

PAUSE: Exploring Mindful Touch Interaction on Smartphones

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ABSTRACT

In recent years, the widespread use of smartphones has become the focus of a discussion on stress and distraction as a negative influence of mobile phones. We argue that this is not just rooted in the cognitive distraction from the present, but also that the style of touch user interface design, while optimized for efficient data manipulation, adds to the stress. With inspiration from the movement qualities of the ancient practice of Tai Chi we investigate if a radical redesign of interaction style can potentially contribute to relieve stress and improve the crucial skill of directing attention at will. In this paper, we present the design and initial evaluation of a stress relief application called PAUSE, which uses *Mindful Touch* as an interaction style. We suggest that *Mindful Touch* can co-exist with the current smartphone interaction as a complementary style, to form a more balanced, constructive relationship between people and smartphones.

Categories and Subject Descriptors

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Keywords

Interaction style; interaction quality; attention; mindfulness; well-being; mobile interaction.

1. INTRODUCTION

Many people complain that constant connectivity and continuous stimulations provided by modern technology make us more stressed [6][17], and lose our ability to concentrate. Recent research uncovered that the average human attention span has decreased to 8 seconds, which is 1 second less than that of a goldfish [16]. Other research has shown that the accident rate in playgrounds is going up, as parents are occupied with their smartphones and look less at their kids playing [5]. We can see our vulnerability to the seductive technology we have created. It makes us feel the experiences provided by our devices are always more important and interesting than what is happening in the here and now. This can make us continuously miss the most fundamental dimensions of our life: our family, our

responsibilities, and our immediate surroundings. It is easy to blame our devices, and a natural reaction is to view them as a dangerous force that we must keep at a distance or set clear boundaries. It seems digital detox [15] has become a widely accepted approach for us to find balance between our digital and physical life: refrain from using any electronic devices for set periods of time. But is that really how we want to live with our technology? Are we too quick to blame our devices and ignoring our own vulnerability? What if technology holds a vast potential to effectively help us overcome our vulnerability and improve our skills of well-being?

In this paper, we investigate some of these questions by presenting the design and an initial evaluation of PAUSE (Figure 1), a stress relief app for smartphones. PAUSE draws upon principles from Tai Chi and mindfulness meditation by extracting the essential qualities of slow, continuous and gentle bodily movements, and transferring them to finger movements. Our main contribution is an interaction style called *Mindful Touch*, which has the potential to be extended into the design of other systems. An exploratory evaluation of PAUSE and its proposed interaction style was conducted. The results suggest that people positively valued the natural and human way that the app attempts to relieve stress, as well as the role of *Mindful Touch* in focusing to reach a relaxed state. The focus of this paper is to provide a detailed account of the design process for PAUSE as means to introduce and discuss the *Mindful Touch* interaction style. A validation of PAUSE where the app's effectiveness in reducing stress will be measured is underway and will be published separately.

The rest of this paper is structured as follows. We begin by reviewing the relevant related work and the notion of interaction styles. Then, we describe the iterative design of PAUSE in detail. Finally, we report the results of the initial evaluation, followed by discussion and conclusions.



Figure 1. The PAUSE App with graphics as seen after an extended period of mindful touch.

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2. RELATED WORK

2.1 Human Attention and Interactive Meditation

In his influential book ‘Flow’, psychologist Mihaly Csikszentmihalyi defined Psychic Entropy as “the normal state of our consciousness, which is a state of uncertainty and chaos, that is neither useful nor enjoyable” [4], and recent research by Harvard neuroscientists concluded: “mind-wandering appears to be the brain’s default mode of operation, and a wandering mind is an unhappy mind” [12]. One study states an average person thinks 65000 thoughts per day, and 95% of the thoughts are the same from the day before [3]. Yet another study reported that 80% of everyone’s thoughts contain some sort of negative content [7]. To avoid this uncomfortable condition, we are naturally eager to fill our minds with whatever information is readily available [4] that gives us something to distract our attention away from an uncomfortable inner state.

This condition makes us become very vulnerable to attractive entertainment and exciting new experiences. We rely on external stimulations to help us organize our attention and make us ‘feel better.’ It becomes a problem when this dependency turns addictive, as it means we have lost control over our own attention.

