



A Journey Inward: The Somaesthetic Experience of a Heated Walking Carpet

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Figure 1: The walking carpet, coupling the ancient wisdom of walking with heat elements to produce a novel interactive experience that promotes introspection.

ABSTRACT

We present a novel walking carpet with integrated heat elements, designed to promote introspection while walking. The three-meters carpet has 10 heater pads spread in a step-by-step pattern, allowing participants to explore the heat sensation using their feet. In an iterative design process, inspired by the somaesthetic appreciation design approach, we created a two-layer fabric-based carpet with heat elements and embroidered visual signifiers. The experience was evaluated in an exploratory qualitative study with 10 participants, who walked on the carpet back and forth without shoes. The thematic analysis of post-study interviews revealed four themes: exploration of the physical body, feelings evoked by the warmth sensation on the feet, contemplation evoked by the warmth sensation, and impact on attention. Our work suggests that coupling the ancient wisdom of walking as a contemplative practice with heat elements produces a novel interactive experience that promotes introspection of physical, mental, and cultural processes.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**.

KEYWORDS

Somaesthetic design, Targeted Warmth, Mindful walking, Introspection, Somatic Awareness, Mind-Body Connection, Well-being

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1 INTRODUCTION

Walking plays an important role in our daily lives. Beyond its basic function as a means of transportation, this elementary activity has deeper aspects related to body and mind that can uncover dimensions of introspection and self-reflection [1, 37]. Throughout history, walking has been recognized as an opportunity for introspection by thinkers from Greek philosophers to modern scholars, including Nietzsche who famously stated "All truly great thoughts are conceived by walking" [29, 32]. Walking also encompasses various practices, including mindful walking [38, 43], walking meditation [6, 14, 15] labyrinth walking [7], and the universal human habit of walking for relaxation and contemplation.

In a fast-paced world overloaded with stimuli [34], refocusing on the feet can help in diverting attention away from the overstimulated mind, and may even help in reducing stress and mental clutter [12, 38]. Walking invites a deeper level of bodily awareness, promoting contemplation not only on the contact of the body with the external environment [24], but also on considerations of balance, gravity, and physical orientation in space [27].

The sensory engagement with the feet serves as a gateway to deeper somaesthetic reflection [24]. Somaesthetic reflection is described by Lee et al. as an "organized inward-looking inquiry by the individual about his or her bodily perception and its related affective experiences, aimed at heightening somatic awareness" [24]. Somaesthetics philosophy, introduced by Richard Shusterman, highlights the importance of bodily awareness and inner sensations in our daily interactions with the physical world around us [24, 36]. Shusterman notes that explicit awareness of one's feet during normal

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walking is often absent, while conscious focus on the feet typically arises in specific situations such as pain in the feet or the need for physical balance when navigating challenging terrain [36]. Shusterman's framing underscores how external physical conditions may trigger bodily awareness, an aspect that can be leveraged by HCI designers. Kristina Hook further expands on this concept through the lens of "somaesthetic appreciation design," emphasizing the importance of leveraging habitual everyday activities such as walking, breathing, and standing, to enhance body awareness [17, 18]. We applied this vision by augmenting the habitual activity of walking with a technological experience of heat sensation felt through the feet, aiming to increase introspection.

Within the context of somaesthetic design, there has been an exploration of various bodily contexts and different sensory stimuli, including heat. The heat was explored as a design material [8, 20, 30, 40, 42], for its aesthetic qualities [19, 20, 30], as well as its potential to influence direction of attention in a subtle, non-intrusive way [20, 30]. Furthermore, heat was shown to be perceived as internal stimuli rather than external one [8, 20, 30], unlike other sensory modalities [8, 30]. This internally perceived quality of heat stimuli positions it as a highly appropriate modality for promoting introspection [8, 20, 30]. This quality of heat, of inward perception, also aligns with the intertwined human-computer integration approach [26], that encourages a seamless blend of technology and human perception.

