Breath in Motion:

Breath Awareness

Design Research Study

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CHAPTER 1

Introduction

The rising crescendo of the digital lifestyle has profoundly affected the human capacity for sustained focus. Since 2000, the human attention span has dropped from 12 to 8 seconds—one second below the attention of a goldfish—with decreased long-term focus as users increase digital consumption. This abundantly flowing stream of screen-based content has left users in a curious, yet addictive state, searching for their next technological, dopamine-activating fix (Microsoft Canada, 2015). In 2015, the average American spent 9.9 hours per day on screens—5.2 of those hours on mobile, desktop, and laptop devices (Meeker, 2015). This tsunami of digital stimulus has resulted in an innate response of continuous partial attention, where users are "monitoring everything" but lacking focus (Firat, 2013). As a result, this modality is influencing well-being by promoting higher levels of technologically-induced stress, or *techno-stress* (Stone, 2006). To offset these effects, "unplugging," or disconnecting, is frequently recommended as the solution for restoring balance (ICMPA, 2010). With the ever-increasing, recurring focus on websites and applications, it appears that users are not getting off their devices anytime soon. In the endeavor to meet users where they are, the question then arises, how might techno-experiences be adapted or reconfigured to counterbalance any detrimental effects?

A related theory from the area of ontological design suggests that the tools our society designs, also design society (Willis, 2006). Essentially, the digital spaces that were imagined and fabricated by designers are shaping humanity in return. This realization beckons designers not just to consider the short-term success of their work, but also speculate how screen-based experiences might forge different behaviors, habits, or mindsets in the long-term. As creators of

experience, designers explore the relationship between digital spaces and users to recognize the factors that affect the well-being of the user. With the constant presence of technology, people are searching for solutions to minimize, filter, or turn off the abundance of messages (Microsoft Canada, 2015). It is essential for designers to understand user experience in today's world and to formulate solutions that re-examine the person/device relationship. The ever-increasing focus on websites and applications beckons designers to examine how visual spaces might be orchestrated to facilitate mindful awareness for the purpose of enhancing one's quality of attention. With the human attention span waning as a result of the way people interact with technology, how might designers improve these tools for the purpose of subsequently improving the human capacity for sustained focus?

One answer to this question may be discovered in the field of mindfulness, where a growing body of scientific evidence is recognizing the benefits of focusing one's awareness in an intentional manner. The goal of mindfulness is not solely relaxation, but rather shifting one's focus from external stressors to internal sensations—from an active, thinking mind to a state of relaxed alertness (Vidyarthi, Riecke, & Gromala, 2012, p.3). Research suggests that practicing mindfulness has the potential to reduce stress, increase productivity, and improve overall well-being (Langer, 2014; Hölzel et al., 2011b; Shapiro et al., 2006). Many designers are beginning to notice these benefits and are creating tools to facilitate these mindful moments. *Mindfulness-based design*, or *mindful design*, focuses on creating opportunities for users to become more attentive to their present state of awareness. The term mindful design has been used both in the field of design education (Rojas et al., 2015) as well to understand design's imprint on society (Akama & Light, 2015; Niedderer, 2007, 2013, 2014). The locus of mindful design is not centered on

controlling behavior, but on the conscious awareness it cultivates. The consciousness generated by the product or system moves beyond its direct function or use (Niedderer, 2013). While some of these technologies specifically seek to teach meditation techniques, others concentrate on creating opportunities to lift the overall thoughtfulness and well-being of the individual. Developments in this area include a breadth of mobile/desktop applications, wearables, and virtual reality devices.

Research Questions

The initial research question emerged in response to the technological overwhelm and digital distraction many are experiencing: "How can visual design be used for the benefit of creating a more conscious culture?" In the effort to design a tool that would facilitate mindful awareness for the user, the insight emerged that many individuals have a challenging time being aware solely for the sake of being aware. Despite its countless benefits, for some, mindfulness may seem foreign, confounding, and impossible. Having an element to focus upon as a guide is the idea behind the mantra used in meditation. When reciting mantras, meditators will concentrate on the repetition of the word or phrase as a strategy to maintain presence. While the primary goal of this research was not to teach users how to meditate, the review of mindfulness meditation practices helped to clarify that providing individuals with a focal point—be it a visual, sound, object, idea, or bodily sensation—would be a significant aspect of the design. Narrowing the focus to the field of interactive design, the questions developed to include, "how can visuals cultivate presence to reduce feelings of overwhelm, integrate calming effects, and minimize digital stressors?" Also, "if the brain can be trained to be more mindful, how are various visual designs influencing one's quality of attention?" Yet, the question remained, "*How* will the visuals guide the user toward mindful awareness?" and "What content will the interface

be making the users aware *of*?"

The Opportunity

The "content" of this mindful design study surfaced with the recognition of a health implication that many experience while working on screens—a phenomenon called "screen apnea," also referred to as "email apnea." The term was coined by Linda Stone (2008), technology consultant, to describe the experience of shallow breathing or breath holding while doing email, working, or playing in front of a screen. According to Stone, 80% of people do not breathe properly while using screen-based devices and the implications are increased stress levels, as well as diminished emotional well-being and attitude. Since breathing is an automatic function of the body, diminished breathing is an area that many can fail to recognize and easily overlook. For those that work on screens for extended periods of time, such as computer-related workers, there is an even greater cause for concern. Evidence suggests there are elevated levels of tension, as well as hyperventilation, in long-term screen users (Hjortskov et al., 2004; Morajevi et al., 2011; Schliefer and Ley, 1994; Schleifer et al., 2008). One solution to screen apnea is choosing to pay attention to the breath, which happens to correspond with many mindfulness practices.

Breathing is one of the only "vital functions" of the body that can be controlled both involuntarily and voluntarily (Ley, 1999). Attention to the breath is a common focal point of many mindfulness meditations, and the experiential effects have long been studied in this area (Adhana et al., 2013; Brown & Gerbarg, 2009; Chandra, 1994). By being intentional with the breath, one can move into a space of mindfulness. Breath awareness activates the mindfulness mechanisms of attention and body awareness, which shifts the focus to an internal experience or sensation (Hölzel et al., 2011b). Focus on the breath has also been recognized as a method

for reducing stress and anxiety, and improving well-being (Brown & Ryan, 2003; Hölzel et al., 2011a).

The need for a tool to minimize the effects of computer-related stress or screen apnea through breathing awareness has been recognized by designers. Existing breathing-related technologies include mobile and desktop software, websites, games, pacers, belts with sensors, breath counting tools, and other wearables. Visuals across these devices vary and include circles, waves, human representation, geometric forms, and nature-based imagery—some seemingly more successful than others. With so many differences, yet some similarities, there emerged a need to understand the digital mindful experience for the purpose of developing a visual language for mindful digital experiences. From the perspectives of visual and motion design, the question surfaced, "How might rhythmic visualizations be more mindfully designed to facilitate breath awareness for the purpose of increasing mindfulness in the context of desktop computers?"

Research Goals

The primary research goal is to understand the relationship between the visual components of rhythmic visualizations—direction, hue, brightness, temperature, saturation, contrast, and imagery—and the factors that affect mindfulness through breath awareness for long-term desktop users. Initial assumptions considered the need for novelty in the age of digital distraction. Brighter focal points, dynamic imagery, and complex customization were visual components that were thought to embody this potential need. Iterative rounds of prototyping, questionnaires, and surveys were utilized to understand the experience from the user's perspective.

The extended goals are to integrate the findings into the development of a web-based tool—potentially a browser extension—to meet users where they are, enhance mindfulness

through breathing awareness, and minimize digital stressors. The final phase of this research asks participants to test the prototype multiple times over the course of extended desktop screen time to test research findings on visual language in mindful digital experiences, as well as speculate how the visualization might exist within the context of a user's daily life.

CHAPTER 2

Review of Related Literature

The foundation for this study is rooted in research and theories in the areas of technostress and screen apnea, attention, mindfulness, mindful technologies, breathing, and visual communication design. The goal is to understand the relationship between the visual components of rhythmic visualizations—movement, hue, brightness, temperature, saturation, contrast, and imagery—and the factors that affect mindfulness through breath awareness for long-term desktop users. This section will introduce existing ideas and findings, as they pertain to the current research, for the purpose of clarifying the relevance and unique contribution of this study. With an abundance of studies in the mentioned disciplined, it is important to make it clear that the depth of the explanation will be focused on how it connects to this study. For instance, there are a large number of studies on breathing. Since the focus here is on visual design facilitated breath awareness to improve overall mindfulness, all studies on this topic will not be described in detail and will be mentioned when appropriate. This section will review the influence of screens, mindfulness, mindful design, breath awareness and technology, motion design and presence, and metrics for evaluation.

The Influence of Screens

People are choosing to spend copious amounts of time using screen-based devices, and subsequently, this digital relationship is transforming how they perceive the world around them. Tools that were designed by humanity are now designing humanity in return (Willis, 2006). In 2015, the average American spent 9.9 hours per day on screens—5.2 of those hours on mobile, desktop, and laptop devices (Meeker, 2015). This abundantly flowing stream of screen-based

content has left users in a curious, yet addictive state, searching for their next technological, dopamine-activating fix (Microsoft Canada, 2015). The constant, *always connected* presence of technology presents an abundance of distraction opportunities including emails, messaging, notifications, continuous content scrolling, and the rabbit hole of hyperlinks and tab switching. Effects of this ubiquitous computing lifestyle include technostress, continuous partial attention, diminished sustained attention, and screen apnea.

Technostress. The blurring line between human life and technology is having an impact on well-being by promoting higher levels of technologically-induced stress, or *technostress* (Stone, 2006). The term was coined in 1984 by Craig Brod to describe "a modern disease of adaptation caused by an inability to cope with modern technologies in a healthy manner" (Brod, 1984). Technostress can manifest in many ways including the over-identification with technology, monitor fatigue, work overload, information overload, invasion of privacy, simultaneous use of multiple interfaces, lack of breaks, usability concerns, lack of training, pressure to keep up with changing technology, and frequent interruptions (Ayyagari, Grover, & Purvis, 2011; Brod, 1984). Ayyagari, Grover, & Purvis (2011) found that work overload and role ambiguity—or "the unpredictability of the consequences of one's role performance and lack of information needed to perform the role"—are the two greatest stressors and intrusiveness as the largest predictor of stress. Intrusiveness can include notifications or reminders that interrupt the user while they are focused elsewhere. In the workplace, technostress can result in lowered job satisfaction, productivity, workplace commitment, and health implications (Ayyagari, Grover, & Purvis, 2011; Ragu-Nathan et al., 2008; Riedl et al., 2012; Tarafdar et al., 2007). Prolonged stress in any form, including technostress, can have a detrimental impact on health including chronic hypertension,

depression, atherosclerosis (hardening of the arteries), sleep loss, burnout, abdominal obesity, diminish immune system functioning, and potentially the onset of other severe diseases (De Kloet et al., 2005; Riedl et al., 2012; McEwen, 2006). Though health implications attributed uniquely to technostress are dependent on the source of the stress, some examples may include eye strain, back/neck pain, increased heart rates, headaches, cognitive overload, fatigue, and diminished breathing quality (Stone, 2008; Microsoft, 2013; Tiwari, Singh, & Singh, 2008; Owolabi, Aregbesola, & Oyesola, 2015).

While not everyone will experience technostress triggers or symptoms, for those that work on screens for extended periods of time, the effects may be more noticeable. Meeker (2015) states that 2.4 of the 9.9 hours per day of screen time are spent specifically on desktop or laptop devices. It is likely that the average office/computer worker spends more time than that. Evidence suggests there are elevated levels of tension, as well as hyperventilation, in long-term screen users (Hjortskov et al., 2004; Morajevi et al., 2011; Schliefer and Ley, 1994; Schleifer et al., 2008). Schliefer and Ley (1994) found that performing data entry increased the breathing rate by 26% and elevated self-ratings of tension. While stressful circumstances, such as working environments, can increase one's breathing rate, it is also important to note that changes in breathing affect both thoughts and feelings. Respiration can be used to induce relaxation, as well as signal moments of higher stress (Ley, 1999; Schliefer and Ley, 1994).

Screen Apnea. A health implication that many experience while working on screens is a phenomenon called "screen apnea," also referred to as "email apnea." Coined by technology consultant Linda Stone (2008), the term describes the experience of shallow breathing or breathing holding while completing email, working, or playing in front of a screen. According to

Stone, 80% of people do not breathe properly while using screen-based devices. The implications are increased stress levels, as well as diminished emotional well-being and attitude. Changing or holding one's breathing pattern activates the "fight-or-flight" response of the sympathetic nervous system and does affect cognition and emotion (Stone, 2008; Ley, 1999). Due to the fact that breathing is an automatic function of the body, diminished breathing is an area that many fail to recognize and easily overlook. One solution to screen apnea is choosing to focus one's attention on the breath (Stone, 2008).

Quality of Attention. As Rheingold (2012) states, "It is not possible to explain the cognitive underpinnings of attention in a simple way without oversimplifying." For the purpose of this research, the goal is not to explain attention in entirety, but rather to convey fundamental ideas as they pertain to the research goals of screen-based technology and mindful awareness. Attention is defined as the "allocation of mental resources to visual or conceptual objects" (Microsoft Canada, 2015). Choosing to focus on anything requires an intention of attention. Humans receive approximately eleven million bits of sensory information per second subconsciously, yet individuals are only consciously aware of about forty of them (Wilson, 2002). It is possible to choose what to focus on, as the attentional pathways are not passive, but rather actively controlled by the conscious mind. Rheingold (2012) states that setting an intention or purposeful goal to focus upon something utilizes the executive functions of the brain. In essence, intention fuels attention.

The amount of time our attention centers on one thing has diminished significantly. Since 2000, the human attention span has dropped from 12 to 8 seconds—one second below the

attention of a goldfish—with decreased long-term focus as users increase digital consumption (Microsoft Canada, 2015). Microsoft (2015) recognizes three different types of attention: sustained, selective, and alternating. *Sustained focus* is "the ability to remain focused on a single task." *Selective focus* is our capacity to avoid distraction. *Alternating attention* is "efficiently switching between tasks." This state is also commonly referred to as multi-tasking. *Sustained focus* is the kind of attention that has significantly diminished. This type of focus is also correlated with the amount of media an individual consumes, their use of social media, multi-screening habits, and the "adoption of technology" (Microsoft Canada, 2015). As digital consumption increases, long-term focus decreases.

Stone (2009) discusses another kind of attention called continuous partial attention that "is referred to as complex multi-tasking in cognitive sciences." This state is a type of awareness where individuals are "monitoring everything" but lacking focus (Firat, 2013). Stone (2009) states that multitasking occurs from a space of productivity and getting things done, while continuous partial attention is motivated by the fear of missing out—or "FOMO" as it is referenced in today's culture. Attention is on full throttle as the individual quickly switches between tasks, or what Microsoft (2015) refers to as *alternating attention*. The person is in an "always on" space of scanning the fight-or-flight response of the body to activate releasing stress hormones into the system (Small & Vorgan, 2008; Stone, 2009). The term *media multitasking* has been used to refer to the tendency to stay connected to numerous streams of content at the same time (Rideout, Foehr, & Roberts, 2010). In *The Shallows: What the Internet is Doing to Our Brains*, Carr (2011) discusses a seemingly related behavior of screen-based reading. Carr describes a shallower mode of continuous scanning with less time being spent on "in-depth reading" and focused

concentration (pp. 137–138). When humans quickly scan or skim content, they are attempting to locate important details amongst a sea of information quickly.