2.1.1 The Inner Skill of Paying Attention at Will

Psychologists say “*We create ourselves by how we invest our attention, and the way to happiness begins with the ability of paying attention at will*” [4]. William James, one of the founding fathers of modern psychology stated: “*The faculty of voluntarily bringing back a wandering attention over and over again, is the very root of judgment, character, and will. An education that aims to improve this faculty would be the education par excellence. But it is easier to define this ideal than to give practical instructions for bringing it about.*” [9]

The ability of voluntarily paying attention allows us to effectively disengage with external and internal distractions, stressful thoughts and worries, and enables us to focus our attention on what is truly important. The constant stimulations and connectivity in everyday life easily captures and manipulates our attention, and makes us often forget our innate capacity of controlling attention from moment to moment, which is at the core of happiness and well-being. The ability of voluntarily paying attention is a skill, which can be cultivated, and traditionally only cultivated through contemplative practices such as mindfulness meditation.

2.1.2 Current Approaches to Interactive Meditation

Besides well-known approaches of designing for well-being such as setting ambient atmospheres¹ and guided meditation or yoga exercises (e.g. Headspace² app), the idea of interactive meditation is of particular relevance. There are two main approaches in designing for interactive meditation. The first focuses on biofeedback - by measuring, for example, brainwaves (e.g., Muse³), breathing (e.g., Spire⁴ and RESPeRATE), heart rate and heart rate variability (e.g., emWave⁵ and Stress Eraser) to provide

¹ Philips Hue. <http://www2.meethue.com/en-US>

² Headspace app. <https://www.headspace.com/headspace-meditation-app>

³ Muse headband. <http://www.choosemuse.com>

⁴ Spire. <https://www.spire.io>

⁵ emWave. <http://www.heartmath.com>

meaningful real-time data on a person’s physiological state, to support and motivate people to maintain their ongoing meditation. This approach requires dedicated accessories or special devices to measure a person’s physiological state.

The second approach borrows the physical forms of traditional meditation artifacts, such as Chinese meditation balls (e.g., Philips Mind Spheres concept), or Tibetan prayer wheel (i.e., Channel of Mindfulness⁶).

Both approaches use interactive technology to sense the particular pattern of movement required by the associated meditation artifact, and augment with meaningful digital experiences as reward when a person achieves the right movement pattern. Both approaches require special physical devices that are often expensive, and they require privacy for their use, as these devices need to be worn or interacted with.

2.2 Meditation, Psychology and Physiology

2.2.1 A Core Element of Mindfulness Meditation

With substantial amount of scientific evidence of its effectiveness on stress reduction and treating diseases, *mindfulness meditation* is widely accepted and practiced by many people, and has become integrated into mainstream medicine [21]. One of the key elements of mindfulness meditation is that the person voluntarily directs and sustains attention on, for example, breathing, the feeling of the body, or a physical object. The moment one becomes aware that the attention has wandered away, one voluntarily brings the attention back to the object, again and again without judgment. In this way one gradually develops a familiarity with one’s own attention.

In our approach the specific object for attention is the slow, continuous and gentle finger movement.

2.2.2 Attention Restoration Process (Psychology)

Professor Stephen Kaplan from University of Michigan proposed two mandates underlying different *attention restorative processes*: 1) Avoid calling on tired cognitive patterns, by being away from everyday environment. 2) Avoid unnecessary effort. Running a single cognitive map for an extended period of time is ideal for attention restoration [10].

In our approach, we use digital design to create a beautiful ambient audio-visual environment that is engaging yet non-stimulating to our mind. The slow, continuous and gentle bodily movement gives people a single cognitive map, which does not strain a person’s cognitive effort unnecessarily. Importantly, the rewarding digital experiences are only available to people when technology detects a person’s focused attention, through the slow, continuous and gentle movements. In this way the digital experience gives meaning to the act of focused attention, which motivates people to keep going for an extended period of time.

2.2.3 The Relaxation Response (Physiology)

Professor Herbert Benson from Harvard Medical School, introduced the concept of *relaxation response* in 1975. The relaxation response counteracts the stress response. It is a coordinated physiological response characterized by decreased arousal, diminished heart rate, respiratory rate and blood pressure, in association with a state of “well-being” [1]. An essential aspect is that the relaxation response can be elicited by anyone, as it is a self-regulative process.

⁶ Channel of Mindfulness.

<http://cargocollective.com/yufan/Channel-of-Mindfulness>

There are only two elements required to elicit the relaxation response: 1) the person directs and pays attention to the repetition of a word, sound, phrase, prayer, or muscular activity, and 2) the person passively disregards everyday thoughts that inevitably come to mind and returning to your repetition [18].

In our approach, we build the repetitive muscular activity by using slow, continuous and gentle movements as the object of attention. When people are distracted by everyday thoughts, it becomes difficult to sustain the focused movements, which can be easily detected by technology. We may design the digital experience to remind people to bring attention back to the focused movements again and again, to trigger the relaxation response in the body.

