KEYWORDS
Wearables; Somatics; Somaesthetics, Vibrotactile music; Body Awareness

Haplós: Vibrotactile Somaesthetic Technology for Body Awareness

Diego S. Maranan
University of the Philippines Open University
Los Baños, Philippines
dsmaranan@up.edu.ph

Jane Grant
University of Plymouth
Plymouth, UK
j.grant-1@plymouth.ac.uk

John Matthias
University of Plymouth
Plymouth, UK
john.matthias@plymouth.ac.uk

Mike Phillips
University of Plymouth
Plymouth, UK
mike.phillips.net@gmail.com

Susan L. Denham
Wotelsat UK
Plymouth, UK
susandenh@googlemail.com

ABSTRACT

Inspired by somatic methodologies and neurophysiology, Haplós is a low-cost, wearable technology that applies vibrotactile patterns to the skin, can be incorporated in existing clothing and implements, and can be programmed and activated remotely. We review existing vibrotactile technologies and known uses of vibrotactile stimuli; describe the hardware, textile, and software components of Haplós; describe results from a quasi-experimental workshop to evaluate Haplós; and discuss future research and development directions.

TEI'20 Extended Abstracts, February 9-12, 2019, Sydney, Australia.

ACM ISBN XXXXXXX XXXXXXX.
DOI: https://doi.org/ XXXXXXX / XXXXXXX.XXXXXXX

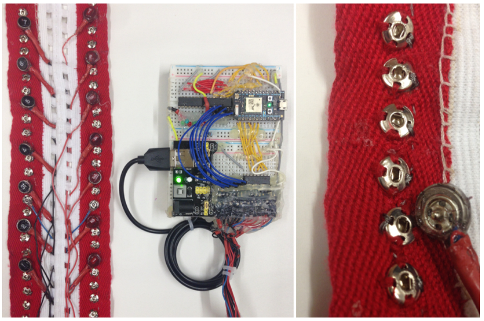

Figure 1: Haplós hardware and textile components (left). Close-up of the snap fastener system (right).

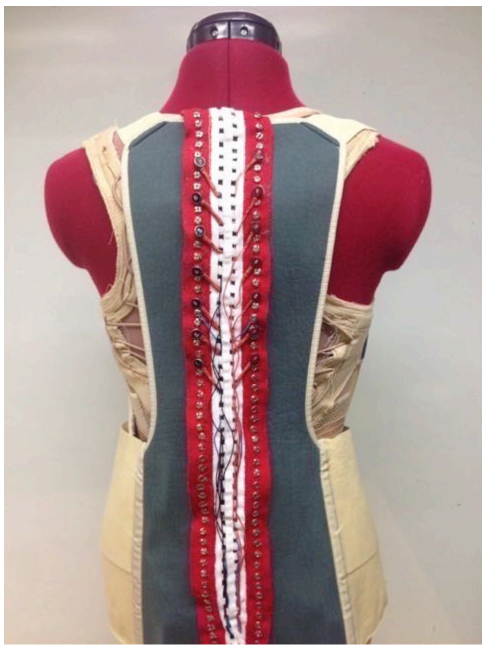

Figure 2: Haplós as attached to a modified, commercially-available back support garment.

INTRODUCTION

Haplós is a body awareness tool that applies programmable, vibrotactile patterns to the skin using small, vibrating motors. It is inspired by research and design in clothing and human-computer interaction, in which clothing and wearable artifacts generate novel, embodied, "somatic" experience [3, 13]. Through a two-year intensive immersion into the Feldenkrais Method™ (hereafter abbreviated as FM), we translated the assumptions, aims, epistemologies, and techniques of FM into the hardware, textile, and software components—as well as application-dependent instructions—that comprise Haplós. Originally developed by Moshe Feldenkrais, FM is an educational approach to sensorimotor learning that relies on attending to the experience of small, gentle movement in order to facilitate greater freedom of movement and increase kinaesthetic and proprioceptive awareness [4]. The design of Haplós is further motivated by research in neuroscience, kinesiology, and experimental psychology suggesting that vibrotactile stimulation can facilitate a range of different effects on an individual's soft tissues and central nervous system. These effects include changes in muscle tone [11], suppler fascia [5], pain relief, improved motor skill, and relaxation. Most interestingly, vibrotactile stimulation can expand cortical representations of stimulated body surfaces [12].