In this work, we present a novel somaesthetic design, a walking carpet with integrated heat elements, with the goal of promoting introspection while walking. The carpet is designed as a short straight path with 10 small heat elements integrated along the path, under the fabric. The heat is programmed to be static, fixed at 45°C. In an exploratory qualitative study, 10 participants were asked to walk on the carpet without shoes for several minutes and shared their subjective experiences in a post-study interview. Thematic coding analysis revealed the top themes and initial insights were derived.

2 RELATED WORK

Prior works within the HCI community that are related to our research include (1) Walking, introspection, and sensory experiences and (2) Heat and introspection.

2.1 Walking, Introspection, and Sensory Experiences

The role of introspection in walking has been studied in various aspects, including the influence of environmental settings, such as walking in nature or urban cities [35], the impact of walking pace and rhythm [21, 23, 27, 39], and the integration of walking and mindfulness techniques [5, 6]. The act of walking offers unique opportunities for introspection and a deep level of body awareness. This is evident in walking meditation, a structured practice that combines the physical act of walking with mindfulness techniques [14].

Few works explored walking meditation. *Ambient Walk* [5], a mobile app aiming to support walking meditation by adjusting visual and sound feedback according to the user's walking pace and breathing pattern. Another design is *VR Meditative Walk* [13], which incorporated a treadmill mapping the user's walking speed to the navigation of their avatar in a virtual environment, with

visual and sonic feedback that changes as the meditator becomes more relaxed. *Walking Mindfulness interactive soundscape* [6], uses biofeedback from the user's heart rate variability to adaptively control a generative soundscape [6]. Their findings indicated that sound was efficient in directing attention during walking meditation. This concept aligns with research showing that sound can enhance engagement [21] and influence walking speed, as seen in the works of Turchet et al. [39], Komninos et al. [23], and Murata et al. [27], applied to both regular walking and walking meditation. *The Slow Floor* [11], a pressure-sensitive surface that generates sound in response to walking, focused on the impact of sound as a form of sensory feedback on walking, aiming to enhance creative agency and somatic awareness. Participants reported an increased awareness of their feet after interacting with this surface [11].

These findings highlight the potential of investigating different sensory modalities to further understand their impact on somatic and introspective experiences while walking.

2.2 Heat and Introspection

Heat offers a sensory experience that has the potential to deepen the introspective aspects, particularly for its potential to direct attention inward. Targeted heat was found to facilitate inward focus, to enhance self-awareness and positive sensations [30]. Complementing these works, Daudén Roquet and Sas [8] explored with their *WarmMind* meditation wearable how heat can shift the focus of attention inward, thereby enhancing bodily awareness and introspection. Participants reported that the warmth patterns, perceived as emanating from within the body, facilitated a more natural and internalized focus during meditation, contrasting with other stimuli like audio feedback, which often led to a sense of isolation [8]. The *Soma mat* work explored the role of heat by gently directing attention to different body parts [20]. The work underscores the potential of heat to facilitate a deeper connection with one's body. The *Soma mat* prototype, used for somatic exercises like the Feldenkrais method, integrates heat elements to enhance bodily awareness and introspection. Unlike smaller-scale wearables, that use thermal stimuli in a localized manner [8, 30, 42], the *Soma mat* represents a larger, spatial application of heat, creating an entire 'space' for introspection and mindfulness.

Our work builds on prior work by studying the potential of thermal stimuli for introspection. Our differentiation is the focus on feet perception alone, in the specific context of walking. Our user study aims to fill this gap by evaluating if and how a novel heated walking carpet promotes introspection during walking.

3 DESIGN AND IMPLEMENTATION

The walking carpet was designed in several iterations, exploring various carpet sizes, heat element placement, fabric materials, color, and heat patterns, as well as two types of heating technologies: Peltier heating elements and Polyimide heater pads. We were inspired by design principles from the Somaesthetic appreciation design process [16, 18], specifically modalities (we focused on heat modality that encourages internal exploration), timing (the heat sensation is available right there when the user wishes to step on it), the intensity of the feedback (we explored and fine-tuned

the heat feedback during the iterations process), and aesthetics (we grounded our work on the common human appreciation of walking)[18].