3. INTERACTION STYLES

3.1 Interaction Styles Thinking

How do movements in interaction with digital devices relate to our attention? We will categorize different ways of moving our bodies in general, to help us understand the foundation of existing principles of designing interaction with digital products, and to support exploration of alternative principles of designing interaction.

Interaction movements are the focus in the interaction style thinking developed by Ørstrand and Buur [19], which was successfully applied in designing innovative interfaces for control devices used in industrial plants. The general idea is to trace the product's design history, identify eras of distinct interaction styles, extract preferred interaction qualities, and use these to support the interaction design of contemporary products. Cheng and Buur [2] later applied this approach in mobile phone interaction design. In this current work, we start our search with two general styles of moving the body.

3.2 Two Distinct Styles of Moving the Body

3.2.1 *The Habitual Routine*

We carry out countless actions everyday as part of our daily routines. We do most of these actions very skillfully and efficiently, as they have been practiced so many times. Our body knows exactly what to do requiring little or no attention from us. In cognitive psychology, this is referred to as 'Automatic processing' [20]. The capability of automatic processing frees our attention from the actions at hand, and allows us to put our mental capacity on to the goal of the action, or even mentally processing other things that may not have direct link to the actions being carried out in the moment. Examples are walking, dish washing, cooking, eating, or drinking. This is often referred to as 'AutoPilot' mode in Psychology [20].

The way our bodies move while doing these actions is often fast, efficient and forceful, with the focus on the goal of the action rather than the journey of the action. It may be argued that the existing principles of interaction design for digital products are based on the 'Habitual Routine' style of the bodily movements. Primary interaction methods like touch are designed to be as fast, intuitive and efficient as possible, where the interaction journey is minimized to almost zero, so it does not require any attention. This follows the Heideggerian ideal of 'ready-at-hand', i.e. computers draw attention to the task at hand, rather than to the interface itself, which would be 'present-at-hand.' [11]

3.2.2 *The Mindful Journey*

There are situations, however, in which we move our body in mindful ways, especially when handling something precious and valuable to us. For instance, kindly caressing a sleeping baby without wanting to disturb her sleep, or handing an expensive and

delicate object such as jewelry. These movements depend on external conditions and rarely last long.

The 'Mindful Journey' style of bodily movement is found most prominently and consistently in the Chinese meditative martial art Tai Chi. With full recognition of Tai Chi's profound philosophical roots and combat techniques, we observe that its practitioners voluntarily move their own body in a slow, continuous and gentle way for an extended period of time. This kind of movement requires one to focus on the movement journey itself – from moment to moment – in order to sustain it. In this way the bodily movement anchors attention in the body and the movement itself, and holds attention away from the often negative and repetitive thoughts that make us stressful, which explains Tai Chi's proven effects to reduce stress and improve concentration [13].

3.3 Transferring Tai Chi Movement Qualities to Touch

Conventionally the fascinating forms and precise patterns of Tai Chi are seen as the core of its practice – they take a long time to memorize and practice. However, the rigid forms of Tai Chi practice is mostly linked to its combat techniques in fighting, rather to the calming effects that the mindful movement of the body from moment to moment directly brings. For this research, we explore if it is possible to extract the essential qualities of slow, continuous and gentle bodily movements from the rigid forms of Tai Chi practices, and to transfer the same movement qualities to a very different scale of movements – finger movements, which the touch display of a mobile phone is already capable of detecting.

4. DESIGN

In the following section, we will introduce the exploration that led to the final design of the PAUSE app and what we learned about *Mindful Touch* interaction, visual feedback, and audio feedback.

4.1 An Interaction Mechanism for Touch

Is it viable to create a user interface for slow, continuous and gentle touch movements? The mobile touch screen is designed to precisely detect human finger movements. We see the mobile touch screen as an open space that has the capacity to accommodate not only fast and efficient gestures (e.g., tapping, pressing, swiping, or pulling), but also gestures that embody qualities of slow, continuous and gentle movements. Slow and continuous movement qualities are detected by the speed and continuity of the finger movement. Gentleness is indirectly sensed by the continuity of the finger movement: if a person applies too much pressure on the screen while moving the finger, the increased friction will disturb the continuity of the movement.

Moving a finger slowly, continuously and gently requires at least some attention from moment to moment in order to sustain it. When we are distracted and lose control of the movement, the finger will either stop, or move faster or lift up from the screen. We designed an interaction mechanism in a way that the phone generates feedback only when it detects slow, continuous and gentle finger movements. As soon as the finger moves too fast, stops, or lifts up from the screen, the feedback will fade away to remind people that they have lost control of the steady, deliberate movement. And the moment the person brings attention back to the movement again, the feedback fades in. We found that this mechanism allows us to easily create meaning for the act of voluntarily paying attention, thus the digital experience can be designed to reflect and motivate human voluntary attention from moment to moment.