While sporadic instances of continuous partial attention, media multitasking, or screen-based reading may seem harmless, research suggests a negative correlation with the cognitive functioning of the brain—attention included (Ziegler, Mishra, & Gazzaley, 2015). Individuals that engage in higher levels of media multitasking have diminished ability at task-switching, also referred to as alternating attention. These people were less successful in filtering out distraction regardless of the input's level of relevance to their life (Microsoft Canada, 2015; Ophir, Nass, & Wagner, 2009; Ziegler, Mishra, & Gazzaley, 2015). Media multitaskers were also found to have more difficulty focusing when asked to do so (Cain & Mitroff, 2011). Disruptions, such as digital notifications, can also have a greater cost than most realize. Any time attention is shifted, Rheingold (2012) infers that "there is always a short interval during which [one] must orient, refocus, and filter out competing information"—called the *attentional blink*. When individuals are distracted, it can sometimes take up to a half hour to refocus on another task (p. 39). Many of these distractions, though at times novel, may divert people from their goals (Ziegler, Mishra, & Gazzaley, 2015). It is important to note that all distractions are not inherently negative. Ulrich (1991) coined the phrase *positive distraction* describing an "environmental-social condition" with the ability to captivates one's attention to elevate one's mood and alleviate stress. Examples include comedic content, smiling happy faces, music, animal companions, and nature scenes. In a society where media multitasking and digital distraction abound, users might more easily fall into mindless habits, such as endlessly scrolling Facebook instead of more personally beneficial choices.

Mindlessness. Before discussing literature in the area in mindfulness, it is helpful to understand mindlessness and how this state of being has permeated the culture. Mindlessness, also known as "auto-pilot" mode, refers to an inactive mindset that calls upon past experiences to respond to present situations (Langer, 2014, p. 11). From this space, a person is not fully interacting within the current moment, but rather living in the mental space of past experiences, schemas or overlearned behaviors. Considering all of the choices a person makes in the span of one day, it is natural that some choices are repetitive. When one is unaware of the subtle changes, or incoming distractions happening around them, they assume a passive mindset and lose the ability to choose to respond in a different manner (Langer, 2014, p. 9). Ellen Langer, Harvard psychology professor, put it best when she stated, "We're unaware of when we're mindless…when we're not there, we're not there to know we're not there" (Langer, 2013).

Mental constructs that support a low thought mindset include shortcuts, inferences, schemas, rules of thumb, and heuristics (Luttrell et al., 2014, p. 258). These rules or routines govern, rather than guide, the thinking process and are dominant factors in the decision-making process. One example of a mental script is a schema. Schemas are mental concepts that inform an individual on what to expect and how to respond within any given context (Mandler, 1984). When one encounters a new situation, they might call upon best practices to use without giving it too much thought. In the field of design, some designers prefer to use the same typefaces for all of their work. While this choice is not to be dismissed, as golden rules are useful for their heightened success rate, the drawback occurs when one abandons contextual awareness and relies too heavily on what has worked in the past. When individuals are too certain, there is a lack of understanding that can limit one's ability to make different, and perhaps better, choices. Repetitive actions

inhibit potential opportunities for innovative solutions. Langer (2014) points out "when we think we know, there is no reason to find out" (pp. 8–12).

Mindfulness

Contrary to the inactive state of mindlessness, mindfulness is an active mindset that focuses on present moment immersion (Langer, 2014). A substantial body of scientific evidence recognizes the potential that mindfulness has to reduce stress (Vesa et al., 2016; Tang et al., 2007), improve self-regulation (Brown & Ryan, 2003; Tang et al., 2007), manage pain (Bakhshani et al., 2015; Cherkin et al., 2016; Grossman et al., 2007), improve psychological well-being (Brown & Ryan, 2003; Malinowki & Lim, 2015; Mitchell & Heads, 2015; Tang et al., 2007), and improve the quality of human attention (Moore et al., 2012; Semple, 2010; Tang et al., 2007). Research in the area of neuroscience has shown that the brain has plasticity and is malleable to change (Falk, 2014). A mindfulness practice has been demonstrated to increase gray matter in the brain which is linked to emotional and physiological functions—while stress produces the opposite effect (Hölzel et al., 2011). Like any muscle, the brain can also be trained to be more conscious.

Origin. Mindfulness is commonly associated with Eastern ways of thinking, although the act of being mindful is secular in nature and transcends belief (ICMPA, 2010). The term originated from the language of Buddhist psychology. The meaning is derived from two words, Sati that means "awareness," and "Samprajanya" that means "clear comprehension." Mindfulness refers to having a clear awareness of what is happening. The term is commonly associated with Eastern ways of thinking, although the origins of mindful practices—including meditation and prayer—have its roots in nearly all religions including Hinduism, Judaism, Christianity, Buddhism, and Sufism (Grecucci et al., 2014).

Components. In understanding the experience of mindfulness, Shapiro and colleagues (2006) have identified three core, overlapping components: (1) intention—"why one is practicing," (2) attention, and (3) attitude—how one attends the experience. In understanding attitude, John Kabatt-Zinn (1990), creator of the Stress Reduction Clinic at the University of Massachusetts Medical School, is a leading expert on the topic of mindfulness and has outlined a list of attitudes to live a more conscious life. These habits include (1) nonjudging; (2) patience; (3) beginner's mind; (4) trust; (5) not striving; (6) accepting; and (7) letting go (Grecucci et al., 2014, p. 2; Kabatt-Zinn, 1990). All of these dispositions seek to bring a person fully into the moment. When one releases preconceived notions, judgments, grudges, and expectations, they can see more completely. The goal of mindfulness is not solely relaxation, but rather shifting one's focus from external stressors to internal sensations—from an active, thinking mind to a state of relaxed alertness (Vidyarthi, Riecke, & Gromala, 2012, p.3).

Mechanisms. To achieve a state of relaxed alertness, Hölzel et al. (2011b) identified the different mechanisms by which mindfulness meditation is successful: attention regulation, body awareness, emotion regulation, and change in perspective of the self. With attention regulation, the goal is to keep awareness focused on a central object—i.e., a mantra, breathing, or sound. When the brain drifts off, as it tends to do, the person is to return their focus to the object (Hölzel et al., 2013). This practice can improve the capacity for sustained attention (Semple, 2010). Body awareness pertains to noticing "subtle body sensations" and can include "sensory experiences" of bodily sensations or emotions. Emotion regulation refers to an open, nonjudgmental reaction to emotions as they arise. Changing perspective of the self involves shifting into a greater perspective of the notion of "I" (Hölzel et al., 2013).

Mindful Design

In response to the mindlessness that permeates society, many designers are beginning to notice the benefits of mindfulness and are creating tools to facilitate mindful moments. In positing how design can be used for the benefit of promoting a more conscious culture, *mindfulness-based design*, or *mindful design*, focuses on creating opportunities for users to become more attentive to their present state of awareness. Unlike design that uses low-thought persuasion to achieve a particular goal (i.e., purchase bottled water), mindful design prompts viewers to think about the significance of their actions—and perhaps move their choices toward what is important to them. The locus of mindful design is not centered on controlling behavior, but on the conscious awareness it cultivates. Aguilera (2014) states that "for a synthetic immersive experience to be most effective, the ideal state of the person experiencing it is that of mindful attention." The consciousness generated by the product or system moves beyond its direct function or use (Niedderer, 2013).

Research in the area of mindfulness and design has gained more attention in recent years. The term "mindful design" has been used both in the field of design education (Rojas et al., 2015), as well to the relationship between design and the awareness level of the individual in society (Akama & Light, 2015; Niedderer, 2007, 2013, 2014). Research in the area merges the disciplines of visual communication design, user experience design (UXD), neuroscience, philosophy, positive psychology, ontological design, cyber-psychology, slow technology, calm technologies, positive computing/technology, contemplative computing, and human-computer interaction (HCI). Many of these areas have sought to understand the relationship between consciousness and device.

Kristina Niedderer (2013, 2014) describes mindful design as a two-part experience that

both disrupts the expectations of the user and directs their awareness toward what requires attention. Through the addition or removal of an expected element, the experience promotes mindful awareness. An example of a company that is creating mindful packaging for water is Boxed Water. Through the use of a strong message on an unexpected packaging, people stop to consider how the choices they make impact the environment. The design challenges the buyer expectation regarding plastic packaging. The changing of this expectation causes them to pause and possibly reconsider their decisions. The company is not just using mindless persuasion to sell water for the sake of profits; they are encouraging global awareness to reduce the use of plastic. The decision to purchase then becomes an ethical choice regarding how one's purchasing decisions impact the world around them. Whenever an external tool is created for the purpose of stimulating mindfulness, this is what is referred to as mindful design (Niedderer, 2013).

One of the main differences between mindless and mindful persuasion is the former seeks behavior change while the latter aspires for attitude change. When the goal is behavior, persuasive influences may be used to coerce people to act in a desirable manner. In these circumstances, the drive is external. Attitudinal shift still occurs, but it is not the primary goal, and the results are more temporary in nature.

When the goal is impacting attitude, the focus is on higher levels of thinking and voluntary participation of the individual. The drive is internal and transcends the ethical concerns surrounding design for behavior change. Awareness, rather than a particular action, is the primary function (Niedderer, 2013, pp. 4565–4567). An example of mindful design that intervenes an expectation is the design of a traffic junction in the Netherlands. To reduce the high number of accidents, the government put up signs and traffic lights. It was only when

they removed the directional elements that the number of accidents decreased. By shifting from automatic, mindless method, they inadvertently heightened the awareness of the drivers (Tromp, Hekkert, & Verbeck, 2011). The movement toward a mindful form of design seeks to draw attention to this pervasive, unaware state by alerting people to what is happening both in and around them. This modality encourages conscious decision making by shifting the locus of control back to the individual.

Mindful Technologies. In recent years, technological developments in the sphere of mindful design have grown exponentially to include a breadth of mobile/desktop applications, wearables, and virtual reality devices. While some of these tools specifically seek to teach meditation techniques, others create opportunities to lift the overall thoughtfulness and well-being of the individual. Related technological fields include calm technology (Vidyarthi, Riecke, & Gromala, 2012; Wongsuphasawat, Gamburg, & Morajevi et al., 2012), slow technology (Hallnäs & Redström, 2001), positive computing (Calvo & Peters, 2014; Riva et al., 2012), and contemplative computing (Hansen, 2005; Pang, 2011). Devices are designed with different goals entirely, such as "relaxation, focus, awareness, a sense of calm, and self-exploration" (Vidyarthi, Riecke, & Gromala, 2012, p.3). While some of these areas focus specifically on slowing down, reflection, self-awareness, empathy, compassion, and emotional well-being, the area of mindful design focuses specifically on the relationship between design and the mindful awareness of the individual.

A study by Buie and Blythe (2013) found that there are approximately 6,000 applications created under the umbrella term of spiritual or religious activities—mindfulness being included in this category. In 2015, Mani and colleagues categorized 606 apps as mindfulness-related content.

Through the creation of training apps, the premise is that individuals can be trained to learn mindfulness as a tool to reduce stress, increase productivity, and promote focus (Akama & Light, 2015). While some of these technologies specifically seek to teach meditation techniques, others concentrate on creating opportunities to lift the overall thoughtfulness and well-being of the individual. A few examples include Headspace, Happify, and The Mindfulness App. Headspace (Figure 1) is a popular meditation application that asks the user to think of the app as a "gym membership for their mind." The company website provides users with the science behind their methods and states that by practicing as little as 10 minutes per day, users can see improved health and happiness in their life (headspace.com). Mani et al. (2015) rated Headspace the highest using the MARs scale of engagement, functionality, aesthetics, information, satisfaction, and an overall score. Another example of mindful technology is the app company, Happy Tapper. Carla White, a designer for NASA and the founder of this business, focuses on using mobile technology to improve lives. Happy Tapper's apps include Gratitude Journal, Vision Board, and Little Buddha. White states, "it is not our reality that shapes us, but the lens in which we view the world that shapes our reality… if we can change that lens, we can change our world and [improve our creativity and innovation levels] (White, 2014)." The goal of Happy Tapper's apps is to improve how people are looking at the world around them, essentially making them more thoughtful individuals.

While there is value to these tools, Akama and Light (2015) point out that the mere endeavor to approach mindfulness as another goal to achieve can result in the opposite effect (p. 627). Trying to be mindful goes against its very foundation. Mindfulness is less about an action, or behavior, and more about a state of mind, or attitude. In their research, Akama and Light were

hesitant to provide users with instructions on how to be more thoughtful, but rather explored how design can create moments to bring about heightened awareness. They focused on the creation of portals or routes that could be opened to allow thoughtfulness to arise. Akama and Light state, "technology alone cannot make us mindful, but it can potentially help to trigger, shift, remind or invite us towards fostering practices of mindfulness." (2015, pp. 631–632). Apps are not immediate fixes like pills we can take to make everything better. If one is incredibly stressed out, simply downloading a mindfulness app will not automatically transform them into a peaceful, Zen master—but it could create a moment that an individual can choose to step into.

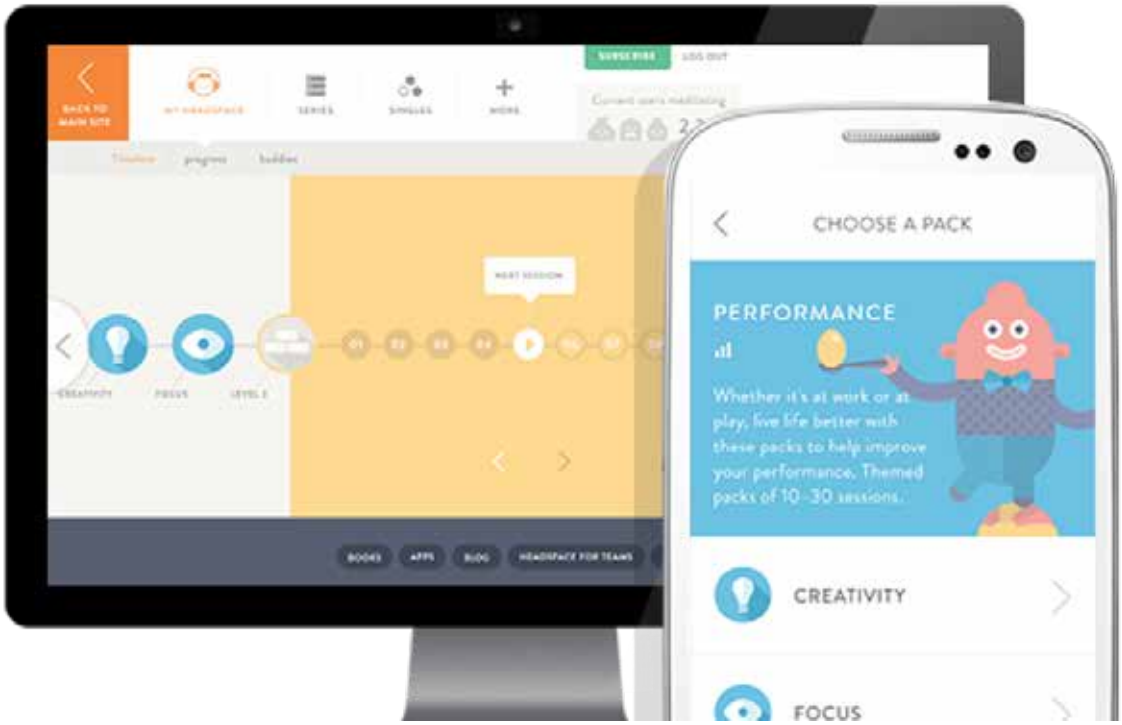

Figure 1. The Interface of the Headspace Progress Tracker. Users can select the skill they want their meditation to improve. Retrieved from http://www.headspace.com.

Technology plays an ever-increasing role in how people live their lives. Pang (2011) suggests that contemplative practices are "portable" and "can be used in virtually any situation, including

situations in which we are using—or immersed in—digital media." The onset of mindful design is a natural response to the rise of technostress, media multitasking, and continuous partial attention. Technology is commonly associated as a source of stress—largely due to its productive, task-based functionality. However, stress is not necessarily an inherent attribute of the tools. This recognition presents an opportunity for mindful designs to assist users to become more attentive to what they are experiencing. While technology has brought an abundance of comforts and amenities to today's society, in some ways, it has also engendered a mindless culture. As the molders of experience, designers have the capability to impact how people experience the world.