Haplós (a Filipino word meaning "touch" or "caress") innovates on existing designs that provide targeted, patterned vibrotactile stimulation. These designs generally tend to fall under one of at least three categories: devices for wellbeing, information presentation interfaces, and instruments for aesthetic experiences. Devices for wellbeing leverage the potential of vibrotactile stimuli to provide symptom relief and effect changes as just described. Information presentation interfaces include those for sensory substitution, audio augmentation and annotation, navigation and wayfinding, and alerts and notifications [6]. Instruments for aesthetic experiences include musical instruments that incorporate haptic feedback, as well as custom-made suits or chairs that generate "vibrotactile music" [2] through "tactile composition" [7] in which the vibrotactile sensations are the primary stimuli, not a proxy for or a translation of other sensory modalities—an approach worth further consideration since the potential of vibrotactile stimuli remains underexplored. Haplós, however, crosses the boundaries of all three categories. Through carefully designed patterns of vibrotactile stimulation, Haplós aims to elicit self-reports of heightened body awareness as well as pleasure by supplying the user with higher resolution information of an area of their body in order to increase its somatosensory cortical representation. To the best of our knowledge, Haplós is the first wearable technology created with the intent of changing representations of the self-image using vibrotactile stimulation. That Haplós both creates an aesthetic experience as well as facilitates body awareness by heightening proprioceptive sensitivity testifies to its embodiment of Richard Shusterman's philosophy of *somaesthetics*. Somaesthetics takes the *soma*—the "living, self-sensing, internalized perception of oneself" [8, p. 20]—as a "site for aesthesis (sensory appreciation) and creative self-fashioning" [14].

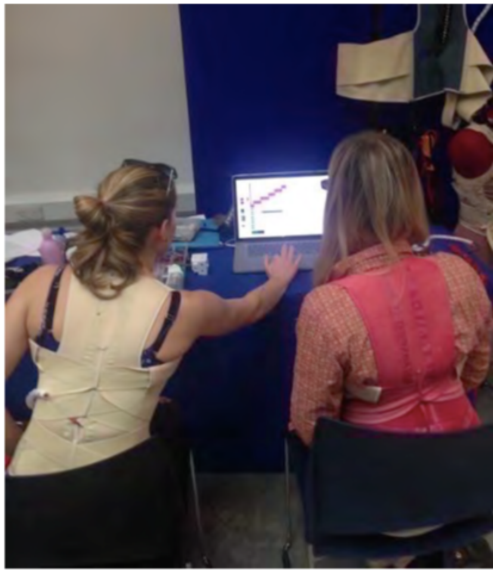

Figure 3: Two participants wearing back-support garments enhanced with Haplós. They are co-creating vibrotactile patterns and experiencing them simultaneously.

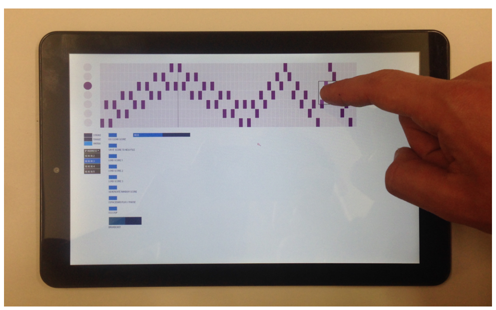

Figure 4: Haplós controller and sequencer. Patterns and pattern playback speed can be adjusted on the fly.

HAPLÓS COMPONENTS

The heart of the hardware and textile component of Haplós is a set of brushless vibration motors on which male snap fasteners are affixed. These motors can be attached to female snap fasteners sewn onto a piece of ribbon (Figure 1), allowing for easy repositioning, unlike in most vibrotactile garments. Because awareness of small differences is a key part of the FM learning experience [4], the fasteners are placed as close to each other to create the highest possible spatial resolution for motor distribution. Users are given the freedom to decide precisely where on their skin the motors should be placed in order to give users agency over their own vibrotactile experience. To maximize user comfort and ease of handling, we devised a system to reduce the amount of wiring trailing from Haplós by close to 50%: the female fasteners on the ribbon were connected with conductive thread, while the male fasteners were wired to each of the motors' lead wire; snapping the motor onto the ribbon completes the circuit. The ribbon can then be attached to a wide variety of existing clothing and implements, and formed into any shape, making Haplós more flexible than most vibrotactile garments. Figures 2 and 3 show Haplós attached to a back-support garment. The motors are powered by a battery pack and controlled by a WiFi-enabled Particle Photon microcontroller. Haplós can thus be controlled and reprogrammed over a local network or even the Internet.