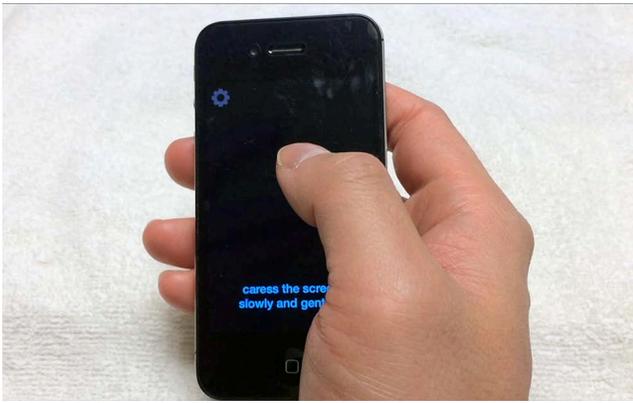


Figure 2. A slow, gentle and continuous interaction mechanism creates meaning for the act of voluntarily paying attention. In this first working prototype, gently moving a finger on the screen triggers a soothing music.

We created a working prototype of this interaction mechanism with sound feedback only (Figure 2). The screen starts with a simple instruction to ‘caress the screen slowly and gently’ to help people get started. After that, the screen will turn completely dark to encourage people to close their eyes, as there is nothing to look at. Shutting off visual stimulation helps people in entering a calming state of mind. As the person starts moving their finger slowly, continuously and gently on the screen, a soothing music starts to play to acknowledge the person’s presence at the moment, and to motivate the person to sustain the finger movement continuously for an extended period of time.

We gathered feedback by inviting 18 participants (10 female, 8 male) working in a creative design studio (i.e., managers, developers, designers) to come and test this version of the app whenever they felt stressed. Participants individually tested the prototype for 12 minutes while sitting in a comfortable chair. Almost all participants (17/18) said that they felt calm and relaxed after just a few minutes of use. However, said they would not use it again. It became clear to us that we needed to create beautiful experiences around this interaction mechanism so that it is attractive and engaging, but at the same time not stimulating to our mind.

4.2 Visual Exploration to Give Meaning

Is it possible to create an experience that continuously draws the attention of the person, without seeking to occupy it fully? After some reflection and a quick round of user testing we realized we needed something beautiful and fascinating that would trigger the interaction, but that in the end would not need to be seen on the screen so the person could focus both on the relaxing effect of their own repetitive movements and the audio instead.

We started out with a realistic design visualizing a fishing float that dives deeper into the ocean in accordance with the person’s stroking movements (Figure 3a). Although engaging and beautiful, there were some pieces that did not fit. It felt heavy, whereas it should have been airy, made of subtle nuances, which adds the scent of mystery that usually surrounds meditation. Also, the colors were garish when we needed them to be soft and silky.