Presence. The practice of mindfulness, or complete awareness of what is, is closely connected to the technological concept of *presence*, or sense of being in the here and now when interacting with virtual environments. Riva et al. (2012, p. 209) describes presence as "the intuitive impression of being where I'm using a proximal tool, for example the keyboard." Slater and Wilbur (1997) propose this as a "through the looking glass" experience where the barrier between person and device disappears. The separation between self and external experience can essentially dissolve into one another. A tool facilitates presence when it brings the user into the moment they currently find themselves in. Pure presence allows complete, unmediated action in alignment with the self (Riva et al., 2011). Virtual simulations that integrate motion, including virtual reality (VR) and augmented reality (AR), have aspired for presence as it has been thought to drastically improve the user experience. Though much of the research on presence centers around VR and AR, the connection between presence, mindfulness, and motion can be seen across numerous technologies ranging from mobile and desktop software, wearables, as well as VR devices. These developments range on a spectrum consisting of tool-mediated devices to

total immersion—from the graphics of the mobile application to the reality-based visuals found in virtual reality. Initially, there may appear to be a difference between presence and mindfulness, as the former deals with the external and the latter with the internal. However, the connection between the two is that one's experience is always happening in their perception of space.

Immersion and *embodiment* are two corresponding ideas frequently mentioned within the literature on presence. When utilizing media, immersion refers to an enveloped experience in which the media becomes the central focus of the user's experience (Vidyarthi, Riecke, & Gromala, 2012). Immersion refers to a level of integration with a tool where the outside world disappears. In VR, one's visual senses are encapsulated as the physical world is obstructed from view. Headset wearables or large screens that envelope the viewer are typically used for these purposes. Higher levels of immersion tend to produce higher levels of presence (Kosunen et al., 2016). While immersion describes an objective quality or characteristic of a digital system, presence describes a subjective "state of consciousness" (Slater & Wilbur, 1997, p.4).

Another related term that arises in the research is embodiment or the sensation of being inside of a body. As all experiences are "mediated through the body," awareness of the body can anchor an individual into the presently occurring reality. To increase one's level of mindfulness while engaging with an interactive environment, the solution must be rooted in one's relationship to their body (Aguilera, 2014, pp. 2–6). Embodiment focuses on improving interactions through the practice of mindfulness. All of the information humans absorb from the external world comes through the senses. As a result, sensory information is one of the most important factors in the cultivation of mindfulness. Tools that promote increased sensory inputs promote mindfulness while those limited in this area encourage disconnect (Witmer and Singer, 1998). From a

technological standpoint, the three primary senses include visual, auditory, and haptic. With breathing technologies, sensory engagement allows the users to follow along and synchronize one's respiratory rate to one or more external stimuli. Entrainment, or the ability to synchronize to an external rhythm, can be used to align one's respiratory rate to an external stimulus. Entrainment has been studied in the area of visual, haptic, and audio technologies (Clayton, Sager, & Will, 2005; Pirhonon et al., 2011). The breath can be aligned to visual animations (Pirhonon et al., 2011; Wongsuphasawat, Gamburg, & Morajevi, 2012), ambient lighting rhythms (Brandt, 2011; Rambaudi et al., 2007), or sounds—such as a musical rhythm that relates to one's breathing pattern (Schein et al., 2001; Pirhonon et al., 2011).

Despite the fact immersion improves presence, it is not always feasible to create a panoramic experience. With many individuals working on screen-based computers and mobile devices, there still exists a need to meet users where they are. VR technologies tend to disconnect people from their current, waking life. Is it necessary to block everything from view or is there a way to promote presence by meeting the users where they are? One answer might be found in the world of augmented reality (AR), in which users commonly rely on the use of mobile devices. Kim (2013) proposed that immersion in these less submerged platforms may be more focused on the context over the display visuals—though they undoubtedly still play a role. With this idea of "context immersion," users can become "aware of real context through [an] embodied interaction and constructive relationships in mobile AR." In this framework, the focus becomes the context of user's "mobility, relationship, and... interaction in a mobile AR environment" (Kim, 2013, p. 81). The immersion, in this case, takes place in the relationship between the device and reality. The use of a GPS or object recognition in the AR becomes a very real experience that dissolves

the barrier between virtual and actual experience. However, rather than VR technologies that disconnect the individual from real-life experience, the user still has the ability to oscillate between the two. Regarding this concept, one of the keys to nurturing presence in screen-based technologies is creating an experience that overlays or supports what is occurring in everyday life.

Breath Awareness

The opportunity for the "content" of this mindful design study surfaced with the recognition of the phenomenon described by Linda Stone (2008) called "screen apnea," also referred to as "email apnea." Stone (2008) has proposed that a solution to screen apnea is to focus one's attention on the breath—a common focal point of many mindfulness meditations (Adhana et al., 2013; Brown & Gerbarg, 2009; Buboltz et al., 2002; Chandra, 1994). By being intentional with the breath, one can move into a space of mindfulness through the mechanisms of attention and body awareness (Hölzel et al., 2013b). In the endeavor to develop a tool to minimize the effects of computer-related stress or screen apnea, this section will review literature on breathing as it relates to this study. The intention here is not to exhaustively review the substantial literature on breathing, but to focus on the following areas: the relevance of breath awareness as a solution to technostress and screen apnea, breath awareness and mindfulness, the benefits of breath awareness, breathing practices, and a review of related breathing technologies.

Breathing and Technostress. When one is experiencing screen apnea, or conditions related to technostress, the breath can become affected. According to Stone, 80% of experience a condition of shallow breathing or breathing while doing email, working, or playing in front of a screen. Changing or holding one's breathing pattern activates the "fight-or-flight" response of the sympathetic nervous system and does affect "emotion and cognition" (Stone, 2008;

Ley, 1999). The implications of screen apnea are increased stress levels, as well as diminished emotional well-being and attitude (Stone, 2008; Ley, 1999). For those that work on screens for longer periods of time, evidence suggests there are elevated levels of tension and hyperventilation, or "breathing a volume of air that exceeds metabolic demand for [oxygen]" (Hjortskov et al., 2004; Ley, 1999; Morajevi et al., 2011; Schliefer and Ley, 1994; Schleifer et al., 2008). Schliefer and Ley (1994) found that performing data entry increased the breathing rate by 26%, as well as elevated self-ratings of tension. Based on the fact that breathing is an automatic function of the body, diminished breathing is an area that can be easily overlooked—despite any negative health implications. While stressful circumstances, such as working environments, can increase one's breathing rate, it is also important to note that changes in breathing affect both thoughts and feelings. Respiration can be used to induce relaxation, as well as signal moments of higher stress (Ley, 1994, 1999; Schliefer and Ley, 1994). Breathing is one of the only "vital functions" of the body that can be controlled both involuntarily and voluntarily (Ley, 1999).

Breath Awareness and Mindfulness. Attention to the breath is a common focal point of many mindfulness meditations, and the experiential effects have long been studied in this area (Adhana et al., 2013; Brown & Gerbarg, 2009; Chandra, 1994). For most individuals, breathing is a mostly unconscious process that can be made more conscious. Breath awareness activates the mindfulness mechanisms of attention and body awareness, which shifts the focus to an internal experience or sensation. Body awareness pertains to noticing "subtle body sensations" and can include "sensory experiences" of bodily sensations or emotions (Hölzel et al., 2013b). Breath awareness activates the mindfulness mechanisms of attention and body awareness, which shifts the focus to an internal experience or sensation (Hölzel et al., 2011b). Research by Levinson and

colleagues (2014) demonstrates that breath awareness can be used to assess one's mindfulness. With attention regulation, the goal is to keep awareness focused on a central object—i.e., a mantra, breathing, or sound. When the brain drifts off, as it tends to do, the person is to return their focus to the object (Hölzel et al., 2013). Levinson et al. (2014) utilized breathing counting as a method to direct and measure the level of awareness.

The Benefits of Breath Awareness. The practice of breathing exercises has been recognized as a method for reducing stress and anxiety (Adhana et al., 2013; Buboltz et al., 2002; Brown & Gerbarg, 2005; Clark & Hirschmann, 1990), lowering hypertension (Adhana et al., 2013; Elliot, 2006; Grossman et al., 2001; Matayan, Singh, & Jain, 2009; Mourya et al., 2009; Schein et al., 2001), enhancing attention (Moore et al., 2012), lowering heart rate (Matayan, Singh, & Jain, 2009), and improving emotional regulation (Arch & Craske, 2006; Brown & Ryan, 2003). While some individuals use pharmaceuticals, or drug therapy, as their primary remedy to manage stress, breathing exercises are gaining attention due to their health benefits and lack of side effects. While it is commonly understood that one's emotional state affects breathing, it has also been found that breathing affects one's emotional state (Ley, 1994). The regular practice of breathing practices has been considered to "[calm] the nerves" by enhancing parasympathetic tone and minimize sympathetic response (Matayan, Singh, & Jain, 2009). Regulating one's breathing activates the "rest-and-digest" response of the parasympathetic nervous system (PNS), relaxing the body, improving cardiovascular and respiratory functions, improving mental/physical health, and reducing stress (Adhana et al., 2013; Brown & Gerbarg, 2009; Morajevi et al., 2011). The pattern of one's breathing can point to one's physiological state (Ley, 1999). Matayan and colleagues (2009) state that "by voluntarily changing the rate, depth, and pattern of breathing, the messages

being sent from the body's respiratory system to the brain can be changed." By regulating the autonomic nervous system, mental processes are positively affected. By calming the nerves, one is subsequently able to calm their mind and body (Matayan, Singh, & Jain, 2009).

The Breath. "To breathe is to live, and without breath there is no life" (Ramacharaka, 1903). Despite it being one of the most important functions of the body, it is believed that few people breathe correctly. For those experiencing technostress, or screen apnea as described by Stone (2008), the breath can be restricted to the upper chest rather than in the diaphragm. This shallower form of breathing can limit the intake of oxygen and exhalation of carbon dioxide (Barrett et al., 2016; Buboltz et al., 2002). Breathe rate is calculated by the number of inhalations per minute which is accepted medically as respiratory rate. Depending on the source, the standard human resting respiratory rate varies between 12–20 (Morajevi et al., 2011). Barrett et al. (2016) report a slightly lower respiratory rate between 12-15 (Barrett et al., 2016). Similar to the heart rate, the breathing rate is constantly changing, even in a resting state, due to internal and external stimuli. It is affected by "arousal, talking, posture, [and] personal health" (Ley, 1999; Morajevi et al., 2011). With the breath being in a constant state of flux, this may indicate that individuals are only able to synchronize their breathing for short intervals and that more prolonged changes to breathing rates are not possible (Brandt, 2011).

However, there is evidence to suggest that breathing patterns can be changed with breath training (Esteve et al., 1996; Ley, 1999). Research on those with a long-term meditation or meditation practice, such as Zen Monks, show evidence that resting respiratory rate is reduced (Lehrer, Sasaki, & Saito, 1999; Wielgosz et al., 2016). A health benefit of having a lower respiratory rate is the positive effect it has on one's heart rate variability (HRV)—or capacity for

variation in heart rate. A higher HRV reflects "adaptive capacity" of sympathetic-parasympathetic balance and is considered to be a "marker of cardiovascular health and autonomic homeostatic control," also referred to as respiratory sinus arrhythmia (RSA) (Lehrer, Sasaki, & Saito, 1999). Heart rate increases during inhalation and decreases during exhalation (Song & Lehrer, 2003). As breathing rate decreases, HRV increases (Song and Lehrer, 2003, 2006). As RSA increases, individuals tend to breathe at what is referred to as the "resonant frequency" effect of 0.1 Hz, or approximately 6 breaths/minutes. 6.4 breath cycles per minute is a calm breath rate associated with high heart rate variability (Song & Lehrer, 2003). By having individuals align their breathing at this pace, positive effects on RSA and HRV can result (Lehrer, Sasaki, & Saito, 1999; Lehrer et al., 2003). The benefits derived from an increased RSA are demonstrated with improved gas exchange in the lung through efficient ventilation/perfusion matching (Yasuma & Hayano, 2004). Research in yoga or meditation has also demonstrated rhythmic breathing often at a rate of 6 breaths/minutes (Peng et al., 2004; Bernardi et al., 2001).

Slow Breathing. When following one's breath to an external stimulus, there is some uncertainty regarding how long the length of each inhalation/exhalation needs to be (Morajevi, 2011). Research in the area of *slow breathing*, also referred to as *paced breathing*, was reviewed due to its long-standing connection with meditation and mindfulness practices (Bernardi et al., 2001), as well as success in treating stress (Adhana et al., 2013), lowering hypertension (Adhana et al., 2013; Elliot, 2006; Mourya et al., 2009), and improving well-being (Arch & Craske, 2006). By increasing the blood and oxygen flow to the brain, "greater self-awareness, mindfulness and clear thinking" can be achieved (Matayan, Singh, & Jain, 2009). While intentional, slow breathing can refer to a pacing below 10 breaths per minute (Elliot et al., 2006), research has

found that a breathing rate of approximately 6 cycles per minute created "resonant frequency" to positively affect RSA and HRV (Lehrer, Sasaki, & Saito, 1999; Lehrer et al., 2003). Pacing that is too slow, as well as fast, will affect the body and may cause sympathetic activation; though it is important to add that hypoventilation cannot be "induced voluntarily," beyond momentary instances, as the body will automatically "evoke involuntary control of breathing" (Ley, 1999; Mourya et al., 2009).

Slow breathing techniques can range in breathing frequencies, depths, and patterns of inhalation and exhalation ratios. For instance, *2:1 breathing*, involves continuous breathing with exhalation twice as long as inhalation and can be used to stimulate the parasympathetic nervous system (Adhana et al., 2013). Elliott (2006) points out that despite its benefits, performing paced breathing on one's own requires "training, practicing, skill, and motivation" and individuals might benefit from the expertise of a coach. Typically, paced breathing involves following along with an auditory or visual guide to pace breathing (Peng et al., 2004, as cited in Brandt, 2011). It is important to note that not all slow breathing exercises are modal, or require the individual's full attention. Morajevi et al. (2011) used a technique called *peripheral paced respiration*, PPR, in their desktop computing tool to allow users to work on other tasks "concurrently." By being mindful with the breath, one can move into a space of mindfulness. Morajevi and colleagues point out that breathing regulation can be used as "a viable treatment for sporadic and subtle stressors such as those that may be encountered during the frequent task switching of information work" (Morajevi et al., 2011, p. 1). The need for a tool to minimize the effects of computer-related stress or screen apnea through breathing awareness has been recognized by others (Morajevi et al., 2011; Wongsuphasawat, Gamburg, & Morajevi, 2012).

Technology-Mediated Respiration. An abundance of breathing applications have emerged to serve different functions—from enjoyment-based games to improving health or well-being. Some technologies monitor breathing while providing guidance on breathing rate or form. Due to the interactivity level of these mediums, they provide a platform for users to practice and develop breathing skills (Patibanda et al., 2016, p.2). Research has found that breathing patterns can change through short periods of breath training (Esteve et al., 1996). Devices to guide breathing currently include mobile applications, desktop applications, games, pacers, belts with sensors, wristband vibrators, virtual reality (VR), websites, breathing counting tools, and wearables. While most tools are used to either track or guide a specific form of breathing, the applications vary in breathing techniques, user goals, sensory engagement (touch, movement, sight, hearing), breath tracking, frequency, technologies, and visuals (Patibanda et al., 2016).