A prominent feature of the Haplós software—which can run on both mobile and desktop devices—is the graphical user interface (GUI) which uses a step sequencer for creating vibrotactile patterns (Figure 4). This authoring paradigm was chosen as it allows users—who may have little experience in authoring time-based media—to easily create and visualize the patterns of the vibrotactile stimuli. The GUI also allows users to customize the playback speed of the patterns on the fly. A single instance of the GUI can control multiple Haplós devices and mass broadcast the patterns, thus allowing users to compose patterns not only for themselves but for other users as well, and to experience a vibrotactile pattern as a group. Users can generate and send patterns in real-time, as well as save and play previously saved patterns.

PATTERNED VIBROTACTILE STIMULATION FOR SOMATOSENSORY CORTICAL REORGANIZATION

The primary application for which Haplós was initially designed is facilitating body awareness, which we tested in one initial quasi-experimental workshop involving eight participants from the general public. We borrowed techniques from FM to structure the experience and direct users' attention to the effects of wearing Haplós, such as unilaterally stimulating the body to create a differences in sensation across the sagittal plane (what is known as a 'one-sided lesson' in FM), experiencing movement pre- and post-stimulation, strategically integrating periods of rest (silence) in the tactile patterns, and using horizontal surfaces (such as a mat) as a "kinesthetic mirror" [15] to explore experiences of muscular tonus. We used 7 motors to play tactile patterns on areas of the back close to the spine and pelvis because of the crucial role (as posited by FM) of these structures in the organization of everyday movement. We concentrated on the area between the scapulae, as

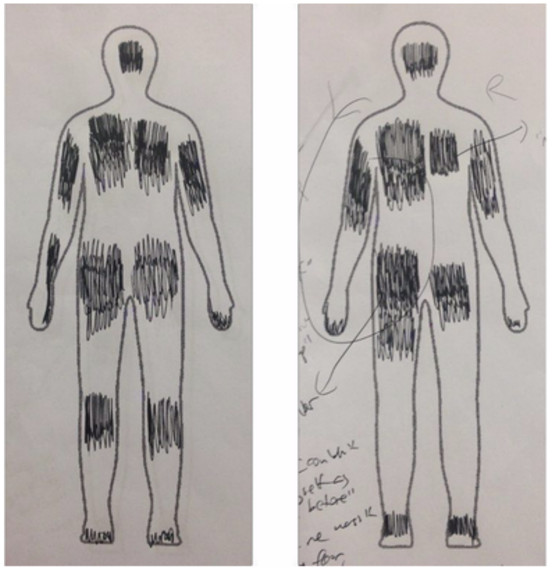

Figure 5: One workshop participant's drawing representing their perception of the contact of their body on the ground before (left) and after (right) experiencing unilateral vibrotactile stimulation on their torso.

this region is difficult both to see and touch and tends to be poorly represented in the individual self-image. To minimize biasing the results of the evaluation workshop, participants were merely told prior to the workshop that they were going to compose "music for their bodies" using vibrotactile stimulation; no mention was made about the potential use of the technology for increasing body awareness. During the workshop, participants were guided through a series of mindfulness techniques, then were asked to lie down on the floor and note how they felt their body to be in contact with the ground. Afterwards, the participants put on the Haplós prototypes and composed vibrotactile patterns for each other, but on only one side of their back; they were told that the reason for the unilateral stimulation was a technical glitch, not a deliberate methodological choice. After 15 minutes of experiencing the "vibrotactile music" in short bursts interspersed with rest (to avoid vibrotactile overstimulation), participants were again asked to lie down on the floor and note how they felt their body in relationship with the ground—a technique borrowed from FM. Generally, participants were surprised at the difference in sensation and reported feeling more aware of the area of their body that was stimulated. Occasionally, they reported experiencing more awareness in parts of themselves that were not stimulated but which belonged to the same side (laterally). These reports were captured both in verbal reports and through visual representations they created of their perception of their body's contact with the ground. A tool for recording these experiences—an outline of the human form that participants could annotate—was used to record and share these perceptible differences in their embodied experience. Figure 5 is a pre- and post- stimulation representation of one participant's perception of their contact with the ground.