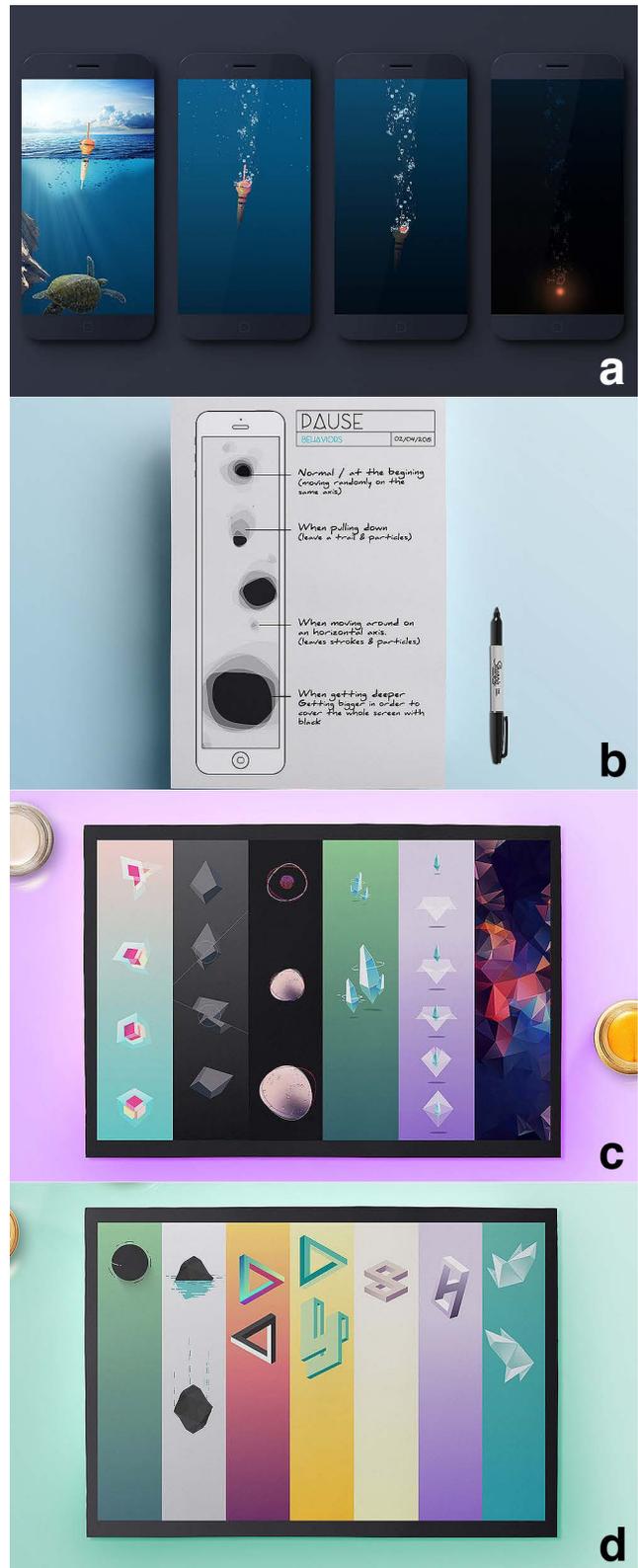


Figure 3. Visual concept exploration: (a) the fish float concept, (b) soft sinking object, (c) floating shape ideas, and (d) Escher’s impossible shapes.



Figure 4. Exploration of different color variations for the air bubbles floating in water as presented in the PAUSE app.

Keeping with the idea of the sinking object (Figure 3b), we focused on experimenting with a more colorful but soft contemporary visual style. We turned the ocean into color gradients and the float into different shapes such as an iceberg, crystals (Figure 3c), or Escher’s impossible shapes experimenting with the soothing experience of Monument Valley (Figure 3d). During this process, we shifted from the concept of sinking to a floating feeling, as it seemed to convey a more positive message, and was more in line with people’s expectations of a meditative and relaxing experience.

4.3 Tweaking the Atmosphere

Satisfied with the results, we decided to push those concepts even further to fully benefit from the geometric, low poly abstract figures. At this stage, we also tucked in more playfulness to test other hypotheses. We thought that instead of darkening the screen we could give people additional objectives such as re-assembling a cube, playing with masks, Russian dolls, or playing with a kaleidoscope-type effect.

Upon reflection, it became clear that we needed something airy, a tad poetic, which would provide people with a seamless but new experience each session – and found that in a spiritual level. *Would a bubble of air floating in water combined with our randomly displayed gradients provide the right atmosphere for PAUSE?*

We drafted up various versions, making sure they were overlaying properly with our colored backgrounds (Figure 4). We also produced some variations of motion to get the right feeling for a shape, as we wanted something organic, random, floating around and dancing along with your finger. We finally ended with the UI in PAUSE, keeping it as minimalistic and airy as possible as to not overwhelm people.

4.4 Sound Design

The sounds for PAUSE were designed through several iterations with the help of a sound artist. The sound was created only when the graphics and motions were in place. It was not until then that it was possible to get the sounds right, to make them work in harmony. We tried different sounds from nature (i.e., waves and birds) and decided to trigger them depending on where a person’s finger is on the screen. The first version contained small subtle rhythms, but we realized pretty early on that a sweeping sound around one chord would work better. A repeating, soothing loop that allows you to drift away. The brief to the sound artist was to create an ambient soundscape that would give the mind a

continuous enjoyable experience, without leading it to think, interpret, and anticipate what could come next. The sound had to be unpredictable to the mind, hence the requirement for it to be non-rhythmic, to not trigger new thoughts.

For the final touch, auditory, and visual experience provided by the PAUSE app, please open the accompanying support video⁷.

5. INITIAL EVALUATION

In order to investigate if the proposed interaction style can potentially contribute to relieve stress, we invited people to experience the PAUSE app. We collected qualitative data both during the interaction with PAUSE and later during semi-structured interviews. Quantitative data was also collected at the end of a task by means of a validated questionnaire.