Figure 2. Apple Watch Breathing Application. Retrieved from https://support.apple.com/en-us/HT206999

One benefit of wearables includes the ability to track user activity such as breathing rate and provide the user with real-time guidance and data. Although these devices are still fairly

new, they have been exploding onto the market. Examples of breathing wearables include Fitbit, Spire, Apple Watch's Breathing Application (Figure 2), Bella Beat, Prana, and Zenytime. Many of these tools include a corresponding application for users to access their personal data. However, research by Gartner (2016) indicates that 29% of smartwatch users and 20% of fitness tracker users abandon using the tool because "people do not find them useful, they get bored of them or they break." This research also indicated that only about 10% of consumers use smartwatches, 19% use fitness trackers, and 8% use VR devices. The greatest barrier to mainstream adoption may be that they are "priced too high, given their perceived usefulness." Another interesting finding of this research was that 29% of consumers felt the designs were unappealing in their attractiveness. Many younger individuals (under 45) felt their smartphone could provide what the wearable would do, and older individuals (over 45) felt the devices were too expensive (Gartner, 2016).

Mobile applications certainly provide a lower cost, level of convenience, and ease that wearables have not yet realized. Examples of breathing mobile applications include Breathe2Relax, MyBreath, Universal Breathing: Pranayama, Paced Breathing, Relax - Stress & Anxiety Relief, Prana Breath, Breathing Zone, and Reachout Breathe. Research by ComScore (2016) found that since 2013, the smartphone app has "accounted for 80% of all growth of digital media." One app that demonstrates mobile convenience is the MyBreath app that tracks and analyzes user breathing as they breathe directly into their phone (MyBreath App). However, introducing new apps to an audience can be challenging with nearly half of users not even downloading a single app in a month, and the "average user downloads two [apps]." Once an app is downloaded, there is another barrier the app faces to stayed actively engaged with the user. Mobile apps depend

on push notifications for this engagement, though a "much higher percentage are rejecting notifications." Despite the fact that mobile devices have a constant presence in the lives of many, apps are easy to download and in many cases, easy to forget about.

With the average user spending 2.4 hours on desktop/laptop devices (Meeker, 2015), there is an opportunity to create a tool that effortlessly integrates within their current habits, without requiring a user to purchase and commit to wearing a device, as well as potentially minimizing the risk of forgetting and ultimate abandonment. Desktop applications, websites, and browser extensions are solutions that fit within this category. Desktop application examples include Breathing Zone - Relaxing Breathing Exercises, Pranayama, and Relax - Stress & Anxiety Relief. Website examples include doasone.com, xhalr.com, and The Center for Healthy Mind's Breathing Counting Tool. Browser extension examples include Breathe and Breath.

Breathing in Motion

There is something about an object in motion that beckons attention. Amidst a field of visual messages, animated graphics ignite life into content that would otherwise go unnoticed. A purposefully designed motion graphic has the potential to captivate the direction of one's focus. Animation techniques can be used as a means to incite awe, presence, and mindfulness. Studying the elements that attract a viewer's gaze has long interested creators (Thomas & Johnston, 1981), though its potential for harnessing a moment of mindful attention is still being realized. Beyond its function in character animations, advertisements, and informational videos, motion design yields capability in the areas of mindfulness and well-being—the ability to cultivate and maintain awareness. In an endeavor to create more mindful users, understanding the factors of motion design that influence the experience of presence can bring to light its integral role in mindfulness-

based technologies. From the perspectives of visual and motion design, the question surfaced, "How might rhythmic visualizations be more mindfully designed to facilitate breath awareness for the purpose of increasing mindfulness in the context of desktop computers?" The primary goal of this design research is to understand the relationship between the visual components of rhythmic visualizations—movement, hue, brightness, temperature, saturation, contrast, and imagery—and the factors that affect mindfulness through breath awareness for long-term desktop users.

Motion design is primarily rooted in the visual, though it functions alongside other sensory channels. Since most of the incoming sensory information comes from the visual, it is this input that may have the greatest influence on one's experience of presence (Witmer & Singer, 1998). In terms of motion design, this is also the area that is perhaps the most considered. From a formal design perspective, the elements of line, color, shape, texture, form, value, and space all coalesce within a specific format to produce an intended result. The elements are used within specific principles including pattern, contrast, emphasis, balance, scale, unity, and movement. All of these visual choices give form to the content set in motion. Designs that are stylistically considered "beautiful" can promote user interaction (Cheng, 2016). In considering how motion-based visuals promote mindfulness through breath awareness for long-term computer users, this section will review literature in the areas of movement, color (hue, brightness, temperature, saturation), space, imagery, and other factors related to the user's experience.

Movement. How a movement unfolds over time affects how the viewer interprets the space. For example, a slower, downward motion could suggest drifting as opposed to falling (Lockyer et al., 2011). In defining the qualities that affect how movement is communicated, previous studies have suggested the following: velocity, amplitude, acceleration, direction, shape, effort, trajectory,

and smoothness (as cited in Lockyer et al., 2011). Though none of these areas exist in a vacuum, there is research that suggests the impact certain traits can have. In regards to path curvature, straight motions tend to be perceived as more positive, calming, and attractive; wavy motions are viewed as neutral, and angular motions are more exciting or threatening (Lockyer et al., 2011). While some research suggests that the preferred transitional direction is a linear transition (Vogels, Sekulovskig, & Rijs, 2009), many breathing tools utilize a circle-based transition in their designs (Morris & Guilak, 2009; Morris et al., 2010).

Pacing is another powerful aspect of motion that affects the level of attention a user will have. Slower movements are calmer and less threatening than faster movements. As speed increases so does the intensity (Lockyer et al., 2011). In a breath-awareness application by Morajevi et al. (2011), users were to align their breath with a gray bar that appeared at the bottom of their desktop screen (Figure 3). Using a ratio of 1:1, the movement included slow-in and

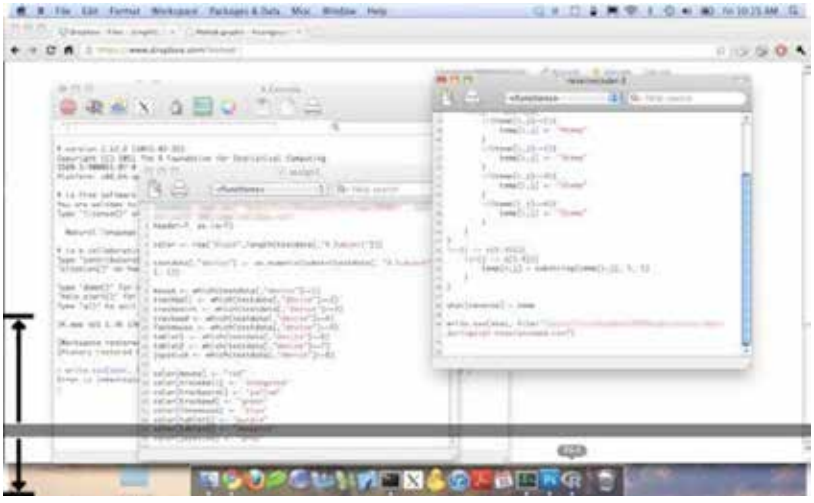

Figure 3. Desktop application integrates animated gray bar to guide user breathing. Adapted from "Peripheral paced respiration: Influencing user physiology during information work," by N. Morajevi, O. Ben, T. Nguyen, M. Saadat, Y. Khalighi, R. Pea, & J. Heer, 2011, UIST'11 - Proceedings of the 24th Annual ACM Symposium on User Interface Software and Technology, 423–427.

slow-out animation to guide the individual's inhalation and exhalation. The bar remained on the bottom third of the screen for two out of every six minutes. The rate of pacing was determined through a sensor that monitored the user's breathing rate (Morajevi et al., 2011).

Color. Hue, brightness, temperature, saturation are all facets of color that affect user experience. Hue refers to the name of a pure color, while temperature refers to the "metaphorical" warmth or coolness of a color (Gage, 1999). Research has shown that color produces a physiological effect (Schauss, 1979). Colors that promote increased levels of pleasure while minimizing arousal bring about a state of calm; while unpleasant colors that increase alertness may heighten anxiety (Valdez and Mehrabian, 1994). Studies on color suggest that cool colors—such as blue and green—induce calm and relaxation (Singh, 2006), while warm colors—such as red and yellow—are more stimulating (Bellizzi, Crowley & Hasty, 1983). However, pastel versions of warm colors can produce soothing effects. It is important to note that personal preference and meaning is attributed to specific colors and this can also influence their effects (Birren, 2010).

When color is created using light, blue light could produce the opposite effect and create more alertness than a warmer lighting (Laufer et al., 2009), with many preferring warmer lighting in their homes (Hartog, Cuppen & Berkvens, 2010). In a study by Jacobs and Suess (1975), color projected on a screen showed higher states of anxiety with red and yellow, as opposed to blue and green. This research is in line with research by Chan (2015) in which individuals sat in a tent filled with colored light. The most relaxing color was purple and the second highest choice as blue. Red was found to be the least relaxing. Based on the RGB color space of computers, many technologies have recognized the power of warm vs. cool light to influence human physiology

and melatonin production (Laufer et al., 2009). In a study by Laufer et al. (2009), blue light was perceived as less pleasant—less relaxing—than red lighting. Blue lighting has a greater impact on circadian rhythms of the body (Holzman, 2010). Furthermore, the term "blue light" can include colors that are perceived to be green, orange, and cyan. White lighting can also be used with warm undertones (+/- 2700K) to create a relaxed visual space (Vogels et al.,, 2009).

Brightness refers to the position of a color "between white and black, or light and dark" (Gage, 1999). Saturation describes the purity of a color (Gage, 1999). The grayer a color, the less saturated it will be. Pleasure is positively correlated with brightness and saturation. Colors that are more saturated tend to create greater alertness. Brighter colors—including whites, light gray, and lighter colors—"are more pleasant, less arousing, and less dominance-inducing than are the less bright colors"—including dark grays, blacks, and darker colors (Valdez and Mehrabian, 1994). Colors that are more saturated on screens tend to be more intense than those found in print due to its light-based origin (Golding et al., 1997). Research on individuals that are already highly stimulated, such as those experiencing higher levels of anxiety, may prefer less saturated colors (Ireland et al., 1992).

Space. Visual perception of space is closely connected to how one feels. Considering the visual space of the desktop/laptop computer to enhance mindful moments is similar to how a landscape architect might envision spaces for contemplation or restoration, i.e., "Zen gardens, monastic quadrangles, pilgrimage sites, and parks" (Pang, 2011). The monitor screen becomes the window to the digital world through which many spend countless hours watching. Designers of physical, contemplative spaces, often utilize contrast by juxtaposing differing elements. One example he provides is the immensity of a mountain overlooking the intimacy of a small garden.

Creating a mindful space within the context of the confined frame of the computer screen seems to have an inherent contrast in it that mimics these ideals. The limited container of a computer screen results in most content appearing in boxes within boxes. While in open, environmental spaces—such as those found in nature—many experience a feeling of freedom. One example of this includes waterscapes, such as those seen at the beach, that tend to provide people with a sense of spaciousness (Lengen, 2015). Likewise, researchers have found that larger screen sizes create a greater feeling of immersion, while those below 3.5 inches have a lesser impact (Rigby et al., 2016). While it may not always be possible to enlarge the scale of a screen, it may be beneficial for designers to consider how they can simulate the feeling of expansiveness to facilitate mindful moments.

Imagery. Research on visuals has found that watching nature scenes increases attention, minimizes stress, and restores cognitive functioning (Brown et al., 2013; Logan and Selhub, 2015; Ulrich, 1991). Fractals with a scaling dimension of 1.3 showed the most promising EEG data for inducing a relaxation effect (Hagerhall et al., 2008). Well-known cinematographer, Louie Schwartzberg, created a program, Visual Healing by Moving Art, that projects time-lapsed, nature-based visuals within spaces for the purpose of "physical, emotional, and psychological benefits" (Moving Art). Watching slow motion, nature-based imagery has been found to induce a calming effect (Chan, 2015). Imagery of device-mediated breathing technologies varies and includes circles, waves, human representation, geometric forms, and nature-based visuals—some seemingly more successful than others. Device-mediated breathing visuals were compiled from mobile apps, wearables, and browser extension and were organized based on circle-based, wave-based, geometric, image-based, text-based designs, and human body representations.

Circle-based Designs (Figure 4):

- MyBreath App
- Tactical Breather – Google Play (National Center for Telehealth & Technology, 2011)
- Reachout Breathe App
- Color Breath Yoga – iTunes
- ECNA-Breath – resizable green sphere (ECNA Lab, 2011)
- Prana Breath
- Fitbit Chart 2 Breathing Functionality – blog.fitbit.com
- Xhalr.com
- Breath – Chrome Browser Extension, by fredsarmento
- Breathe – Chrome Browser Extension, by Chris Carter
- Essence Breathing Relaxation App – iTunes
- 3 Minute Mindfulness: Meditation and Breathing, by Zenco Limited
- Breathe mobile app, by Jordan Olson
- Breathe 4 7 8, by Oscar Morrison
- Breathe: Meditation, Mindfulness and Stress Relief Button, by Stefan Djordjevic
- Zen Calm – Meditation to Breathe & Relax Better, by Edmond Bayne-Powell

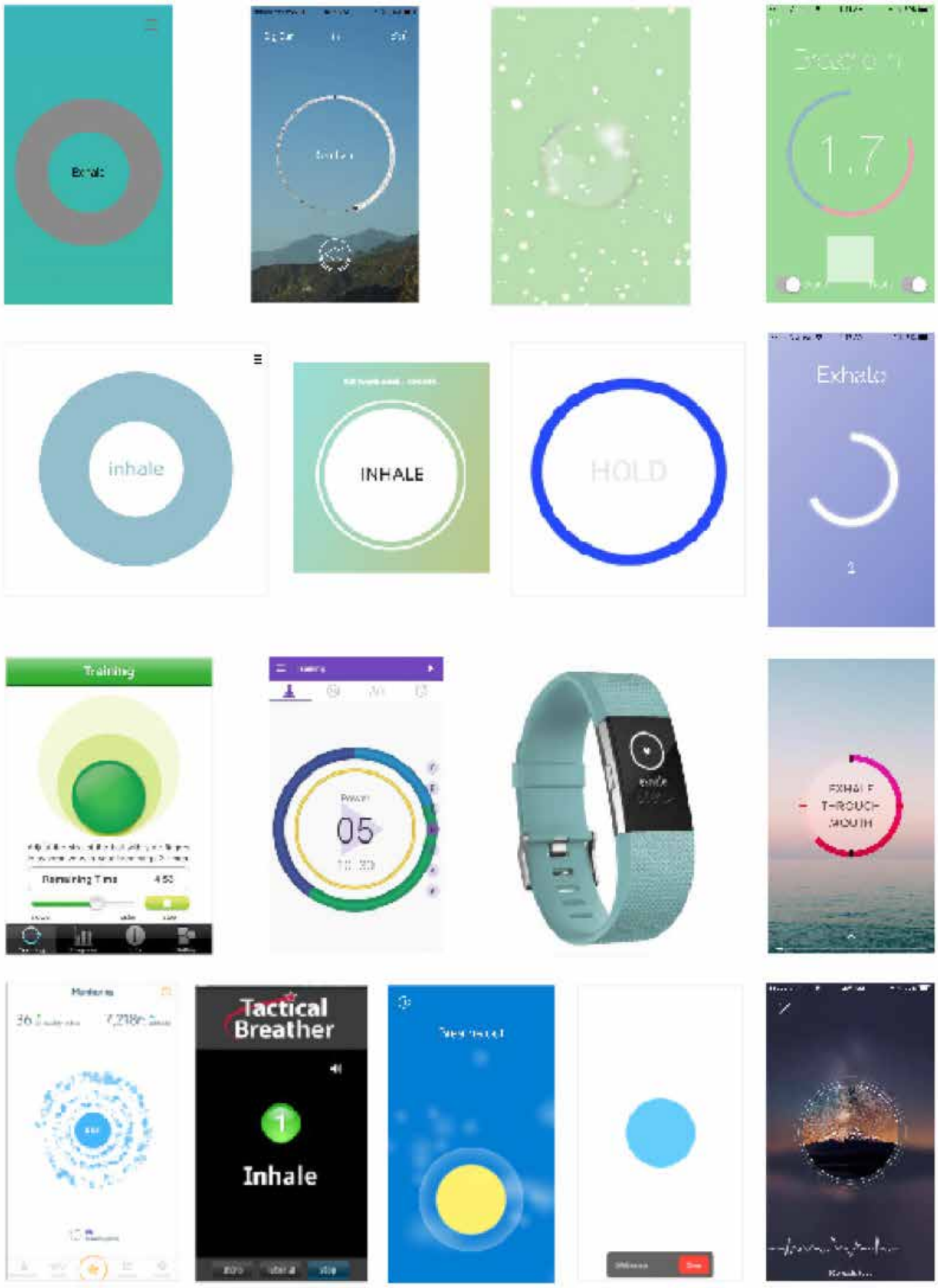

Figure 4. Breath awareness technologies: Circle-based designs.

