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journal homepage: www.elsevier.com/locate/ijhcsInteractively mediating experiences of mindfulness meditation[☆]Jay Vidyarthi^{*}, Bernhard E. Riecke¹

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ABSTRACT

Sonic Cradle is a human–computer interaction paradigm designed to foster meditative attentional patterns. A user's body is suspended comfortably in a completely dark sound chamber while the interaction paradigm subtly encourages them to focus on their breathing to summon and progressively shape an abstract immersive sound experience. Basic interpretive qualitative methods with a purposive sample of 39 participants were used to systematically analyze interview data after a 15-min experience of the system. Results suggest that this persuasive medium can pleasantly encourage an experience comparable to mindfulness by consistently inducing a calm mental clarity and loss of intention. Surprisingly, participants also reported perceptual illusions, feelings of floating, and emotional responses. Mounting evidence implies mindfulness meditation as an effective practice for self-regulation; this study represents a first step toward realizing technology's potential to increase wellbeing by introducing people to this psychologically beneficial contemplative practice.

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1. Introduction

"I cease thinking any thoughts about sources and give myself over to hearing. It is very much a bathing in sound, a sensuous luxuriating in pure sound and the spaces between them, in layer upon layer of sounds. Now they are simply what they are, no longer identified, no longer listened for in a straining, reaching sort of way." – *Kabat-Zinn (2005)*

For decades, the persuasive power of technology has been exploited for sales and corporate marketing. Recently, we have seen a new crop of persuasive technologies which aim to support their users, helping them exercise, eat healthy, take breaks, quit smoking and more (*Chi et al., 2008; Consolvo et al., 2009; IJsselsteijn et al., 2006*). While these persuasive tools join a large family of healthcare technologies designed primarily to prevent and treat physiological problems, there are relatively fewer systems specifically designed to provide psychological support. Such technologies would not only be critical to help those suffering from mental disorders (prevalence has been observed to be as high as 30% in the United States, with other countries approaching this number; *Bijl et al., 2003; Kessler*

et al., 2005), but also to help anyone identify and self-regulate unhealthy excesses in life (a key virtue in positive psychology; *Peterman and Seligman, 2004*).

Bj Fogg describes "computers as persuasive media" (juxtaposing them with "computers as persuasive tools" and "computers as social actors") as systems which provide "a compelling experience that will persuade people to change their attitudes or behaviours" (*Fogg, 2003*). This is a powerful idea for psychological health and wellbeing, an area where patients suffering from problems like depression, anxiety, and chronic pain need solutions which can fuel lasting changes. If a persuasive medium could offer a compelling experience which influences people's general outlook, it could potentially trigger long-term changes in behaviour and routine toward a healthier lifestyle. Since a growing body of evidence suggests that the practices related to mindfulness meditation can have profound effects on stress and psychological problems (*Baer, 2003; Bohlmeijer et al., 2010; Fjorback et al., 2011; Kabat-Zinn, 2003*), persuasive media for the adoption of contemplative practices have the potential to impact wellbeing.

We have previously published the underlying theory and iterative design process of the *Sonic Cradle* concept (*Vidyarthi et al., 2012*). To summarize, the system was designed to experientially motivate and teach mindfulness meditation, a practice known to be effective for stress reduction. The hope was for *Sonic Cradle* to be a persuasive medium which catalyzes interest and engagement with this vital contemplative practice. In the present

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article, we will start with a brief recap on theoretical foundations for our work. Next, we will discuss the *Sonic Cradle* concept with specifics about its intention to promote patterns of awareness and attention characteristic of mindfulness meditation. This will set the stage for a comprehensive investigation of whether subjective experiences in *Sonic Cradle* align with contemporary literature on mindfulness meditation. We will conclude by discussing future directions for persuasive media aimed at wellbeing with emphasis on orienting this new research agenda towards a positive influence in people's lives.

2. Theory and apparatus

2.1. Stress management through mindfulness meditation

As many interactions with technology rely on attention, memory, executive functions, language, problem-solving, perception and decision making, the study of human psychology made – and continues to make – a major impact in the design of new technologies. However, the majority of interaction between psychology and human–computer interaction design is one-directional; most projects exploit an understanding of psychology to improve design. Only recently are we beginning to see research moving in the opposite direction: using design to improve people's psychological state (a rare example can be found in [Thieme et al. \(2013\)](#)). *Sonic Cradle* represents an instantiation of human–computer interaction design and validation which not only draws from psychology, but also aims to benefit users' psychological state by promoting self-regulation of stress through mindfulness meditation. If an interaction design artifact can mediate longitudinal changes in behaviour and attitude which lead to improved mental health, it would help substantiate the argument for applying human–computer interaction design to promote wellbeing.