5.1 Participants

The initial evaluation was conducted with 10 participants. Participants were chosen to represent a variety of user types, including parents, students and professionals. The participants varied in gender (5 male, 5 female), age (between 21 and 42 y/o), handedness (9 right, 1 left), and background (5 technical, 5 non-technical). All participants had previous experience with graphical user interfaces, owned a laptop and a mobile phone, and some of them had tablets (6/10). All participants were tested individually.

5.2 Procedure

Each 30-minute session with a participant consisted of three parts: introduction, completion of task, and a semi-structured interview. First, we explained the purpose of the study and gathered participants’ background information (10 min). Then, participants used the PAUSE app without any prior training (10 min), and filled-out the AttrakDiff [8] questionnaire, which measures pragmatic and hedonic aspects of interactive products along four dimensions. Pragmatic quality (PQ) refers to the product’s ability to support the achievement of behavioral goals (i.e., usability). Hedonic quality refers to the users’ self: stimulation (HQ-S) is the product’s ability to stimulate and enable personal growth (i.e., personal goals and aspirations), and identification (HQ-I), is the product’s ability to address the need of expressing one’s self through objects one owns (i.e., social aspects of product ownership). Both HQ-S and HQ-I have been found to contribute to perceived attractiveness (ATT), which describes a global value of the product based on the quality perception. Participants indicate their perception of the product by rating 28 pairs of opposite adjectives that relate to the four dimensions on a 7-point scale (-3 to 3). Finally, semi-structured interviews were conducted where participants were asked a consistent number of open-ended questions (i.e., *general impression, audiovisual feedback, the slow movement and how it compares to current touchscreen movements, other potential uses for this movement*), prompting them to reflect back on the experience of interacting with the app (10 min). The semi-structured interviews were recorded on video. Participants were not compensated for their time.

5.3 Setup

Each session was conducted either in a meeting or hotel room. Participants used an iPad Mini 3 running the PAUSE app, except for two participants who used their personal iPhone 6s device. Participants were given the choice to sit on a comfortable chair (Figure 5a), lounge on a Fatboy beanbag (Figure 5b), or lie in bed (Figure 5c). The experimenter observed and took pictures from a distance. Participants were otherwise alone and in a quiet space.

⁷ PAUSE video. <https://youtu.be/N0nuNkU58Lw>



Figure 5. Evaluation Setup. Participants trying out the PAUSE app while: a) sitting in a chair, b) lounging on a Fatboy, and c) lying in bed.

6. RESULTS

In the following sections we describe the main results of the initial evaluation of the PAUSE app. First, we discuss people’s reactions to the app’s role in relieving stress. Second, we examine people’s use of slow, steady, and gentle movements for interaction. Finally, we explore people’s ideas to increase the expressiveness of the movement.

6.1 Relieving Stress

In general, all participants (10/10) positively valued the potential behind the app to relieve stress and getting your mind off things. Participants were surprised about the use of a mobile phone app for such purpose: *“It’s surprising that the interaction with a tablet or a computer (can be) something to relax (or for meditation) because usually it is very much connected to work.”* [P5] They also commented on the natural and human way used to achieve a relaxed state: *“This app was very human. I felt like I was with someone, it was like a conversation, and I was very relaxed. I almost slept, actually.”* [P2] On the AttrakDiff questionnaire (Figure 6), the app was rated high on the pragmatic quality (PQ) dimension, indicating that it supports people’s goals and they see a practical use for it.

The combination of visual feedback, ambient audio, and the slow steady movement were all mentioned as key elements of the interaction: *“It was very relaxed, easy to get into an ambient kind of experience. In general it was very appealing.”* [P6] *“I liked that the task (visual) feedback was very short and to the point, so you were just following.”* [P2] *“This sort of ambient music makes you relax.”* [P1] On the AttrakDiff questionnaire (Figure 6), the app is located in the above-average region on the attractiveness (ATT) dimension and thus the overall impression of the product is very attractive. These high ratings indicate that the participants perceive the app as motivating and pleasant.

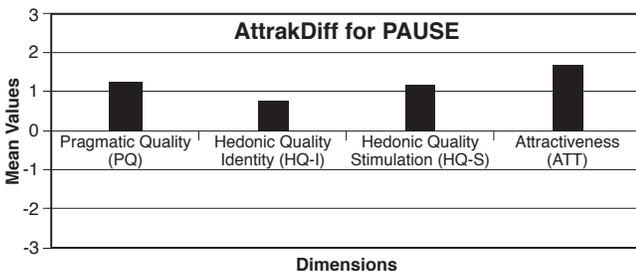


Figure 6. Mean values along the four AttrakDiff dimensions.