3.1 First prototype design and testing

The goal of this prototype was to evaluate if heat can be sensed using the feet sensation alone without any visual representation of the heat element location. We created a 30cm x 70cm carpet (see fig 2A) designed for standing and not yet for walking. The prototype was constructed from a foam board covered with plain fabric, with four Peltier heating elements mounted into the foam board, producing a heat cycle ranging from 35°C to 45°C. The foam board was used as it enables seamless integration of the heating elements and wiring while maintaining a smooth walking surface. The heating temperature was defined based on previous research [20] as well as self-exploration by the research team without shoes but with socks on, taking into account the reduced thermal sensitivity of feet [25] and slow accumulation of warmth perception [4]. We tested the prototype with five lab members, and the result was that visual representation of the heat element location is essential, as users found it challenging to identify where to place their feet.

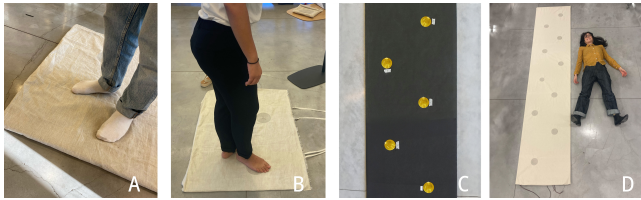


Figure 2: The iterative design process: the initial prototype (A), the 2nd prototype (B), the final full-scaled carpet's heating element layout on foam board (C), and the completed design with embroidered walking path (D).

3.2 Second prototype design and testing

Building on the insights from the first design iteration, we created a second prototype. We used the same carpet size, heating elements, and heat cycle, and added minimal visual signifiers indicating the location of the heat area. The signifiers were designed as an embroidered spiral pattern (see fig 3), inspired by energy-efficient heating patterns [33] as well as traditional symbols for traditional labyrinths and introspection practices [7, 41]. This prototype was tested with seven visitors during an informal exhibition, allowing visitors to explore the carpet, followed by an informal interview. The insights showed that the visual signifiers were effective. All users engaged in a subtle process of exploration using their feet reported that both low and high heat levels were easily felt, that the heat sensation was pleasant, and the novel experience of exploring using their feet was exciting.

3.3 Third prototype design and testing

Building on the positive experience of users with the 2nd prototype, we developed a longer "walking carpet", 70cm by 330cm, with 10 integrated heating elements placed along the carpet in a step-by-step walking pattern, with the same visual pattern embroidered on

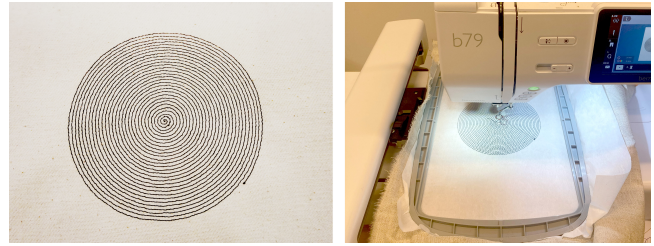


Figure 3: The embroidered spiral pattern (Left) and its making (Right). The spiral provides a minimal visual signifier communicating simplicity and authenticity.

the fabric (see fig 2D). From a technical perspective, the Polyimide heaters were preferred. They are flat, flexible, and easier to power with one Arduino board due to their low power consumption. They are constructed from a combination of polyester filament and conductive metal fibers, encased within a protective layer of polyimide film, and able to produce the needed heating cycle with similar low and high temperatures. The heater pads were regulated by two ToolkitRC P200 power supplies, with an internal safety control based on voltage and current limits of 6V and 2A, to prevent overheating. Using the Arduino Uno controller we explored various heat cycles (i.e. pulsing all heater pads simultaneously or activating them sequentially), however, for the purpose of the exploratory user study reported in this initial work, we decided to produce a constant heat of 45-46°C on each of the 10 heater pads. This decision was informed by our self-exploration, which demonstrated that at this temperature range, with socks on, the heat is noticeable yet comfortable. As in previous iterations, the walking carpet was designed with a base layer of foam board (see fig 4) covered with a cream-colored cotton blend textile. The top layer of linen-cotton blend fabric was chosen for its effective heat transfer [2], durability, and softness. Color-wise, we chose a simple cream-white color to symbolize simplicity and clarity, aligning with the introspective goals of the design.