Geometric Designs (Figure 5):

- Apple Watch Breathing Application
- Breathing Meditation Guide
- Breathing Zone – Google Play
- iBreathe – Relax and Breathe, by Lukasz Gryl

Figure 5. Breath awareness technologies: Geometric designs.

Image-based Designs (Figure 6):

- Breathe2Relax (National Center for Telehealth & Technology, 2011)
- Relax: Stress & Anxiety Relief
- Doasone.com
- The Center for Healthy Mind's Breathing Counting Tool
- Spire Breath + Activity Tracker: Discover Calm, iTunes
- Here and Now Application
- We Breathe, Headfirst Publishing Pty Ltd
- MyCalmBeat – iTunes (MyBrainSolutions, 2012)
- Universal Breathing: Pranayama

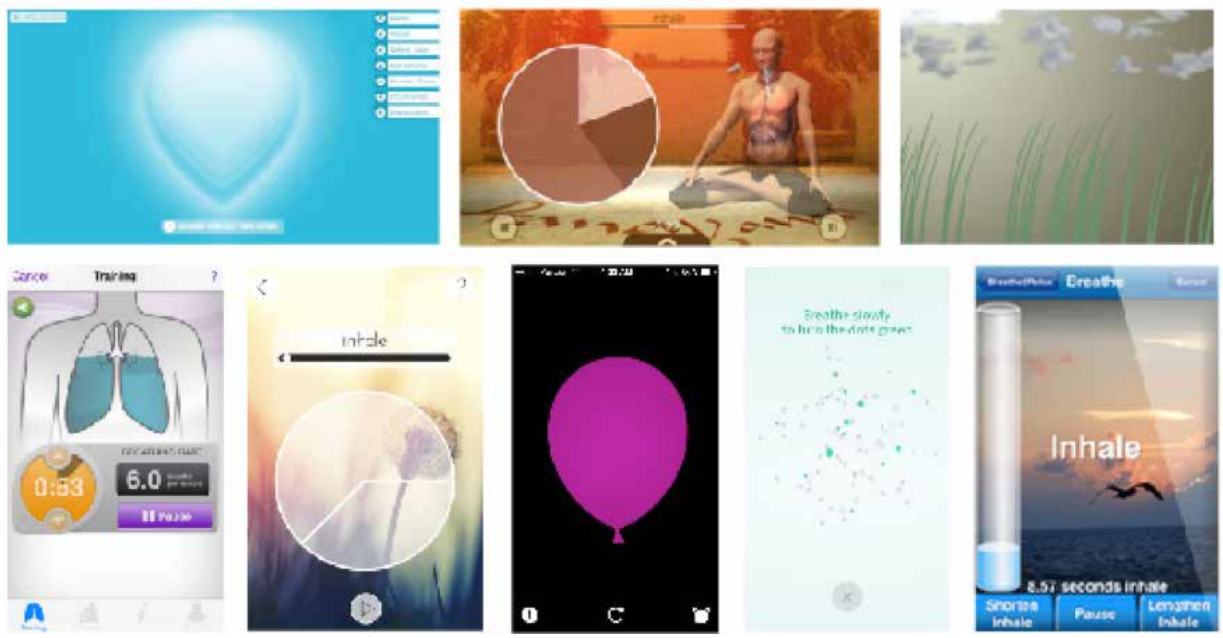

Figure 6. Breath awareness technologies: Image-based designs.

Wave-based Designs (Figure 7): Wave line to represent optimal respiration

- Paced Breathing App (IQPuzz, 2013)
- Vital-EQ Respiroguide (Landelijk Centrum Stressmanagement, 2009)
- Breathe + Relaxation and Breath Training, by Dynamic App Design LLC

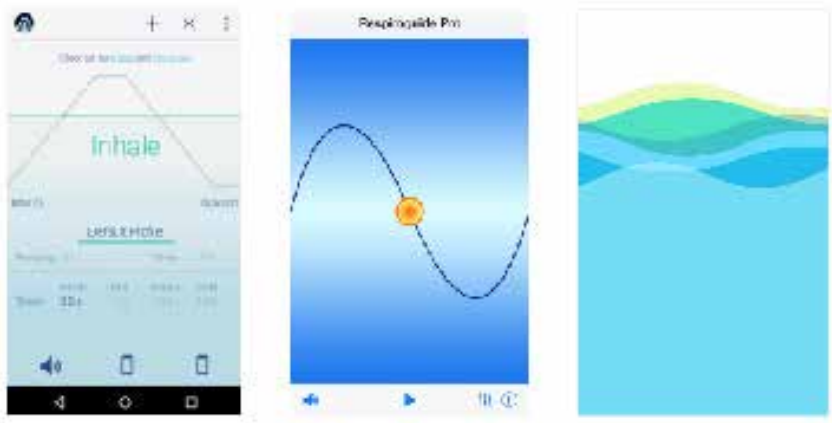

Figure 7. Breath awareness technologies: Wave-based designs.

Text-Based Design (Figure 8):

- Breathe – Chrome Browser Extension, by breath.site44.com

Figure 8. Breath awareness technologies: Text-based designs.

UX Factors.

Control. Within any technological experience, users tend to embody higher levels of presence when they perceive higher levels of control. When one can intuitively take action within a virtual space, presence is increased (Witmer and Singer, 1998; Riva et al., 2012, p. 204–209). Conversely, Held and Durlach (1992) state that lags between action and result, inability to predict next actions, unfamiliar environments, and inability to modify objects in the space can all diminish presence (as cited in Witmer and Singer, 1998). Lack of control may also lead to higher levels of stress and ultimately disconnection. When it comes to any digital space, expectation plays a significant role in overall engagement. Individuals desire a level of control and familiarity for awareness to increase. That being said, while users desire a level of control and familiarity to increase awareness, a small level of ambiguity could improve engagement by creating a feeling of discovery and influence over the experience (Vidyarthi, Riecke, & Gromala, 2012, p. 6–7). Sprinkling in unexpected elements—ones that do not disrupt overall control—can intrigue the viewer to spend more time on an experience (Grivois, p.83).

Cues. One aspect of a design that can facilitate feelings of control include appropriately inserted cues. Instructions help the user know what to focus on amongst a field of various stimuli. A complete lack of instruction can increase stress and confusion. Brandt (2011, p. 20) suggests that people must have instruction to align their breathing with the visual; otherwise, stress levels may increase—especially if the animated rate is significantly lower than their natural breathing rhythm. Conversely, too many directives could cause the user to "think very semantically about the experience" and motivate the user to focus on an action-based goal, i.e., trying to win (Vidyarthi, Riecke, & Gromala, 2012). When contemplating whether to use audio or visual cues to enhance presence, a study by Wongsuphasawat et al. (2012, p.1) found that auditory cues produce more "self-reported" calming effects. The researchers attributed this effect to the reduced cognitive load and ability for the user to "map sound to respiration." Visual instruction resulted in a change in respiration with less of a "subjective calm."

Minimize Distraction. Isolation from distraction is a known factor that enhances the quality of presence. Unlike mobile and desktop devices, VR devices permit complete isolation from the external—which makes it a strong tool to research in the area of presence. However, even when no headset is present, the use of headphones to block out secondary noise can serve a similar function (Witmer & Singer, 1998, p. 230). The key is to minimize distraction and clutter for the user—in whatever form it takes. It is important to note that the use of visual motion does not inherently generate presence, and could promote the opposite effect during instances where the animation is irrelevant or distracting. If a user is attempting to perform a separate task and a movement interrupts their focus, the element could be perceived as visual noise and negatively impact their cognitive load (Hong et al., 2004; Wongsuphasawat, Gamburg, & Morajevi, 2012).

Keeping this in mind, if the goal is to promote mindfulness, implemented visuals must always align with the intentions of the viewer.

Affect. Research in the area of emotion and VR has found that the experience of meaningful emotion is connected with presence (Willans et al., 2006). The area of affect focuses on how something feels. Lockyer et al. (2011, p.91) categorize the qualities of emotional impressions into the following: "valence (positive/negative), intensity (calm/exciting), dominance (reassurance/threat), interaction (attraction/rejection) and urgency (relaxed/urgent)." Reviewing these traits, experiences that are positive, calming, reassuring, attracting and relaxed tend to align with the effects of mindfulness and could be beneficial goals when considering design principles in the field of mindful technology.

Conclusion. In recent years, there has been an abundance of research and technologies in the areas of mindfulness (Hölzel et al., 2011b; Langer, 2014), mindful design (Akama & Light, 2015; Niedderer, 2007, 2013, 2014), calm technology (Vidyarthi, Riecke, & Gromala, 2012; Wongsuphasawat, Gamburg, & Morajevi, 2012), slow technology (Hallnäs & Redström, 2001), positive computing/technology (Calvo & Peters, 2014; Riva et al., 2012), and contemplative computing (Hansen, 2005; Pang, 2011). Calling upon the principles of mindfulness and design, mindful technologies generate opportunities for users to bring more presence, or sense of being in the here and now, into their lives. This conscious method does not seek awareness for the sake of solely selling a product or forcing alternative behaviors. This modality encourages a greater awareness by shifting the locus of control back to the individual. It guides one's focus from external stressors to internal sensations.

With many living in a space of continuous partial attention, media multitasking, or screen

apnea, awareness of the breath has been suggested as a solution (Stone, 2008). Focus on the breath is also a common focal point of mindfulness practices (Adhana et al., 2013; Brown & Gerbarg, 2009; Buboltz et al., 2002; Chandra, 1994; Hölzel et al., 2011b). The stress reducing and attention enhancing benefits of breathing exercises make it a viable focus for the content of this mindful design research. Slow breathing techniques were selected due to their longstanding connection with meditation and mindfulness practices (Bernardi et al., 2001), as well as benefits in treating stress (Adhana et al., 2013) and improving well-being (Arch & Craske, 2006).

Though the human attention span seems to be ever diminishing, designers are becoming increasingly aware of the capability motion design has to captivate and facilitate focused attention. Motion design is primarily rooted in visual design, though it functions alongside other sensory channels. As most sensory information comes through the visual senses, it is this input that may have the greatest influence on one's experience of presence (Witmer & Singer, 1998). With the average user spending 2.4 hours on desktop/laptop devices (Meeker, 2015), there is an opportunity to create a tool that effortlessly integrates within their current habits, without requiring a user to purchase and commit to wearing a device, as well as potentially minimizing the risk of forgetting and ultimate abandonment. Users that work on screens for long periods of time, such as information workers, were selected as the target audience due to their extended intervals of screen time. For these individuals, visual input can be substantial.

From the perspectives of visual and motion design, the question surfaced, "How might rhythmic visualizations be more mindfully designed to facilitate breath awareness for the purpose of increasing mindfulness in the context of desktop computers?" The purpose of this design research was to design and evaluate a series of iterative prototypes for breath awareness.

Reviewing the visual differences and similarities in breathing-assisted devices, there emerged a need to understand how visual spaces affect one's internal experience of breath awareness using an external tool. To the best of my knowledge, at the time of this research, there were not any studies focused specifically on the analysis of the visual components of motion-based, mindful experiences. Studies most similar to this research include:

- Colored lights and nature films projected within the physical space of a tent to improve well-being. The research demonstrates that "moving pictures" have the capacity to capture the attention of the viewers and then to provide a slowing down effect, as the viewer's mind begins to mirror the movements on screen. It also suggests that the "experience of spending quiet time immersed in one's own choice of coloured light has relaxing effects: (Chan, 2015).
- The creation of a desktop, system-wide, breathing regulation interface to target information workers. The goal here was for users to breathe while not primarily focusing on the tool. Users wore a belt to measure thoracic circumference during respiration. The design displayed a visual of a pulsating circle in the corner of the screen. In the animation, a horizontal, thin gray bar would move upward and downward on the bottom third of the screen to guide the user through inhalation and exhalation using a ratio of 1:1. Animation techniques use slow-in and slow-out animation. Two issues that emerged was that real-time feedback was distracting and it was difficult for users to notice a peripheral visual when highly engaged in work. However, when completing the breathing exercises, users did not find them to be "too distracting" and expressed an interest in pursuing a more sustained practice. They called for future research in this area to "help motivate users to maintain low

respiratory rates while they work" (Morajevi et al., 2011).

- An audio-visual breathing regulation tool based on the concept of entrainment. "The focus is in the design of interaction elements which support entrainment process." Similar to this study, no breath monitoring devices were used in the research. The extent of the visual exploration included a circular, expanding/shrinking animated shape for inhalation and exhalation. In animation, opacity changed from 0% to 100%. Saturation changed from gray to blue. Three sound elements were explored using frequencies of white noise and a musical tone. It was found that "easiness and low mental load" was necessary for breathing entrainment. All users opted to leave the visual turned on during this study, with "five [out of 6] participants found animation more essential than sound." Based on the importance of visual animation discovered in this study, there is a need to continue research in more deeply understanding the visual effects (Pirhonen & Tuuri, 2011).

Insights from this research will contribute to the design of a digital tool, and the development of a visual language for mindful digital experiences. It is important to note that this study will not include monitoring of actual breathing, as the focus here is primarily on how breath awareness, assessed through subjective user perception, might be supported using motion visuals in a browser-based application. This study will consider the visual factors that affect the user's ability to synchronize, or entrain, their breath to the visuals. While the purpose of this research was to primarily look at the visual factors, there is the opportunity for other factors—such as audio inputs—to be studied in subsequent research. The extended goals of this research are to integrate the findings into the development of a web-based tool—potentially a browser extension—to meet users where they are, enhance mindfulness through breath awareness, and

minimize digital stressors. The final phase of this research asks participants to test the prototype multiple times over the course of extended desktop screen time to test research findings on visual language in mindful digital experiences, as well as speculate how the visualization might exist within the context of a user's daily life.

CHAPTER 3

Phase I

The goal of this design research is to understand the relationship between the visual components of rhythmic visualizations—direction, hue, brightness, temperature, saturation, contrast, and imagery—and the factors that affect mindfulness through breath awareness for long-term computer users. Initial assumptions were that brighter focal points, dynamic imagery, and complex customization might be needed to enhance novelty and contend with digital distractions. Iterative rounds of prototyping, user testing, questionnaires, and surveys are utilized to understand the experience from the user's perspective. To better understand the relationship between rhythmic visualizations (using animation as a visualization aid) and presence through breath awareness, participants were invited to complete an initial survey, and participate in four phases of iterative prototyping. The feedback from each phase informed subsequent phases.

Procedures

Qualitative data was based on a survey of data—self-generated descriptive words and self-reported Likert scales—collected through digital questionnaires. Questionnaires were completed directly following user testing as a means to understand the experience from the user's perspective. Self-reported quantitative data was collected to discover correlations between visual motion parameters and their effects on mindfulness through breath awareness. Prototypes were developed using the application Tumult Hype and uploaded to a personal subdomain for testing. Questionnaires were created using Typeform and embedded within each prototyping website. As the tool is context-dependent, all testing took place remotely while users worked in their native environment. All prototypes and questionnaires were accessed through an Internet browser on

their computer. This study will not include monitoring of actual breathing, as the focus here is on how breath awareness might be supported using motion visuals in a browser-based application. This research focuses on the user's perception of mindfulness as they synchronize their breath to the visuals. Mindfulness is evaluated in the final phase using the condensed 5-item, state version of the Mindful Attention Awareness Scale (MAAS) (Brown & Ryan, 2003). The original 15–item version focuses on measuring trait mindfulness, while the shortened version assesses the short-term level of mindfulness, or awareness of what is taking place in the present moment.