Stress is a “cognitive perception of uncontrollability and/or unpredictability that is expressed in a physiological and behavioural response” ([Koolhaas et al., 2011](#)). Too much stress can have negative impacts on the immune system ([Herbert and Cohen, 1993](#)) and the brain ([Lupien et al., 2009](#); [McEwen, 2006](#)). Excessive activation of the stress response has also been associated with behavioural responses which can have disastrous consequences on the body ([McEwen, 2006](#)). Along with well-accepted forms of self-regulation like diet and exercise, encouraging individuals to learn how to regulate stress is absolutely essential for wellbeing. Psychological self-regulation can be especially critical for those suffering from chronic diseases which have negative effects through prolonged activation of the stress response: “prolonged physiological arousal and activation of neural and hormonal processes associated with the stress response, whether initiated by pain or anxiety, act as stressors... that can have detrimental effects on various body systems” ([Asmundson and Katz, 2009](#)).

Mindfulness meditation represents an attempt to discourage our minds' tendency to think in abstractions while simultaneously encouraging a pure experience of the present moment. In the words of [Kabat-Zinn \(2005\)](#), the major academic proponent of mindfulness meditation in the medical community:

“Mindfulness can be thought of as moment-to-moment, non-judgmental awareness, cultivated by paying attention in a specific way, that is, in the present moment, and as non-reactively, as non-judgmentally, and as openheartedly as possible.”

Ongoing research depicts mindfulness-based practices as promising for stress management, especially for those suffering from chronic clinical problems like anxiety, chronic pain, panic disorders, and depression ([Baer, 2003](#); [Bohlmeijer et al., 2010](#);

[Fjorback et al., 2011](#); [Kabat-Zinn, 2003](#)). Jon Kabat-Zinn sees this effect as central enough to refer to it directly in the title of his clinical treatment intervention rooted in meditation: *Mindfulness-Based Stress Reduction* or *MBSR* ([Kabat-Zinn, 2003](#)). This MBSR intervention and its ongoing validation suggest that designing interactive systems which can help generate, encourage, motivate or teach mindfulness meditation can help engage broader audiences to experience its vital benefits. At least, such interactive systems suitable for broader audiences could help demystify meditation practice for secular audiences who are unaware of its growing status as a proven psychological phenomenon.

2.2. *Sonic Cradle*: externally simulating meta-awareness

Sonic Cradle aims to cultivate an experience of mindfulness meditation without the complex instruction and initial effort demanded by typical meditative practices. The goal of the system is to experientially educate users about a process intrinsic to their own mind. Mindfulness meditation is already known for its positive influence on our lives ([Kabat-Zinn, 2005](#)); there is little reason to replace the practice with a permanent technological implementation. Instead, we aim to inspire new practitioners. The training wheels of a bicycle serve as a clear metaphor; an interactive medium may be able to motivate and introduce an experience of mindfulness meditation in critical early stages of engagement with the practice.

Sonic Cradle is a non-traditional interactive medium where users are suspended in darkness, controlling sound through the exploration of their own respiration ([Fig. 1](#)). The system's interaction paradigm has been intentionally designed to encourage users to focus on a familiar internal sensation – breathing – in order to control and progressively shape an abstract sound experience for themselves. *Sonic Cradle* also involves a complete lack of visual input which aims to prevent visual distractions from stealing attention while encouraging users to actively co-create the experience. Further, comfortable suspension removes direct connection with the ground while greatly reducing somatic distractions like discomfort and pain, deemphasizing irrelevant aspects of physicality. While this concept seems similar to *ExoBuilding*, a breath-controlled external architectural structure ([Schnadelbach et al., 2012](#)), *Sonic Cradle* is unique in its aim to draw attention inward. Its respiratory biofeedback sensors are used to help root users' experience in the subtle, internal sensation of breathing and its influence on sound, as opposed to a visible external stimulus. *Sonic Cradle's* physical manifestation provides minimized distractions and a lack of competing input from the physical world.

A typical mindfulness meditation session starts with a focused attention (commonly directed at breathing or other internal sensations). After some time, one's attention inevitably wanders. Through extensive practice, mindfulness practitioners have developed some kind of *meta-awareness* which gently guides their attention back to the initial focus point, without feeling discouraged or punitive. *Sonic Cradle's* interaction paradigm was designed to guide users' attention in a similar way ([Fig. 2](#)). Users should naturally start by focusing on their respiration as they attempt to discover how to influence their sound environment. Inevitably, users will be distracted by other thoughts which steal attention away from the interaction between respiration and sound. However, since human respiration proceeds autonomously and automatically without attention, users will have no choice but to continue to influence their sound environment despite their distraction. *Sonic Cradle* intends ongoing changes in the sound environment to eventually trigger the users' curiosity and thus elicit a re-orientation of their attention toward how the sound is being shaped by their breathing, effectively restoring their inward attention. In this way, *Sonic Cradle* serves as an externally-driven

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