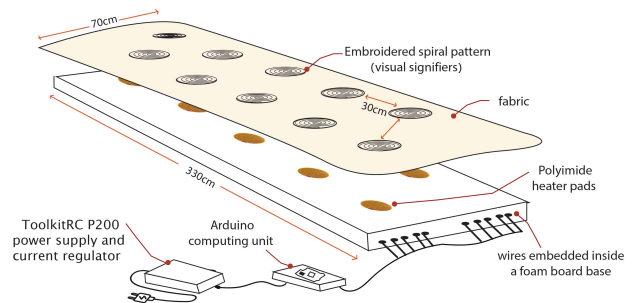


Figure 4: Exploded view of the walking carpet's third prototype, showing its layers and components.

4 METHOD

In this initial study, we leveraged a qualitative approach to explore how people perceive and interact with a walking carpet. We used

semi-structured interviews, focusing on participants' feelings, sensations, emotions, and preferences related to the experience. The study received IRB approval from the university's ethics committee.

4.1 Participants

Ten participants (5 females, 5 males; age range: 20-35 years, mean age: 28, SD= 4.7) were recruited through the university's social media channels. Participants received a coffee and pastry voucher for their participation.

4.2 Experimental Settings and Measures

To minimize the influences of the research environment on the experience, we performed the study in a distraction-free environment using a quiet classroom on campus with a maintained regulated temperature of 25°C. The carpet prototype was placed at the center of the room. In an effort to explore the potential heat sensation for introspection, and not the well-known introspection effect of walking meditation known in mindfulness practices, we decided to focus on a short walking duration of four minutes, rather than the common mindfulness practice of walking meditation which typically spans 10-20 minutes [6, 9]. This decision is also aligned with prior work [11]. The walking session was followed by a semi-structured interview to better understand participants' experiences, emotions, and thoughts during the experience. The interview followed clear guidelines (see [22]) and included open-ended questions concerning the overall experience e.g.,: "Please describe the experience you just had" and "What did you feel during the experience?", with follow-up questions building on participants' comments.

4.3 Procedure

Participants were instructed in advance that the study involves walking without shoes and with socks. Upon arrival, participants were informed that they would be asked to experience a technology of heat integrated into fabrics. Safety measures were emphasized, specifically that the carpet has a safety mechanism that prevents overheating, that participants choose if they wish to step on a heating element or not, and they can stop their participation at any time. Participants were asked to sign the consent form, take off their shoes, and "walk on the carpet for four minutes in any manner they chose". The researcher exited the room and returned for the interview after four minutes. At the end of the interview, the researcher debriefed the participant and verified that the experience was positive overall.

5 FINDINGS

The qualitative analysis of participants' interviews was conducted using thematic coding [3] by two coders and a senior researcher. First, all interviews were transcribed. Next, each coder independently reviewed four transcripts and identified initial themes. The initial themes were discussed with a senior researcher, inconsistencies were resolved and final themes were defined. The two coders analyzed two more interviews and verified inter-rater reliability (Cohen's kappa=0.9) and continued to individually analyze the rest of the interviews.

The analysis revealed four high-level themes: Physical Exploration Using One's Body, Feelings Evoked by the warmth sensation

on the feet, Contemplation Evoked by the warmth sensation, and impact on Attention.

5.1 Theme 1: Physical Exploration Using One's Body

Physical Exploration was the most dominant theme in participants' interviews. Sub-themes include Exploration of Bodily Sensations and Exploration Led by visual and heat affordances.

5.1.1 Exploration of Bodily Sensations. Participants reported an urge to explore the heat sensation using their feet in various ways, reflecting on the experience: "I put my foot on the spot and it's interesting because in the first moment, you can't understand if it's really a hot spot or not. Then I stand on it for a bit and it's clearly warm, then I deliberately started going from point to point to see if they really feel the same." (P3); "I was curious how it feels, and then I tried to understand with myself if it was a different temperature or not and if it felt different in the right foot or the left" (P8).