Participants

Research began with a written introduction (See Appendix A), informed consent and non-disclosure agreement (See Appendix B), and initial survey (See Appendix C) on digital habits, perceived level of technostress, and previous experience with mindfulness and mindful technologies. Each phase of the research included a different number of participants, as participation for each phase was optional and anonymous. There was a total of 18 participants involved in various phases of this study. Regardless of their level of involvement in this study, all participants were required to read and complete the written introduction, informed consent, and non-disclosure agreement and initial survey.

Demographics. Both males (8) and females (10) took part in this research. Users were approximately between the ages of 20–40. All participants had previous experience with graphical user interfaces and used a desktop/laptop computer on a regular basis. The call for participants was sent out on social media for those that work on screens for extended periods of time and potentially experience technostress; however, technostress was not a requirement for involvement. 94% of participants worked on screens more than 30 hours a week.

Technostress. Participants were provided the following definition of technostress before answering questions: "stress or psychosomatic illness caused by working with computer technology on a daily basis." The participants varied in their experience of technostress when working on computers for prolonged periods of time, as well as the factors that contributed to their stress. 94% (17/18) of participants reported feeling some level of technostress. None of the participants attributed their level of technostress to inexperience with computers of lack of training. Factors selected as having the greatest impact on technostress included 67% (12/18) lack of breaks from technology, 61% (11/18) information overload, 50% (9/18) overworked, 50% (9/18) performance anxiety, 44% (8/18) fast pace of work day, and 44% (8/18) using multiple interfaces simultaneously. The data demonstrated a clear need for cognitive and technological breaks. When asked to describe additional factors, not listed, that contributed to the participant's experience of technostress, participants stated decision fatigue (1/18), frequent interruptions or digital stimuli (1/18), digital multitasking (1/18), personal anxiety disorder (1/18), eye strain (2/18), customer support (1/18), changes in screen color when multi-screening (1/18), and the compulsion to frequently check for email and social media updates (1/18).

Internet Browsing Habits. Users were asked to select how many hours per week they utilize an Internet Browser (e.g. Chrome, Safari, IE, Firefox). Usage varied with 44% (8/18) at 10–20 hours, 17% (3/18) at 20–30 hours, 12% (2/18) at less than 10 hours, 12% (2/18) at more than 10 hours, 17% (3/18) at "approximately the entire time." 83% (15/18) stated they preferred to create a new tab when going to a new website. 2/18 participants preferred opening a new window and 1/18 participants state they preferred to open the page in their current tab/window. However, all participants stated they tended to have more than one tab open at a time (Table 1).

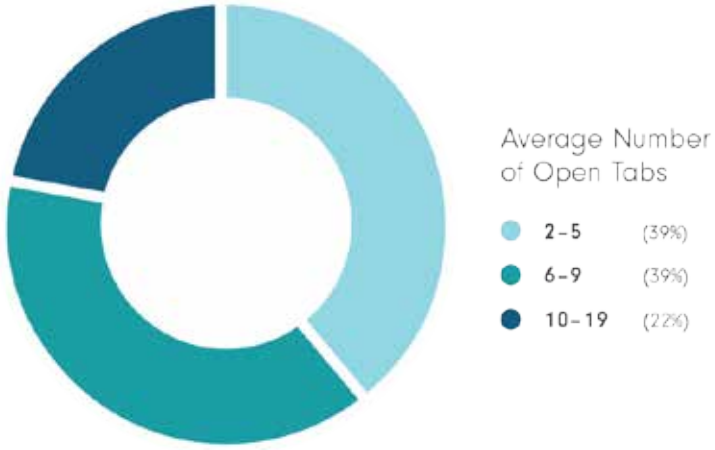

Table 1. Participant's average number of tabs they tend to have open at one time.

Barriers to Adoption in Mindful Technology. While there is an abundance of mindfulness-based technologies flooding the market, this questionnaire sought to understand the barriers, if any, that might be affecting the adoption of these tools into one's daily routine. Users were asked what factors, if any, affect their decision to use a mindful technology. One participant stated "The Apple watch reminders are nice and I definitely appreciate the benefit, but they became too easy to dismiss after a while. At first I thought they were just coming at inappropriate times, but I think I probably prioritized anything else I'm doing at the present moment over them." Another remarked that they utilized Headspace for a period of time and found it beneficial: "it helped me clear my thoughts and feel lower level of stress. However, I'm not sure why, but I did not keep up with it." Over half of the participants, 53% (9/18), did not know mindful technologies existed (Table 2). None of the participants felt the tools had a lack of value to their life, suggesting that they were open to the value they could potentially provide. 29% (5/18) stated that a lack of time was a factor. 24% (4/18) stated that the technologies were novel and they lost interest over time. When asked if there any other factors not listed that may have impacted their limited use of mindful

technologies, participants stated a desire to do something about stress and anxiety holistically (1/18), privacy (1/18), forgetfulness (1/18), aversion to transcendental meditations (1/18), and usefulness outside of the app (1/18). When asked whether they were open to trying a tool that could improve their mindfulness, opinions were neutral (1/18), somewhat (7/18), or strongly agree (10/18).

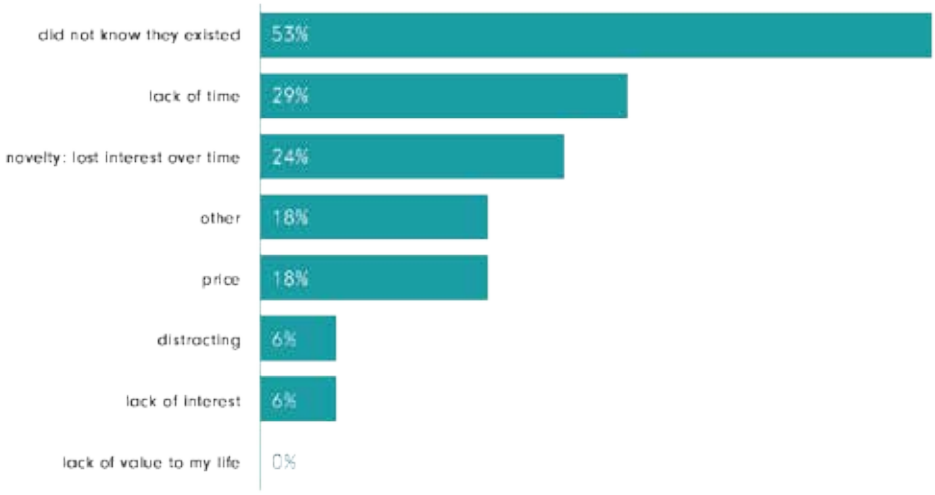

Table 2. Factors that affect participant's decision to use a mindful technology.

Interest in Mindfulness. 50% (9/18) of participants stated they were strongly interested in mindfulness. 28% (5/18) were somewhat interested in mindfulness, and 22% (4/18) were neutral

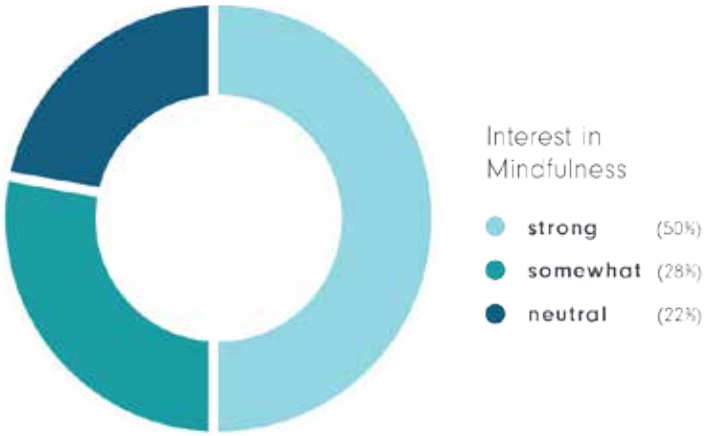

Table 3. Participant interest in mindfulness.

on their interest in mindfulness (Table 3). None of the participants selected a lack of interest in mindfulness. When asked about their daily practice of mindfulness, only 13% (2/16) strongly agreed that they practice mindfulness on a daily basis, while 28% (5/18) stated they practice mindfulness on a weekly basis (Table 4).

Table 4. Daily versus weekly practice of mindfulness for participants.

Breath Awareness. When asked to rate on a scale of 0–4 whether they pay attention to their breathing on a normal basis, responses varied significantly. 6% (1/18) participants stated they strongly agreed. 17% (3/18) strongly disagreed with this statement. 17% (3/18) were neutral with this statement. The average response was 1.72M (SD=1.23), or slightly below neutral.

Phase I Procedures

The first phase explored the connection between breath awareness and the direction of animated movements using color fields. While studies suggest that the preferred transitional direction is a linear transition (Vogels, Sekulovskig, & Rijs, 2009), many technologies utilize a circle-based transition in their designs (Morris & Guilak, 2009; Morris et al., 2010). Users were asked to fully test five prototypes and complete all six questionnaires, although some users ended the phase before completion. This may have been due to the development process using

Tumult Hype and embedded Typeform questionnaires. In earlier phases, some users reported an inability to see a button or click through to the next page. Two buttons were included on each questionnaire page: one to submit the survey and another to move forward to the next prototype. As the research progressed, links were added in more locations to minimize error. Despite these efforts, each phase did experience some variance in participation. It is important to clarify that the difference in responses did not affect the importance of feedback that was given by users, though it did limit the number of responses that evaluated them in comparison. Each prototype and questionnaire were independent but grouped into phases. Questionnaires that compared the prototypes were included at the end of each phase. The participant breakdown for each is as follows: prototype 1 (12 responses), prototype 2 (10 responses), prototype 3 (10 responses), prototype 4 (9 responses), prototype 5 (7 responses). 9 participants responded on the final preferred design questionnaire which means that two users either did not submit the prototype 5 submission correctly, or they skipped answering that questionnaire altogether. Either way, due to the anonymous nature of the user testing and the remote testing environment, the data could only be assessed based on correctly submitted responses.

Participants were asked to use a desktop or laptop computer. Before starting, they were also asked to turn off all sound and expand their browser to fill their entire viewing area. The entire phase was to be completed in one sitting. The steps of this phase were broken down into the following:

- Prototype 1
- Prototype 1 survey (See Appendix D)
- Prototype 2

- Prototype 2 questionnaire (See Appendix D)
- Prototype 3
- Prototype 3 questionnaire (See Appendix D)
- Prototype 4
- Prototype 4 questionnaire (See Appendix D)
- Prototype 5
- Prototype 5 questionnaire (See Appendix D)
- Preferred design questionnaire (See Appendix E)

For each prototype, participants were asked to breathe in and out a minimum of five times (five inhalations and five exhalations) before moving on to the survey. While breathing, each user focused on their breath and the feeling of the visual movement. To minimize variables for comparison, all of the prototypes were monochromatic animations using white and light teal. The complexity of each prototype is simple to determine if there is a directionality that majority of users will resonate with. Following the breathing exercise, users were asked to complete a brief questionnaire (See Appendices D and E). Each prototype opened with the text “press spacebar to begin” and “click anywhere to end.” The only text present during the breathing exercise were two, small text-based cues that instructed the user to “breathe in” and “breathe out” with a difference in descriptive words (slowly, deeply, fully). The text faded in and faded out with each inhalation and exhalation. Respiratory pacing varied for each prototype to determine what pacing to use for future phases.

Figure 9. Part I: Prototype I.

Prototype 1

Prototype 1 (Figure 9) displayed a full color bleed transitioning in-and-out over a period of 13 seconds (6s inhalation/7s exhalation). The cue instructed "breathe in deeply" and "breathe out fully." The simplicity of the design received positive remarks by many regarding focus and the ability to relax. One user likened the direction of the movement to "pouring water into a glass." Individuals felt mostly neutral to the ability to breathe along with the visualization. Two others felt that a visual indicator of some type to display the passing of time could be useful. An idea of an ending chime to designate the of the session could be useful and help to minimize anxiety around "having to breathe forever or if they are doing it right." Other issues that emerged for some with this design was the constant presence of the text-based cues, the inability to look away from the screen or close one's eyes, anxiety around missing a breath and forgetting their current

breath number, syncing one's breathing to the cadence of the visual. Another issue for one user was the presence of notifications appearing from other applications while breathing. Pacing is an important facet of the user experience. One user remarked that they "normally breathe a lot faster than the exercise wanted me to, but I didn't realize it until I completed the exercise."

Figure 10. Part I: Prototype 2.

Prototype 2

Prototype 2 (Figure 10) displayed a white, linear gradient moving in from the top of the screen layered on a solid background over a period of 11 seconds (5s inhalation / 6s exhalation). The cue instructed "breathe in slowly" and "breathe out deeply." One participated stated, "it reminded me of the ocean tide going in and out." Regarding cues, another individual felt confused by the guidance to breathe in "slowly" and was unsure how to execute this type of breath properly. With minimal instructions, it is important to consider how users will respond to specific descriptors such as fully, slowly, or deeply. With this prototype, it is becoming increasingly

apparent that significant role pacing plays in user perception. If users felt the timing synced with their breath, they were not distracted and rated high on presence and ease of breathing. Users that got off rhythm or were unsure how to breathe, rated lower on presence and ease of breathing.

Figure 11. Part I: Prototype 3.

Prototype 3

Prototype 3 (Figure 11) was a reverse direction of Prototype 2 with the white gradient coming in from the bottom of the screen with similar timing. The cue instructed "breathe in slowly" and "breathe out deeply." The respiratory rate over a period of 11 seconds (5s inhalation / 6s exhalation). The similarity to the previous design was noted by participants, and some found their minds comparing the differences between the two. A few participants found the prototypes easier to breathe with and more smoothing, while another found the movement distracting and not as strong as the previous design. The wording of slowly and deeply were also mentioned. One found these terms more calming than fully, while another found slowly to feel more confining

than deeply. However, the fading out of the text allowed one “a small break from reading.”

Figure 12. Part I: Prototype 4.

Prototype 4

Prototype 4 (Figure 12) moved in a similar direction to Prototype 4 with a solid white box entering in and out from the bottom of the screen over a period of 11 seconds using a timed ratio of 1:1. The cue instructed “breathe in slowly” and “breathe out deeply.” The solidity of the design was more attention-getting and allowed users to clearly follow a linear motion. However, the visual reference would disappear as the light teal screen became fully white and back again. Losing the visual anchor completely was a weakness of this design for one user. The entire background appeared to move and felt less static that previous prototypes. For those that were unable to follow the pacing, they were bothered by the moving line. However, the negative remarks of this design are that it is too bold, less natural, less calming, more constraining than the gradient, and slightly jarring. In the endeavor for focus and calm, this one was stronger in

focus, though less calming. Collectively, this design was the weakest regarding user preference. One user stated the design felt “more like an active game and less like a form of calming meditation.” Another said “I found myself getting upset at the line. It seemed to be moving too fast.” However, one user appreciated the clear visualization and felt their lungs both fill and empty of air.

