MOODsic: A Computational-Musical Augmentation to Support Mindfulness

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ABSTRACT

In this paper, we describe MOODsic, a computational artifact aimed at supporting mindfulness in emotion regulation practices. MOODsic can be attached to any object the user uses in their usual emotional regulation practices (e.g. a yoga roll), and leverages a combination of electronics and machine learning to respond to the user's actions with that object with music and sound stimuli. Here we offer a detailed description of the design and development of MOODsic, including: its functionalities and technical specifications, the design process behind it, and a contextualization with previous works at the intersection of HCI and mindful practices. Our contribution offers a series of design and experiential qualities that might inspire other designs in this space.

CCS CONCEPTS

• **Human-centered computing** → *HCI theory, concepts and models.*

KEYWORDS

Mindfulness, Emotion Regulation, Interaction Design, Participatory Design, Music Therapy, Embodied Design, Tangible Interface

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1 INTRODUCTION

Computational Media (CM) is increasingly present in our daily lives. More and more, computational artifacts intervene in a variety of activities we do, mediating our interactions with objects, spaces, and with other humans. Once mostly used for work-related purposes, CM now transcends the scope of the workplace and invades (virtually) all of human life—from the way we keep track of our time and our basic needs, to the way we interact with others, or the way we entertain ourselves.

This broadening of the use cases of technology-mediated artifacts has implications from a design perspective. The technology paradigm that historically guided the design of work-related technologies, and its underlying values (e.g. automation, efficiency, or ease of use), might no longer apply to other scenarios [1, 2, 10]. In a variety of everyday situations, values of efficiency might even be irrelevant, or at least at a second order of importance behind other values such as physical and emotional well-being, social connectedness, or enjoyment and joy. That is the case of practices of mindfulness and emotional regulation, which are at the core of our work in this project. As a response to this shift in paradigm of technology use and design, the so-called *third wave of HCI* [1, 2, 10], HCI scholars have proposed alternative approaches that focus on a variety of values other than efficiency.

In this paper, we focus on one of those approaches: *Slow Technology* [9], that focuses heavily on supporting a rich and mindful experiencing of everyday activity. Through the design of an exemplar of a slow technology, we explore how computational artefacts can support people in performing mindful emotional regulation. Our final design, *MOODsic*, embodies a series of design and experiential qualities that we have found to be beneficial to supporting mindful engagement.

In the following sections, we begin by discussing relevant concepts at the intersection of mindfulness and HCI. We then describe our method and design process, illustrating the rationale behind our key design decisions. Finally, we present our final design, covering both its functionalities and its underlying technical infrastructure in detail. We hope that our contribution will inspire other designers to continue exploring the space of slow technologies that focus people's attentions to experiencing the here and now.

2 RELATED WORK

In this section we discuss existing work and concepts at three intersections of the following areas: Mindfulness, HCI, Music, Emotion, and Artificial Intelligence (AI).

Mindfulness and HCI

Mindfulness is understood to be: “the cognitive and embodied practice and process that is characterized by intentional awareness and non-judgmental acceptance of the present moment” [5]. It’s not about the past or the future. It has an emphasis on the present and ongoing actions one is performing[5]. Interfaces that promote mindfulness should allow a user to experience the present.

The usefulness of technology may seem counter intuitive as computational media often contribute to our experience of fragmentation[29] - but it doesn’t need to be that way [5]! We believe using concepts from slow technology and embodied interaction we may be able to create artifacts to promote mindfulness.

Slow technologies are artifacts that through their expression and slow appearance promote reflective “use”, focusing on affording rich experiences rather than efficiency in functionality [9]. ”When we use a thing as an efficient tool, time disappears, i.e. we get things done. Accepting an invitation for reflection inherent in the design means on the other hand that time will appear, i.e. we open up for time presence” [9].