As participants were making the bubble larger and larger by following the on-screen instructions, they moved from a mode where they were completing a task towards slowly achieving a relaxed state: *“Fully filling the screen means that you have a target in your mind and when it said close your eyes, it was like ‘ok, I did all this effort and now I close my eyes?’ But then you are very much hypnotized by the movement. This contrast I think is very interesting.”* [P2] *“At a certain point you lose track of the (bubble) itself, it’s like a bit hypnotizing, and I think that was a bit of the purpose. (...) I was into it.”* [P1]

One participant reflected on failed attempts at engaging in meditation during the Christmas break after feeling exhausted from the year that was about to end: *“I got so bored when I started (meditating). I couldn’t concentrate on it even for 5 minutes, so I was quite surprised (with this app) that I didn’t feel this pressure. It felt a little bit like meditation. But I didn’t feel the pressure that I get if there’s nothing. So there were enough stimuli and enough input that I could still stay focused but still relaxed.”* [P5]

6.2 A Slow, Continuous and Gentle Movement

Participants generally commented on the novelty of interacting with a mobile device in this manner: *“It was different. It was the first ever that I interacted with this device in that way.”* [P3] Participants also commented in more depth about the role of this particular movement in focusing to reach a relaxed state: *“It was nice because you got into a kind of mode. (...) Like getting concentrated on the surface itself and the texture of the screen. So in that sense it stopped the experience from referring to some function, to actually stay focused.”* [P6] *“(The movement) is part of the experience of relaxing because at a certain point you don’t think about it anymore. You just do it and you cannot really feel it.”* [P1] On stimulation (HQ- S), the second of the two hedonic dimensions of AttrakDiff (Figure 6), the app is located in the above-average region, which means people think it is inventive and creative. This rating is mostly connected to the proposed interaction style on a touch-enabled mobile device.

Inevitably, participants compared the proposed movement to the type of fast, segmented, and hectic gestures that they normally use to interact with their mobile devices: *“Usually you are always hurrying up, you try to do things as fast as possible, and you try to get rid of all the work that you have to do. So it’s a new experience I would say, which was quite pleasurable.”* [P5] *“When I’m using a phone I am typing (doing) singular bits of movements and in this specific case it was something continuous.”* [P2]

Some participants also compared the slow, continuous, and gentle movement to their interactions with some of their existing apps. A couple of participants (2/10) mentioned some similarities with the guided movement used in Angry Birds⁸ to launch birds: *“In Angry Birds when you are flicking a bird, you are pulling the launcher very slowly but very accurately.”* [P3] Another participant mentioned the dating app Tinder⁹ to reflect on a slow movement she uses: *“It’s like the Tinder swipe. (...) You can press the heart or the cross (to) like or dislike people. Often for me that gets really repetitive. So I always use swipe instead because I like the movement, it’s not that stressful for my fingers. (The movement) is*

⁸ Angry Birds. <https://www.angrybirds.com>

⁹ Tinder. <https://www.gotinder.com>

slower so you still have time to think and it's more relaxing for you." [P4]

A few participants (3/10) had trouble with lack of tactile feedback while interacting with the app, especially as participants were unable to see the edges of the screen when their eyes were closed: "The phone does not have tactile sense of the edge. I don't know if (growing the bubble) stopped because I entered the wrong area." [P3] "I was missing some feedback to be sure that I don't go out of the border of the display." [P10] A couple of other participants (2/10) commented on the screen surface: "I don't like the screen's texture at all. I would prefer if it had a different texture while I was doing (the movement). That would give me something different." [P2] "I'm missing some tactile feedback. (...) It makes me think of how dull, uniform, and annoying the screen is. (...) If you could at least feel the sides, if there was something that you could bump into, then the movements would be more interesting. (...)" [P7] Finally, one participant mentioned the stickiness of the screen as potentially problematic: "The surface of the phone gets sticky when holding your finger for a long time, it got hard to move the finger." [P3]

6.3 Increasing the Expressiveness of the Movement

All participants (10/10) explored some variation of the movement by switching hands, changing finger, using multiple fingers, pressing harder on the screen, or modifying their trajectory. The most commonly observed movement consisted of making circular motions with one finger: "I suppose for all people it's going to be the same (movement) because this type of music makes you do (circles), and this is very much of a movement that makes you sleep or relax." [P2] Half of the participants (5/10) explicitly commented that they wanted to explore a little bit more with their movements, thus requesting higher expressive qualities of the movement: "I was asking more from the app. (...) There were no expressive qualities, whether I pushed the screen." [P6] "I think it's nice if you could do more with it. It's missing a layer, or something. Along the lines of 3D touch." [P7] 3D touch on the iPhone 6s¹⁰ could indeed allow people to explore other sounds when participants have their eyes closed. This could potentially prevent the problem with not feeling the edges of the device. However, the pressing movement should be done slowly, continuously and gently so as to maintain similar expressive qualities as the swiping movement.