CONCLUSION AND FURTHER WORK

In this paper, we briefly described how the Haplós technology was designed by first selecting fundamental principles of the Feldenkrais Method for somatic education, then translating these principles into a set of design strategies for vibrotactile stimulation. A detailed report on this design methodology is reserved for future publication. We described results from an initial study that suggests that Haplós measurably influences participants' bodily self-perceptions and bodily awareness. We are currently conducting additional validation studies on Haplós, as well as exploring other applications of the technology. For instance, in addition to being used as an interface for vibrotactile compositions, Haplós has been incorporated in a neurofeedback-based "vibroacoustic" [10] therapeutic wearable prototype for inducing mental states. The technology—called Bisensorial—was initially developed as a proof-of-concept at the Hack the Brain hackathon where it was awarded first place [9]. We are also investigating Haplós' efficacy in reducing cravings as part of a series of controlled studies based on the Elaborated Intrusion theory of desire [1]. Finally, Haplós is a low-cost technology that can be integrated into a variety of existing contexts; we intend to provide the hardware schematics and code under an open source license. Haplós may be further applied to research problems that are already looking into vibrotactile and vibroacoustic stimuli, such as new forms of creative expression, and for improving motor coordination and sensorimotor rehabilitation.

ACKNOWLEDGMENTS

This work was supported by the Marie Curie Initial Training Network, FP7-PEOPLE-2013-ITN, grant number 604764, in collaboration with Kin Design, Curiosity Design Research, and Space Ecologies Art and Design (SEADS).

REFERENCES

[1] Jackie Andrade, Sally Pears, Jon May, and David J. Kavanagh, “Use of a Clay Modeling Task to Reduce Chocolate Craving,” *Appetite* 58, No. 3 (June 2012), pp. 955–963.

[2] Anant Baijal, Julia Kim, Carmen Branje, Frank Russo, and Deborah I. Fels, “Composing Vibrotactile Music: A Multi-Sensory Experience with the Emoti-Chair,” in *Haptics Symposium (HAPTICS), 2012 IEEE*, 2012, pp. 509–515.

[3] Sally Dean, “Amerta Movement and Somatic Costume,” in Sarah Whatley, Natalie Garrett Brown, Kirsty Alexander, eds., *Attending to movement: Somatic Perspectives on Living in this World* (Devon, UK: Triarchy Press, 2015).

[4] Moshe Feldenkrais, *Awareness Through Movement; Health Exercises for Personal Growth*, 1st ed. (New York, USA: Harper & Row, 1972).

[5] P. Frenzel, R. Schleip, and A. Geyer, “Responsiveness of the Plantar Fascia to Vibration and/or Stretch,” *Journal of Bodywork and Movement Therapies* 19, No. 4 (October 2015), p. 670.

[6] Alberto Gallace and Charles Spence, *In Touch with the Future: The Sense of Touch from Cognitive Neuroscience to Virtual Reality*, (Oxford, UK: Oxford Univ. Press, 2014).

[7] Eric Gunther and Sile O’Modhrain, “Cutaneous Grooves: Composing for the Sense of Touch,” *Journal of New Music Research* 32, No. 4 (2003), pp. 369–381.

[8] Thomas Hanna, *Somatics: Reawakening the Mind’s Control of Movement, Flexibility, and Health*. (Cambridge, USA: Da Capo Life Long, 1988).

[9] Diego S. Maranan, Agi Haines, Jack Fletcher, Sean Clarke, “Bisensorial: A brain-computer interface hack using tactile and auditory stimuli,” presented at the Cognition Institute Conference 2016, University of Plymouth, UK, July 2016.

[10] Ann Morrison, Cristina Manresa-Yee, and Hendrik Knoche, “Vibrotactile and Vibroacoustic Interventions Into Health and Well-being,” *Universal Access in the Information Society* (January 2017), pp. 1–16.

[11] H. S. Park and B. J. Martin, “Contribution of the Tonic Vibration Reflex to Muscle Stress and Muscle Fatigue,” *Scandinavian Journal of Work, Environment & Health* 19, No. 1 (February 1993), pp. 35-42.

[12] Karin Rosenkranz and John Rothwell, “The Effect of Sensory Input and Attention on the Sensorimotor Organization of the Hand Area of the Human Motor Cortex,” *Journal of Physiology* 561, No. 1 (November 2004), pp. 307-320.

[13] Thecla Schiphorst, “Self-Evidence: Applying Somatic Connoisseurship to Experience Design,” in *Proc. of the 2011 Annual Conference On Human Factors In Computing Systems* (New York, USA: ACM Press, 2011), pp. 145–160.

[14] Richard Shusterman, *Body Consciousness: A Philosophy of Mindfulness and Somaesthetics*, (Cambridge; New York: Cambridge Univ. Press, 2008), p. 1.

[15] Frank Wildman, *The Busy Person’s Guide to Easier Movement: 50 Ways to Achieve a Healthy, Happy, Pain-Free and Intelligent Body*, 3rd revised ed. (Berkeley, USA: Feldenkrais Movement Institute, 2006).