For the design of tangible interfaces for embodied interaction, we can design objects in such a way that they “stimulate the user’s behavior by means of their function, thus causing mindful reflection and interaction” [21]. Tangible interaction leverages the connection of body and mind, affording physical thinking and involvement-centric interactions like mindfulness[28]

Play therapy [13] may also be useful in creating such a device. Playful engagement helps people to be self aware. Play can help us to reveal our inner selves [27] by allowing us to be anyone we want temporarily[4]. Through play we reveal ourselves, our desires and instincts [8] from a “dimension of experience that’s between the subjective and the objective” [4]. Play is thus a wonderful way of connecting with, being aware of, and reflecting upon ourselves and our actions. The potential of play as a space for self-awareness is very relevant to technology design—it can support the design of technologies that do not only improve user experience but also afford spaces for reflection [6].

Music and emotion

Musical pieces are often associated with particular moods. For example, Beethoven’s *Moonlight Sonata (Mvt.1)* could be categorized as forlorn, while the composer’s *Ode to Joy* is upbeat, lively, and downright bubbly. Furthermore, these associated moods could affect one’s emotional state[14],[26]. Several studies in functional anatomy have been conducted on the emotional affect of different musical pieces [25][19]. This concept has been used as a technique in receptive music therapy to guide emotional regulation [17].

Figure 1: Photo taken during the workshop, featuring the participants discussing the qualities of the objects they selected.

We hope to use these findings in a similar vain to receptive music therapy for emotional regulation by guiding listeners from one musical excerpt to another.

AI and Music

The emergence of artificial intelligence in the past century has allowed for increasing computational applications in artistic domains. AI has been demonstrated to be a useful too for creativity and new media creation [3][18]. There is even a discussion of whether computers themselves will ever be considered artists [12].

Specifically with regard to music, artists and composers have been creating using new technology from the beginnings of music itself - instrument creation is at the heart of music technology. This continues on to mechanical music automatons (player pianos, etc.) in the late 1800s [16]. In the 1900s computer music emerged with digital sound synthesis.

John Cage and many other composers use technology (various radio broadcasts, sensors, etc.) as a part of their creation and performance process. More recently, artists have adopted AI into their creation process, both for it’s ability to create new sounds [23], and interesting compositions [15]. Music generation has also been evolving within the fields of procedural content generation and algorithmic music.

For the purposes of this paper, we use variational autoencoders and latent space interpolation to evolve one piece of music into another. This application aligns well with our intentions of creating an artifact for mindfulness - a tool which can help guide a user from one state to another.

3 DESIGN PROCESS

Design Goals and Method

The goal of this project was to design a computational artifact that supported mindful practices through music. We wanted our intervention to help users focus on the here and now through an experience of embodied interaction with a musical transition.

To develop our prototype and explore the desirable experiential qualities it should afford, we followed a Research through Design methodology [7, 30] with a participatory approach [20]—that is, we used design methods to explore the necessary qualities of our intervention, and involved users throughout the process to make sure the final outcome responded to their needs and desires.

Inspiration from Previous Work

The first step of our process involved looking at previous works at the intersection of HCI and mindful practices. We looked at both theoretical and design-focused contributions. Our ground research surfaced 5 insights we thought were relevant to the design of our artefact:

- Active engagement focuses people on the here and now [21] [28], and thus seems desirable in mindful practices.
- Within the scope of active engagement, embodied interaction seems to do a good job in supporting engagement with an activity [28].
- Explorative playful engagement is also desirable when it comes to promoting reflection and self-awareness [13].
- Ambiguity in an interface often makes people focus more on the present ongoing of an activity rather than on its results [9], which is quite aligned with what mindful practices often look like.
- A good coupling between form, context and interaction supports mindful action [28].