Participants explored the contrast between the heated parts and the non-heated parts of the carpet: "I wanted to try it without stepping on the heat spots, just to have something to compare to properly" (P9). Participants also reported how they investigated the sensations using different parts of their feet: "I examined the carpet, I tried to see how the different parts of my foot react to the heat. So I felt it both with the heel and the front part of the foot" (P7). Some mentioned a feeling of movement along their body: "It started down at my feet and then slowly it went up my body"(P2); "Even though it's just your feet, it really goes through your whole body"(P9).

5.1.2 Exploration Led by Visual and Heat Affordances. Participants' responses revealed how the visual signifiers, as well the heat elements, served as affordances that influenced their walking patterns: "the fact that I see the circles, there is something about it, it makes me more conscious of where I step. It is as if it directs me where to step, and what the size of the step should be"(P4); "there are so-called steps or traces that you have to follow" (P7); "It's like you don't want to step on the thing that is not hot once you have stepped on the hot thing. I tried not to walk on it, and then it was kind of hard to let go, so I walked back and forth only on the hot spot because I wanted to" (P9); "The pleasant feedback of heat made me want to keep stepping on it"(P4).

5.2 Theme 2: Feelings Evoked by the Heat Sensation on the Feet

Participants expressed how walking on the carpet evoked various feelings. The feelings were experienced as pleasant or unpleasant emotions, as associations, or as a state of relaxation and calmness.

5.2.1 Feelings experienced as Pleasant or Unpleasant Emotions. Participants frequently reported feelings of pleasure and enjoyment while interacting with the carpet. Many expressed a desire to remain on the carpet for extended periods: "It feels like I want to be on it all the time" (P2); "you feel comfortable, you feel cozy, like you kind of don't want to leave it" (P8). "I had a lot of fun" (P2). However, there were also reports on unpleasant experiences, when the heat transitioned from cozy to uncomfortable due to prolonged duration of touch, indicating a nuanced balance between pleasant

and unpleasant sensations: *"It was very comfortable and I kind of submerged into some kind of warmth and pleasantness, I'm in my moment...until I'm not, when it becomes too hot."* (P10).

5.2.2 Feelings Experienced as Associations. The heat elements on the carpet evoked various associations and memories, for example *"it sends me to a winter day, it's raining outside but it's cozy inside"* (P4); *"It's like what people are looking for when they snuggle up in a duvet in the winter"* (P3).

Some associations revolved around the sensation of heat: *"It felt to me like going to a sauna and or hot stones massage, in a way that it's pleasant at first but if you stay too long, it feels too hot"* (P7); *"I remember myself as a child walking on sidewalks barefoot, and the feeling of the hot asphalt"* (P1); *"it's a bit like a cat. A cat that goes from 'pet me love me' to scratching and getting angry, it's like a game of staying or moving to maintain comfort, it also depends on your tolerance for heat and when it starts to feel a bit tingling"* (P3).

5.2.3 Feelings experienced as a State of Relaxation and Calmness. A significant number of participants reported a sense of relaxation, calmness, and stress relief. Some reported a change in their walking pace to a slower one: *"The walk is much slower. I made it much more calm and peaceful"* (P1). Others noted an overall sense of relaxation: *"It puts you in a calm place"* (P8); *"The main thing is that it's very relaxing. It goes really through your whole body. Weirdly I would say it would be hard to get tensed and get stressed, harder to shout and get into arguments when you're on on this carpet. It has a very strong calming effect"* (P10).

5.3 Theme 3: Contemplation Evoked by the Warmth Sensation on the Feet

Some participants shared thoughtful reflections on their sensory experiences and reflected on their senses, control, and cultural practices.

5.3.1 Contemplation: Sensory. Some participants reflected on sensorial aspects of the experience: *"I was intrigued by the size of the circle compared to the feeling of the heat, like, what does the brain think about it? I closed my eyes and tried to understand if the heat had a circle?"*(P8). Others reflected on the way body parts affect the whole body: *"I thought about it, when the edges of the body like our hands or feet are hot, the whole body tends to relax and become hot"* (P9).