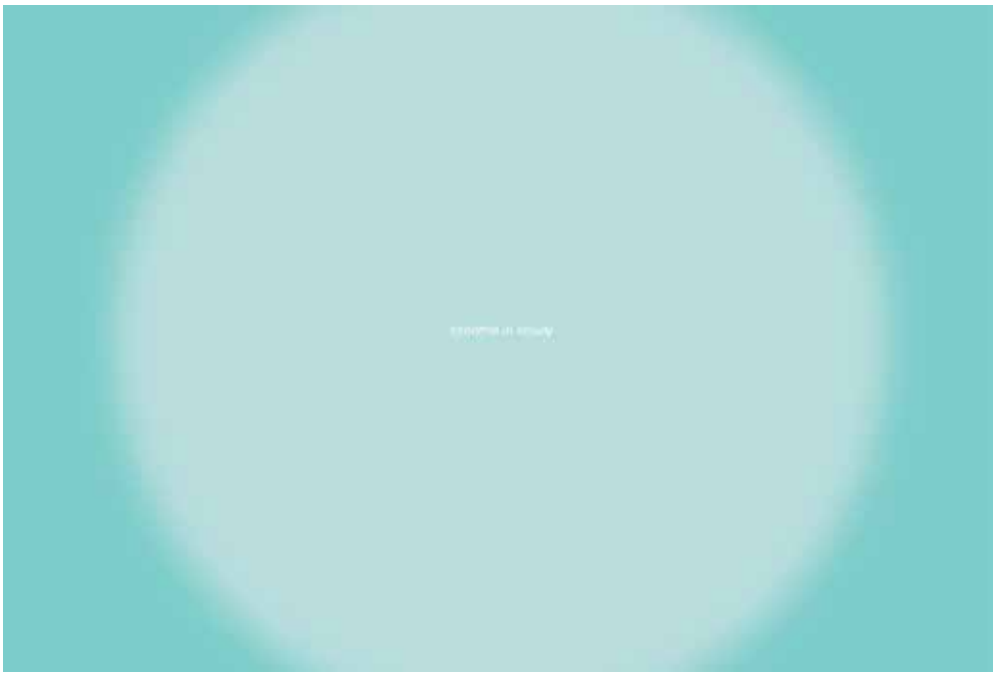

Figure 13. Part I: Prototype 5.

Prototype 5

Prototype 5 (Figure 13) showed a lighter circular gradient opening expanding and contracting on a darker background over a period of 12 seconds using a timed ratio of 1:1. The direction of the animation received many positive remarks. User comments of the direction include that it “matched up with the direction of my breathing,” “really felt as though my lungs were expanding and contracting,” and “providing a bar” to measure their breathing against. The direction and aesthetics of this design allowed more presence and less distraction causing the

viewer to focus clearly in the center of their screen. However, one user stated, “This prototype almost felt too cliché and caused me to focus on the screen more than I would want. After spending hours [looking] at a screen, the last thing I would want to do is be strictly focused on the screen while practicing mindfulness. The slow gradients allowed a less intrusive mindfulness activity.”

Results

Following each prototype user testing, individuals were asked to rate each prototype based on ease (Table 5), presence (Table 6), direction (Table 7), and simplicity (Table 8) using a Likert scale of 0(strongly disagree)–4(strongly agree). The tables below illustrate the rating comparison between each of the five prototypes. Results varied when users were asked to select their preferred their design. 0% (0/9) selected Prototype 4, 22% (2/9) selected Prototype 1, 22% (2/9) selected Prototype 2, 11% (1/9) selected Prototype 3. Prototype 5 received the strongest response of 44%

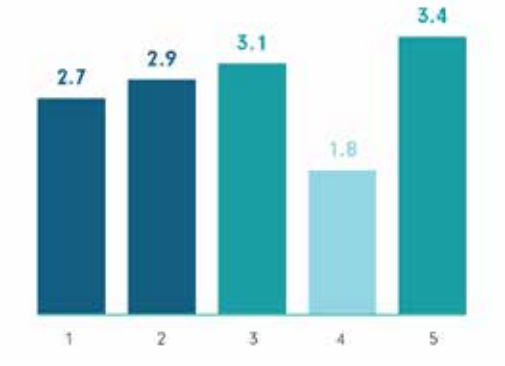

Table 5. Phase I: Ease. “It was easy to breathe along with the visualization.”

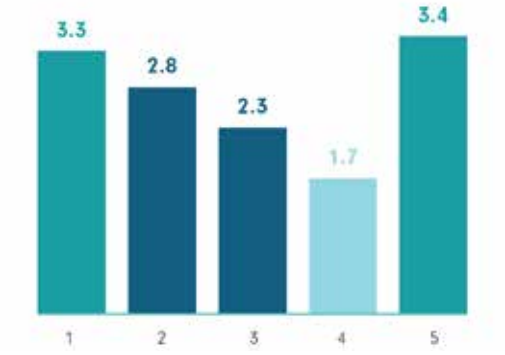

Table 6. Phase I: Presence. “I felt present while breathing along with this visualization.”

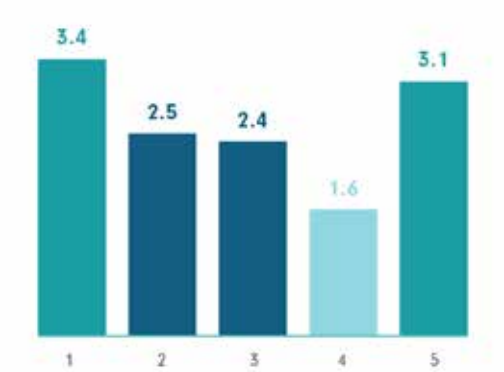

Table 7. Phase I: Direction. "Did the direction of the movement diminish or enhance your breathing experience?"

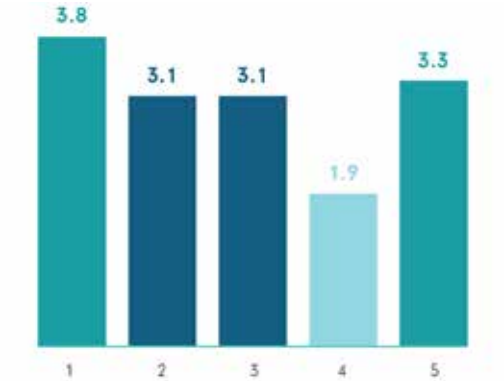

Table 8. Phase I: Simplicity. "Did the simplicity of the animation diminish or enhance your overall experience?"

(4/9).

One user selected Prototype 1 because they felt "relaxation exercises should be as simple as possible so they feel less like tasks that must be completed and more like organic refreshments." Two users selected the second prototype because they found it more relaxing and easy on the eye. This prototype was less intrusive, calming, and allowed users to focus more on their breathing. One user selected the third design because of its simplicity, stating that "the less there is to focus on the more you can focus on yourself." No users selected the fourth design, though one suggested that the "hard line seemed abrasive." The design that received the greatest response was the circular movement of Prototype 5. One user stated that they were "extremely impressed in how subtle color changes and movement can get me to actually breathe while working on a computer!" Another stated that Prototype 5 was selected because of "its relatively literal

representation of breathing."

Insights

One finding that emerged from the first phase was the need for smoothness in the transition. One participant remarked, "the slight of the white field on the breath started to distract and irritate me." This detail aligns with research done by Sekulovski et al. (2011) that suggests sudden changes in lighting—including flickers—may be perceived as unpleasant. Across the board, most users made their choices based on their perception of ease, minimal distraction, and simplicity. Other significant preferences included clear signals or references for breathing in and out and stopping, as well as how relaxing the experience was. The oscillation of movement needs to be synced with the user's breathing rate, otherwise presence and focus with be diminished. Data from the previous phase suggests that future phases will need to collect more insights on breathing rate and pacing. It was also recognized that a constant present of text-based cues could be distracting for some users.

CHAPTER 4

Phase II

The second phase explored the connection between breath awareness and color (hue, brightness, temperature, and saturation) using animated movements of color fields. Research suggests various colors can affect an individual's mood, as well as their state of alertness and relaxation (Chan, 2015). The visual pacing for respiratory rate was set to 10 seconds (4s inhalation / 6s exhalation).

Procedures

While 18 participants were sent the link to test the prototypes, only 8 participants chose to complete this phase of research, while some participants chose not to complete all of the four parts to Phase II. Participants were asked to use a desktop or laptop computer. The participant breakdown for each part is as follows: part 1 (8 responses), part 2 (6 responses), part 3 (7 responses), part 4 (7 responses). Before starting, they were also asked to turn off all sound and expand their browser to fill their entire viewing area. The entire phase was to be completed in one sitting. The four-part phase included:

- Part 1 prototypes (4 visualizations)
- Part 1 questionnaire (See Appendix F)
- Part 2 prototypes (3 visualizations)
- Part 2 questionnaire (See Appendix G)
- Part 3 prototypes (3 visualizations)
- Part 3 questionnaire (See Appendix G)
- Part 4 questionnaire (See Appendix H)

For each prototype, participants were asked to breathe in and out with the visualization for a minimum of 30 seconds (3 full breaths) before moving on to the survey, though users were welcome to breathe longer if they desired. While breathing, users were asked to focus on their breath and how the change in color affected their awareness of breathing. Each prototype opens with the text “press spacebar to begin” and “click anywhere to end.” The only text present during the breathing exercise were two, small text-based cues instructing the user to “breathe in, fill your entire body” and “breathe out, effortlessly and completely.” The text would fade in and fade out with each inhalation and exhalation.

Part 1: Warm vs. Cool Colors

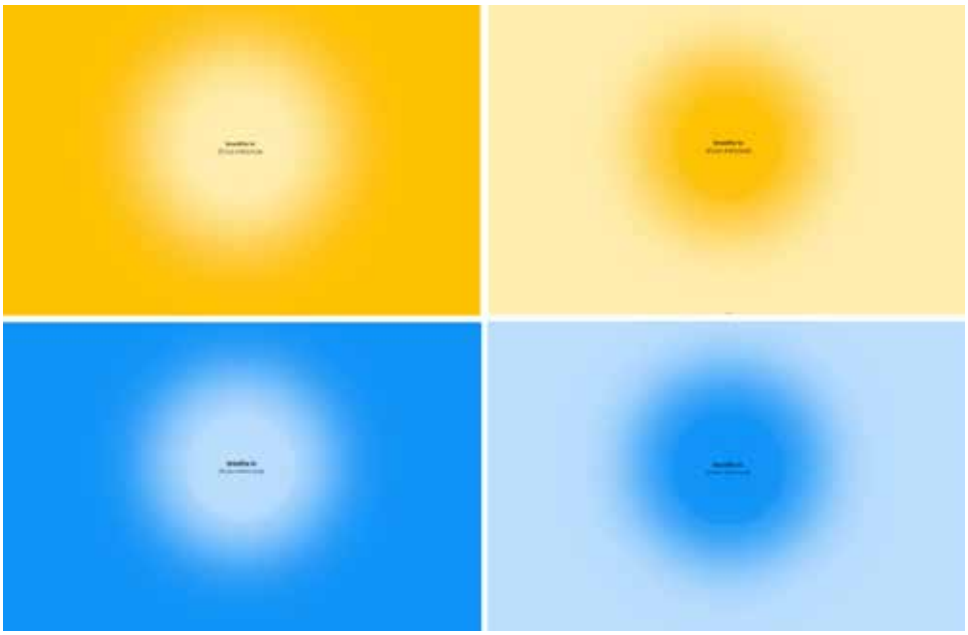

Figure 14. Part II: Warm vs Cool Colors.

Do users feel most present during warmer or cooler colors? Do users prefer to focus on the brighter portion of the design? Colors for this phase (Figure 14) were selected from Google’s material design color palette. Warm colors included Amber 500 and 100. Cool colors included

Blue 500 and 100. Participants were asked to choose a design based on ease (Table 9) and presence (Table 10). The tables below illustrate the user's selections.

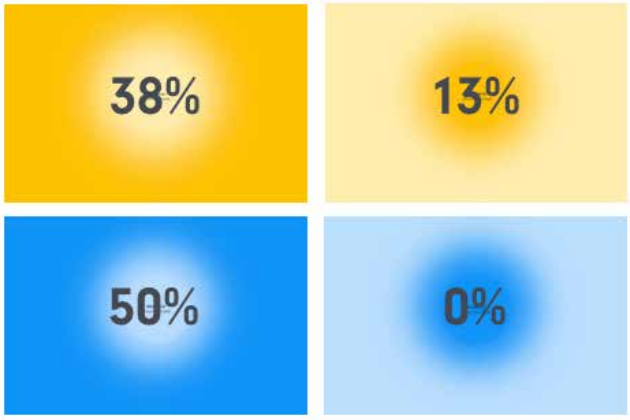

Table 9. Phase II, Part I: Ease. "Out of the four designs, which visualization felt the easiest to breathe along with?"

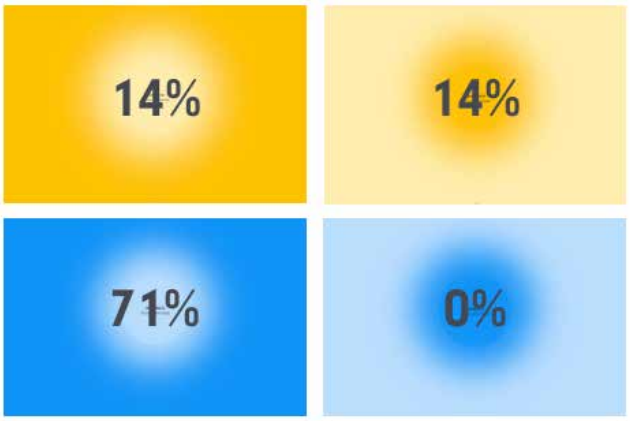

Table 10. Phase II, Part I: Presence. "Out of the four designs, which visualization did you feel most present with?"

Participants were also asked whether they preferred a brighter focal point or a dark focal point. 88% (7/8) participants preferred the brighter focal point over the darker one (Table 11). One participant stated, "The screen brightening brought [a] kind of energy to inhaling, while returning to the blue background made exhaling feel better." 71% (5/8) of participants selected their chosen design because they felt it was calming or pleasant in appearance. Those that selected design C felt the blue was more relaxing, quieter and easier to breathe along with. Users that selected a warmer design (A or B) associated with it with the sun, as well as feelings of warmth,

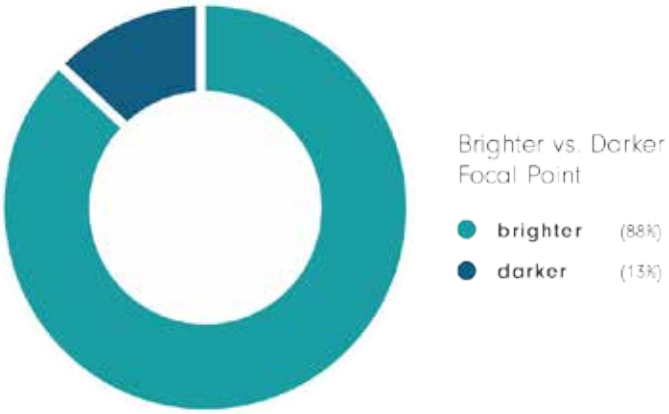

Table 11. Brighter vs. Darker Focal Point.

happiness, and positive emotions. One user stated that they enjoyed the warmer prototype because it provided them with a "break from all the blue."

Part 2: Contrast

Figure 15. Part II: Contrast.

Do users feel most mindful when viewing designs with more or less contrast? Colors for this phase (Figure 15) were selected from Google's material design color palette, Teal (500+FFF), (500+100), and (500+300). 6 participants tested three prototypes (Figure 15) with decreasing contrast for ease of breathing and presence while breathing. Participants were asked to select a design based on ease (Table 12) and presence (Table 13). The tables below illustrate the user's selections.

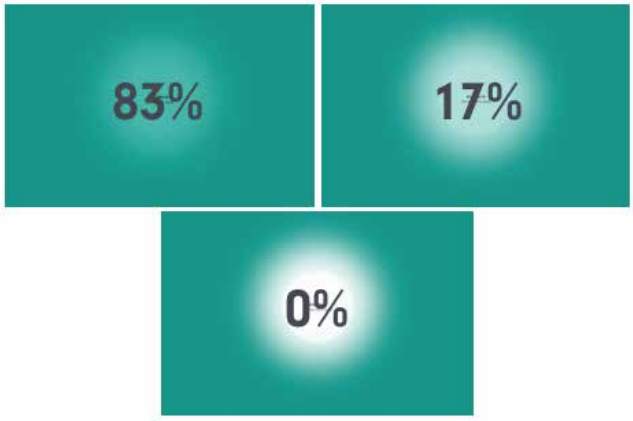

Table 12. Phase II, Part II: Ease. "Out of the three designs, which visualization felt the easiest to breathe along with?"