Co-design Workshop

From our ground research of literature on HCI and mindfulness, we learned that our design should have a series of qualities: it should be interactive, embodied, somewhat playful and ambiguous, and contextually meaningful. Building on that, we decided to conduct a co-design workshop with people with different relationships with mindful practices, to see what kinds of devices and interaction they thought we should consider. The workshop structure included 4 phases:

- We began with a 5 minute presentation where we introduced our research agenda, literature findings, and goals for the workshop.
- Then, we presented participants with a bunch of objects with different properties, textures, shapes, etc. and we ask them to chose the object they thought would do a better job at supporting their mindful practices.
- Following, inspired by previous work that used user-defined gestures in interactive interfaces (e.g. [11]), we asked the participants to imagine how they would use those objects as an interface that would allow them to progress through a musical transition during a mindful practice session. We asked the participants to share their thoughts with the rest of the group.
- Finally, we conducted a group reflection on what would be the desirable qualities of the interface we wanted to design.

The workshop led to a series of findings we thought were relevant to our design process:

Focus on mindfulness, not on meditation. First, participants noted that we should focus on mindful practices at a general level rather than on meditation specifically. P1 argued that "I think it's gonna be much easier for you to answer your questions if you focus either on emotion regulation or meditation, because they are not the same", while P6 suggested that "I'd focus on mindfulness or emotion regulation rather than on meditation... When you are meditating, you don't wanna play with any object really."

Form factors are very personal. When looking at the different objects the participants chose in the workshop (see Figure 2), we realized that they were too different for us find useful patterns. Some people preferred bigger objects, some others smaller, some others chose objects that required full-body interaction... Here, we also realized that people gave a lot of importance to the meanings they associated to their personal objects.

Recurrent haptic qualities. While we could not observe patterns in the form factors of the objects the participants chose, in our discussion there were a series of haptic qualities that came across. Participants agreed that they preferred devices that were soft to touch: "For the sake of emotional regulation, I really like large, fluffy things" (P1). They also noted that simplicity was an important factor: "It's nice to have something tangible, that you can touch and is really simple" (P3). Finally, they suggested that elasticity was an interesting factor, and that having the chance to play with an object that has some "give" but gets back to its initial state is pleasurable: "I've been thinking about having something that's elastic, that has give, but it takes its shape again... So you can change it but those changes are impermanent." (P6)

Recurrent interactions. Similarily, we also found similarities in participants' ideas about how to interact with the different objects. A number of interactions kept emerging throughout

Figure 2: Objects selected by the workshop participants to indicate form factors and haptic qualities that are desirable in their mindful practices.

the workshop. For example, P3 noted that "I just grabbed this thing and started rolling it on me...", to which P6 responded that "Yeah, I did the same! It feels good to roll and rotate things". Participants also talked about the pleasure that lies in pressing and feeling the materiality of the object in one's hands: "I've been touching and pressing it, I like feeling its edges on my fingers" (P6). Finally, some participants noted that they enjoyed figetting with their objects: "I like doing things that focus me in the moment, like fidgetting or tapping rhythmically" (P2).

Different relationships between cognitive activity and "being present in the here and now". Our discussion about the participants' desired interactions made us realize that, generally, there were two approaches when it came to engaging actively in mindful practices. On the one hand, some participants preferred interactions that were simple and lightweight. For example, P3 noted that "It's nice to have something tangible that you can touch and is simple, not overly complicated", and P5 said that "I took this ball because it just feels natural to fidget with it, it's just simple to move it around". Differently, other participants thought that cognitively-intense interactions helped them more when it came to focus on the here and now. For example, P2 said that "If I do an action that requires some cognitive effort, it takes me away from the other cognitive processes that are going on in my brain. So I like things that actually make you focus in the moment by requiring your attention", and P5 noted that "I like it when there's a little bit of a challenge, some sort of mental effort involved."

Overall, from the workshop we learned that our design needed to: (i) target mindful emotion regulation practices, (ii) adapt to people's personal objects, (iii) emphasize the experiencing of soft, simple, and flexible tactile qualities of those objects, (iv) afford somewhat open-ended interactions (e.g. rotating, turning around, tapping, caressing...), and (v) embrace both lightweight and demanding cognitive activity.