5.3.2 Contemplation: Sense of Control. Some of the participants reflected on their agency and control over the experience. Some contemplated the difference between discomfort that is within their control versus discomfort that is not: *"There is a difference between pain that bothers you and pain that doesn't bother you, the fact that I know I'm doing it on purpose for the feeling, and I can move my leg when I want to so I don't get stressed when the heat starts to get a little too hot. I would say: OK, it's an extended range in my feeling"*(P3); *"I felt I can control it. Because I can simply go down to a neutral surface as soon as I feel too hot and cool down"* (P1)

5.3.3 Contemplation: Cultural. Participants also reflected on cultural and habitual aspects of walking and the notion of being barefoot: *"We are not used to being barefoot, most of the day we wear shoes so there is something a little more exposed in being barefoot"* (P1);

"I can think about how the default way of walking is artificial...In certain parts of the world, they walk barefoot, and they walk a little more carefully" (P3).

5.4 Theme 4: Impact on Attention

Some participants described how walking on the carpet influenced their attention, particularly focusing attention on their body and the present moment: *"My attention went there. It helped me to stop for a second and focus on the moment, what is happening now, what I am experiencing now, not what I am bothered about"* (P2); *"it brings such awareness. When I walked on the carpet I didn't have many things on my mind, it doesn't happen often. It puts me in the moment, just being barefoot and concentrating on something very simple, the heat"* (P8).

6 DISCUSSION

In this preliminary work, we showed the potential of adding heat sensation to the mundane activity of walking. As prior literature showed, walking has a long history of promoting contemplation, relaxation, and reflection [1, 37]. Heat sensation that is produced by technological heat elements is experienced as an internal bodily sensation [8, 20, 30], and has the potential to promote introspection [8]. Our exploratory qualitative study suggests that even a very short walking activity can lead to introspection processes, including exploration of the physical body, feelings, emotions, associations, sensorial and mental processes, as well as reflection on broader aspects of culture. Furthermore, the experience promoted focus on the present moment rather than on distracting thoughts, without any prior training or practice in mindfulness or walking meditation.

Looking more deeply into the qualitative themes and sub-themes, we suggest the following interpretation. The combination of a walking carpet with heat spots provides users full autonomy to explore the heat sensation by choosing the exact heat duration and feet-to-heat surface contact (heel or toes etc), promoting sense-of-control and exploration. Users moved freely, explored, and engaged in subtle investigation of the heat sensation on their feet, an uncommon sensation that gives them control in exploring pleasant and slightly unpleasant sensations. It seems that the freedom to shift between being in and out of the experience promoted greater exploration. The heat sensation coupled with the visual embroidered spiral symbol served as strong affordances, inviting users to explore not only their walking pattern but also their subtle sense of touch using various body parts of the feet. By providing autonomy and a sense of control, participants were able to explore nuanced transitions between different sensations in a controlled and engaging way. In addition, in line with prior work, heat has a promising potential as design material [20, 30, 40, 42] as well as an experience that promotes introspection [8, 20].

Possible practical implications of our research on thermal stimuli and walking include body-focused domains such as alternative medicine, well-being, meditation, and immersive art. One participant suggested placing the carpet in her stressful office environment to promote a few minutes of relaxation, and another suggested using it at the beginning of a psychotherapy session to promote openness.

In conclusion, our work suggests that coupling the ancient wisdom of walking as a contemplative practice with technological heat elements, produces a novel interactive experience that provides users with sense-of-control in their exploration process, leading to introspection of physical, mental, and cultural processes.

7 LIMITATIONS

Our study has several limitations. First, it was conducted in the winter. It is possible that the cold weather affected the participants' experience. To minimize this risk, the temperature in the experiment room was controlled always to be 25°C. Second, our findings are based on a one-time use and might be affected by the "novelty effect" [10]. Future research should explore the influence of feet-targeted warmth on walking over time to further understand the possibility of habituation effects. Lastly, interviews may be biased by the 'good subject effect' [28, 31]. To control this we followed a detailed protocol and emphasized that all answers were helpful.

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