7. DISCUSSION

7.1 Mindful Touch as an Interaction Style

Besides for a relaxation and mindfulness app such as PAUSE, the slow, continuous and gentle finger touch movement can be used to rethink every existing touch gesture included on smartphones to perform usual interaction tasks. For example, the tapping gesture could be done in a slow, continuous way, from approaching or barely touching the display and being mindful about applying pressure slowly, evenly and continuously in the process of pressing down and releasing the finger. This would turn the tapping gesture into a mindful journey, where people need to focus on the interaction itself in order to perform, and it can be readily detected by commercialized technology already on our smartphones.

When asked if they could imagine the slow, continuous, and gentle movement used in other phone applications, the evaluation

participants suggested drawing and photo editing apps (4/10), games (3/10), and situations where precision is important (2/10). One participant mentioned musicians and what he called the coupling issue: "If coupling is too straightforward, musicians get pretty tired. Whereas if there is an uncertainty about the coupling from the control part and the expressive things, it actually increases the level of engagement and the explorative issues." [P6] It could indeed be interesting to look into the coupling issue as an interaction quality.

Importantly, we see the real potential of a *Mindful Touch* interaction style in that it suggests a clear intention of people performing the task, which is fundamentally different from the habitual routine style used to do simple operations such as opening an app. Knowing people's clear intention enables interaction designers to simplify interaction tasks, and create uniquely satisfying user experiences, in return for the user's presence of mind. One example could be a mindful tapping on the Music app icon that could play a favorite song best suited for the current context immediately after releasing the finger, as software gets a clear intention and also enough time to process relevant information in real-time to find the most suitable piece. In this way, we can design digital experiences to honor and motivate people to frequently exercise the innate capacity of paying attention at will, which is at core of our happiness and well-being, with tangible and enjoyable benefits to create a positive cycle of forming a mindful usage habit for smartphones.

We see a clear opportunity to integrate the *Mindful Touch* interaction style into system-level gesture definitions, as it works distinctively different from the current interaction paradigm, yet is detectable with existing technologies. This enables the smartphone touch display to accommodate both habitual and mindful interaction styles without intruding on each other, as each style draws upon different and important human skills and capacities. Depending on the tasks, external contexts or inner conditions, people could have the freedom to choose the most appropriate relationship with their smartphones from moment to moment.

7.2 Limitations of This Work

PAUSE¹¹ has been downloaded more than 500,000 times, allowing us to obtain feedback through customer reviews on the iOS and Google Play app stores. In line with the initial results reported in this paper, PAUSE seems to be an effective sleep aid, helping people with insomnia, as well as contribute to relieve stress. However, stress is a serious issue around a complex mental health construct. We need to properly measure if the app is able to reduce stress effectively.

We are currently running a major validation of the PAUSE app where we aim to shed some light on this issue. We will evaluate the impact on mindfulness using a validated mindful questionnaire [14], adopt physiological sensing (i.e., EEG), and run a long-term study to investigate the actual effect of the app on people. We acknowledge the importance of conducting serious evaluations of health apps, and it is beyond the scope of this article to provide a definitive answer on this. In this paper, our main focus has been to provide a detailed account of the design process for PAUSE as means to introduce and discuss the *Mindful Touch* interaction style.

¹⁰ 3D Touch. <http://www.apple.com/iphone-6s/3d-touch/>

¹¹ PAUSE App. <http://www.pauseable.com>

8. CONCLUSION

We introduced *Mindful Touch* as an interaction style that can be achieved practically with existing technology on smartphones. We suggest that *Mindful Touch* interaction can co-exist with the current smartphone interaction style as a complementary style, to form a more balanced, constructive relationship between people and smartphones. We introduced PAUSE as a standalone, dedicated app that enables people to practice mindfulness on smartphones to effectively release stress and focus attention. In our initial evaluation of the app we showed that it has indeed potential, both as stress release and by introducing an innovative new interaction style.

Furthermore, we suggest that *Mindful Touch* interaction style principles may be integrated into the design of existing touch gestures as an opportunity to create new and unique digital experiences. A tangible benefit would be to motivate people to frequently exercise the innate capacity of paying attention at will and forming mindful usage habits. With this paper, we hope to start turning the stereotyping assumption of smartphone interactions on its head, and suggest we as designers and researchers have the power and responsibility to reshape a new and healthier relationship with technology. We would like to openly invite designers and researchers to together explore the potential of the *Mindful Touch* interactive style on smartphones.

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