4 FINAL DESIGN

Based on our literature review and workshop, we have come up with an interaction design and initial prototype. Our design concept can be seen in Figure 5. Our initial prototype can be seen in Figure 3

Slowly evolving musical and LED transitions were selected to support the concepts of slow technologies. From our findings in the workshop, we chose to create a device that can be adhered to an object of the users choice. To allow for exploration as well as either of the two alternate mindfulness approaches, the artifact can be interacted with in two distinct ways:

- **Sweeping/Rotational Movements**: Supports those who want simple interactions without cognitive load.
- **Tapping/Shaking Interactions**: Supports those who want more challenging tasks. The user can tap or shake along with the music, or create alternate rhythms.

Music-Interaction Coupling

The core idea behind the project is a transition from one state to another. An initial musical state and a final musical state which are associated with specific emotions are selected. We

Figure 3: Photo of our early prototype.

use Magenta's Music Variational AutoEncoder [22] to transition from one musical state to the other. The interaction with the device affects how the musical snippets are interpolated over. Interacting by tapping more frequently or making large sweeping motions will cause the music to transition faster and increase the note density over time.

This music-interaction coupling is also supported by the LED lights in the interaction. The the light begins simple (only one color) and as you transition, becomes more complex and full (many colors) along with the music.

At this time generated musical states are selected to represent specific emotions, but in the future we would like to give the user the choice of emotion to interpolate over and generate them on the spot. This will require training a generative model for specific musical styles for each emotion.

Hardware and Software

All software and instructions for setup can be found at github.com/bbaltaxe/moodsic.

For the sake of ease of development, this design makes use of the Adafruit maker ecosystem to create the controller and manage the data collection. At the base is a circuit Playground Classic, of which, we make use of the accelerometer to detect user interactions with the device. The activity is visualized using the ring of RGB LED's built onto the board. As the user engages in smooth continuous interactions, the LED's gain in brightness and speed of color rotation. As the user engages in more purposeful discrete actions such as tapping the variety of colors in the rainbow pattern. The device has a Bluetooth module from the Adafruit flora series of wearable maker hardware components. This pairs with the Adafruit Bluefruit android and ios app to transmit the data to an Adafruit IO website allowing for the magenta component of the system to query the latest data point.

Latent Space Interpolation

In order to transition over time from one musical state to another, we use Magenta's Music Variational Autoencoder (VAE) [22]. Autoencoders consist of two parts. A decoder which takes an input and creates a latent vector, and an encoder which creates an output based on the latent vector. Variational autoencoders use these latent vectors to generate new media outputs. The Music VAE interpolates over two musical snippets by taking samples from within their latent spaces and reconstructing realistic samples. A good visual example of this can be seen by interpolating over Magenta's Sketch RNN [24], Figure 4.

5 CONCLUSION

In this paper, we described *MOODsic*, a computational artefact that supports mindful emotion regulation practices through interaction with music and lights. *MOODsic* can be attached to any object the user uses in their usual emotional regulation practices (e.g. a yoga roll), thus adapting to the user's specific context and emotional regulation practices. Here we offered a detailed description of the design and development of MOODsic, including: its functionalities and technical specifications, the design process behind it, and a contextualization with previous works at the intersction of HCI and mindful practices. Our contribution allowed us to surface a series of desirable design qualities for slow technologies aimed at mindful emotional regulation: First, allowing users to choose their own form factors. Second, allowing users multiple modes of interaction at different cognitive load levels for somewhat open ended interactions. Third, simple interfacing. Fourth, soft, flexible tactile experiences. We hope that our work will inspire other designers in this space, and that it will contribute to a body of work that explores alternative uses of computational media.

