the system to detect when users are self-conscious or unfocused and "bring [them] back."

7 DISCUSSION AND CONCLUSION

User experiences with SoniSpace highlighted the importance of accounting for many different movement ranges and styles when designing for movement, especially open-ended movement expression. Due to the variety of movements that users expressed, some users may not have been able to experience the full range of the sound and visual experiences that we designed. Following the experience study, we implemented an adaptive mapping strategy to automatically scale the sonification and visualization to the individual's movement, as employed in [5].

Although most soma-based interaction designs direct attention inwards, we found that focusing on an external point of attention, particularly with the interactive visuals, could help people who are less comfortable with movement reduce self-consciousness as they move. This suggests possibilities of designing interaction flows that guide the attention according to the user's experience levels, the current regime of movement, or the stage of the interaction (for example, starting with bringing attention inward, then expanding the attention outwards).

We demonstrate SoniSpace, a system that utilizes somatically-designed audiovisual feedback for movement to promote taking up space with the body through open-ended movement exploration. We detail our design process and considerations, and report on user experiences showing preliminary evidence that interacting with SoniSpace supported both the physical and felt experience of taking up space. Future work can involve more in-depth evaluation of the impact of the sound and visual feedback on movement and emotional experience and explore therapeutic and creative applications of such interactive expressive movement systems.

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