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Figure 4: Interpolating over Magenta's Sketch RNN. Original image from https://magenta.tensorflow.org/music-vae

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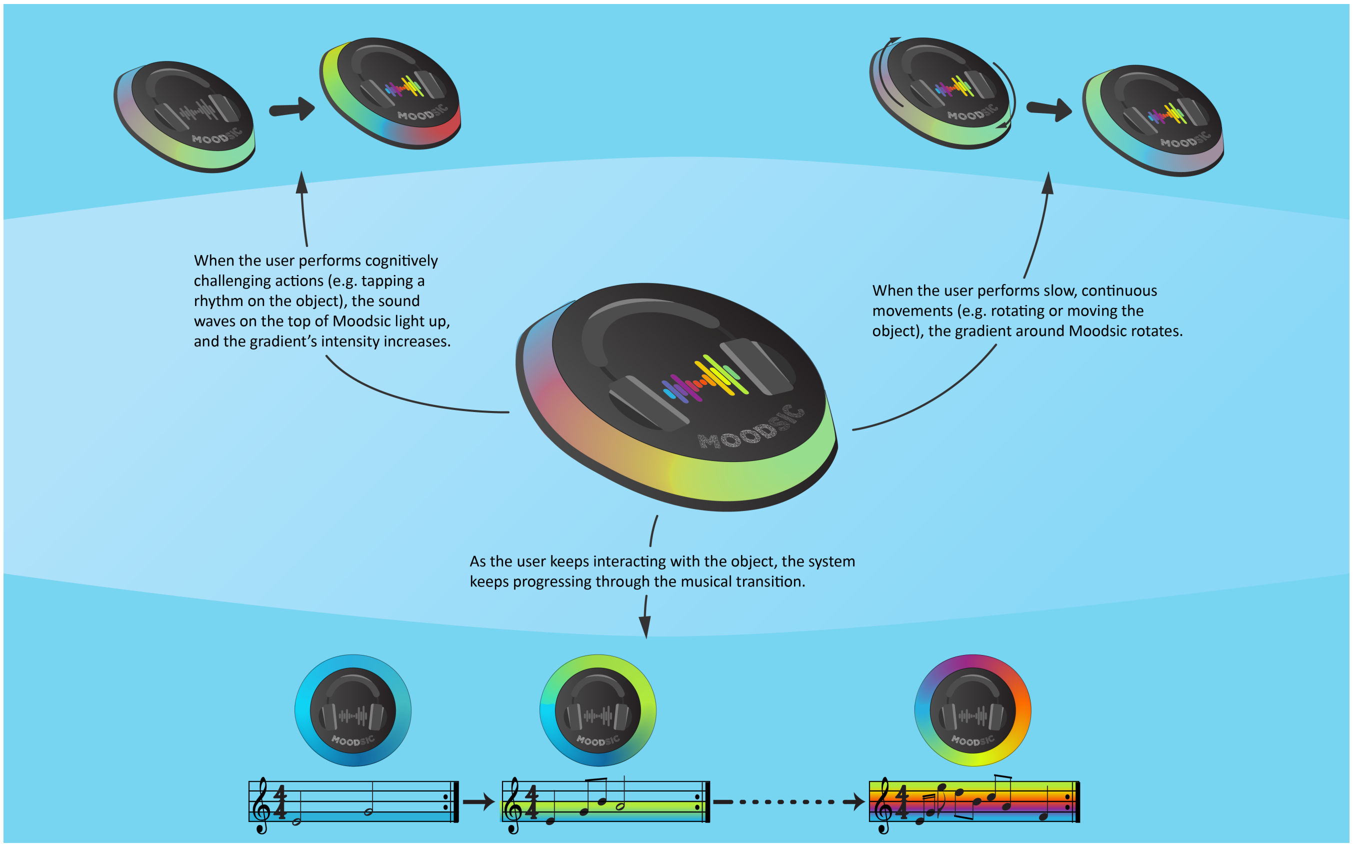

Figure 5: Key interaction design mechanisms behind *MOODsic*, including direct feedback (top) and progressive emotional transition (bottom).