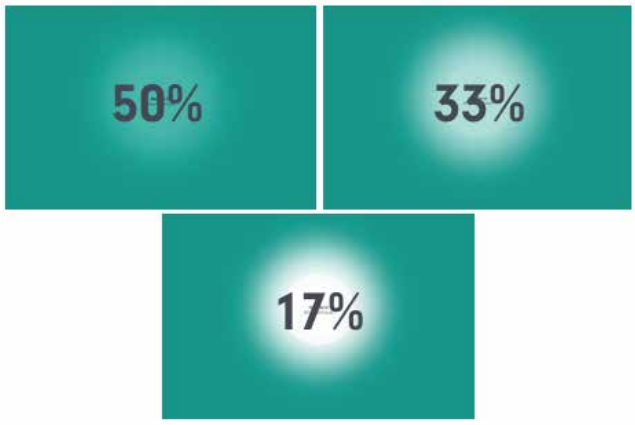

Table 13. Phase II, Part II: Presence. "Out of the three designs, which visualization did you feel most present with?"

One user stated they were "more focused on the brighter focal point...but the dimmer focal point was more calming." Users selected design C for both presence and ease and felt the design with less contrast was smoother, gentler, and "less distracting to breathe with." At this part, users are expressing favor for the simpler design. "I like how understated these are - please don't make them any busier." While it seems less contrast is favored, it is important to consider that too little contrast could hamper usability for the colorblind. While less contrast was more relaxing and easier to breathe with, contrast should not be reduced too greatly that it becomes hard to see.

Figure 16. Part II: Brightness/Saturation.

Part 3: Brightness/Saturation

Do users feel most mindful when viewing designs with more or less brightness/saturation? Colors for this phase (Figure 16) were selected from Google's material design color palette, Blue (A700+400) (A400+200) (A100+100). 7 participants tested three prototypes (Figure 16) with decreasing contrast for ease of breathing and presence while breathing. Participants were asked to select a design based on ease (Table 14) and presence (Table 15). The tables below illustrate the user's selections.

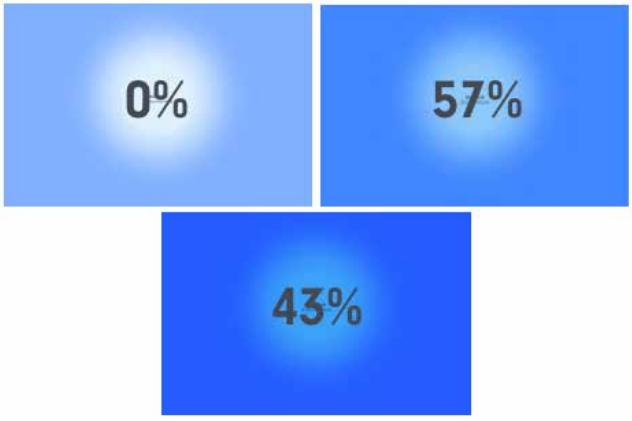

Table 14. Phase II, Part III: Ease. "Out of the three designs, which visualization felt the easiest to breathe along with?"

Participants that selected design B stated it was more pleasant and natural. One participant stated that center of design A was "too white" and "jarring." 3/7 participants selected design C

stating that it was more brilliant, pleasing to the eye, calming, enhanced presence, minimized distraction, and the "lower contrast was less abrasive." Those that favored design B felt the blues were more natural and the color was more pleasant than the others.

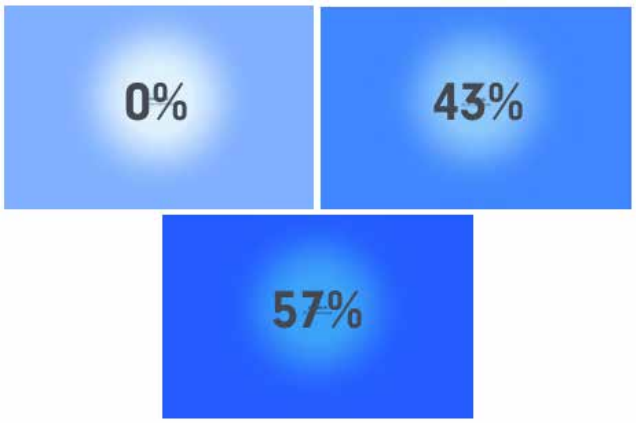

Table 15. Phase II, Part III: Presence. "Out of the three designs, which visualization did you feel most present with?"

Part 4: Hue

One assumption before beginning this phase is that individuals would select different colors based on personal preferences and meanings. Though hue preference can be subjective (Table 16), the goal of this part was to determine if there were colors individuals would gravitate toward for a breathing application. 3/7 selected amber (E), 1/7 selected green (F), 1/7 selected dark teal (G), 1/7 selected bright teal (H), 1/7 selected light blue (I). Comments on why amber was selected stated that the color "mimics the color of sunlight," reminds them of "Tibetan Buddhist monk's robes," and found the "brightness and warmth that the yellow exhibits...very calming." Green was due to personal preference and its connection to nature. Dark teal was "most pleasant and most conducive to a calm state." Bright teal was an "unusual color" that is "not so hot of hue that makes [them] anxious but not so cool to make [them] feel sad or icy cold." Light blue was selected because it was "calm, nostalgic, [and] pleasant."

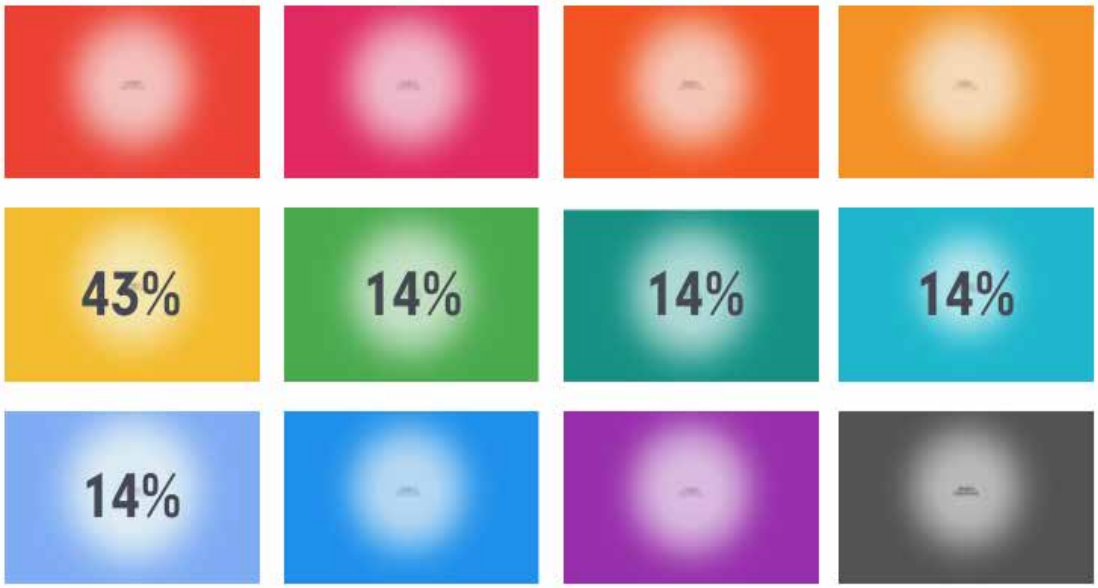

Table 16. Phase II, Part IV: Hue Preference.

Results

Overall, 100% (7/7) of participants felt the direction of the movements and simplicity of the visualizations either *somewhat* enhanced their experience 43% (3/7) or enhanced their experience 57% (4/7). One participant stated "the growing/shrinking animation of the circle in these designs correctly mapped up with my inhaling/exhaling in my mind, so they were all fairly present to breathe with." One user suggested that the breathe out cue may not be necessary, pointing to the fact that the cue option may need to be optional.

Insights

The insights from phase II showed user preference for designs that had less contrast, included a brighter vs. a darker focal point, were not too high in brightness, were smoothing in movement, and were more calming/pleasant in appearance. While the results showed a slight preference for cooler designs as being more relaxing and calming, warmer designs also received

positive remarks due to their positive associations with sunlight, warmth, and happiness. In regards to brightness/saturation, there were no participants that favored the brightest design with the lowest saturation. A mid to low-level brightness in this instance was found to be the most pleasing to the eye. While the data on color saturation was inconclusive, in the final phase, it is worth noting that no users selected hot colors such as red, magenta, bright orange, or bright purple. No participants selected gray or bright blue. Amber yellow had the most selections. Based on this data, the design may need to move in the direction of a color palette that is alive, warm, or vibrant, yet not harsh or too bright. Inspiration from colors found in nature may be a good area to explore. One other detail that emerged was that one user commented on how the “breathe out” text felt unnecessary after they read “breathe in slowly.”

CHAPTER 5

Phase III

The third phase looks at the connection between breath awareness and imagery. The imagery in other device-mediated breathing technologies varies and includes circles, waves, human representation, geometric forms, and nature-based visuals—some seemingly more successful than others. Earlier prototypes of this study were simple, and this phase looked at the desired level of complexity for a breathing application. The focus here is primarily on how breath awareness, assessed through subjective user perception, might be supported using motion visuals in a browser-based application. This phase will explore the user's ability to synchronize, or entrain, their breath to various imagery.

Procedures

Participants were asked to use a desktop or laptop computer. The participant breakdown for each part is as follows: prototype 1 (9 responses), prototype 2 (8 responses), prototype 3 (8 responses), prototype 4 (8 responses), and preferred design questionnaire (8 responses). Before starting, they were also asked to turn off all sound and expand their browser to fill their entire viewing area. The entire phase was to be completed in one sitting. This phase included four prototypes followed by a short questionnaire. The phase concluded with one final questionnaire. The prototyping sequence was broken down into the following:

- Prototype 1
- Prototype 1 questionnaire (See Appendix I)
- Prototype 2
- Prototype 2 questionnaire (See Appendix I)

- Prototype 3
- Prototype 3 questionnaire (See Appendix I)
- Prototype 4
- Prototype 4 questionnaire (See Appendix I)
- Final questionnaire (See Appendix J)

For each prototype, participants were asked to breathe in and out with the visualization for approximately one minute (5–6 full breaths) before moving on to the survey. Users were welcome to breathe longer if they desired. Following the breathing exercise, users were asked to complete a brief questionnaire (See Appendices I and J). Each prototype opened with the text "press spacebar to begin" and "click anywhere to end." The only text present during the breathing exercise were two, small text-based cues that istructed the user to "breathe in, fill your entire body" and "breathe out, effortlessly and completely." Prototype 2 excluded the breathing cues and included only the visual animation. The text faded in and faded out with each inhalation and exhalation.

Prototype 1: Sacred Geometry

The first prototype of Part III included sacred geometry imagery (Figure 17). The respiratory rate for the animation was set to 10 seconds with 4 seconds for inhalation and 6 seconds for exhalation. Participants that did not feel this imagery was easy to breathe along stated that the intervals of the image expanding/contracting were choppy or not as smooth or fluid as the users desired. One user stated, "the shapes…were not added smoothly, but rather in 2 or 3 intervals, which kind of broke up my breathing a bit." One participant that strongly agreed that this design was easy to breath with mentioned that, "the shape was intricate enough to draw me out of my own head without being busy. I also really liked the shade of blue." Another found the design easy

to breathe along with because it moved in time with deep breaths. While the complexity of the design *did* attract more attention, many felt this prototype was not smooth enough. One user felt the design made them anxious. Many found the design to be pleasant, beautiful, or "flower-like." This phase suggests that geometric imagery can be integrated if the design is fluid.

Prototype 2: Human Representation

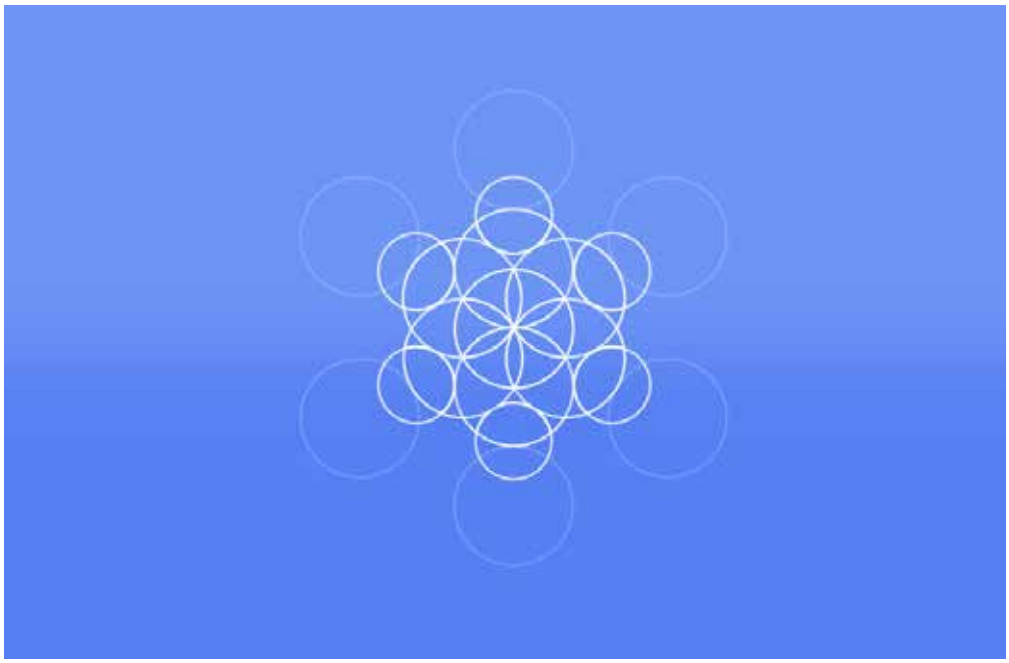

Figure 17. Part III: Sacred Geometry.

The second prototype of Part III included a motion design of human representation (Figure 18). Respiratory rate for the animation was set to 9 seconds with 4 seconds for inhalation and 5 seconds for exhalation. This visual received lower ratings than anticipated. One user commented that the visuals resembled lungs and found the animation helpful. Another found the literal representation easy to understand. It was stated that the fluidity of the movement and transition of color made the experience more effective. Other participants had a diminished experience due to the lack of clarity with inhaling and exhalation. 3/8 participants described the design as busy or

Figure 18. Part III: Human Representation.

having "too much going on." This phase did not include text-based cues and relied solely on the visual direction, though the visual affordances here were lacking. One user had to watch it cycle twice before understanding how to breathe correctly. Preferred aspects of this design included the colors, the yogi, the animation, the circles, the fluid movement, the human representation, and ease of understanding. Less preferred aspects of this design included the complexity, conflicting movement, distracting circles, pacing of the circular lines moving too quickly, direction of the circles, multiple focal points, the forward movement of the figure in space, and too literal representation.

Prototype 3: Natural Landscape

The third prototype of Part III included a motion design inspired by a natural landscape of an ocean scene (Figure 19). The respiratory rate for the animation was set to 10 seconds with 4 seconds for inhalation and 6 seconds for exhalation.

Figure 19. Part III: Natural Landscape.

4/8 participants strongly agreed this visualization was easy to breathe along with, and strongly agreed that they felt present while breathing along with this visualization. 3/8 participants somewhat agreed this visualization was easy to breathe along with, and somewhat agreed that they felt present while breathing along with this visualization. One participant felt neutral on how easy the visualization was to breathe along with, and their feeling of being present stated that the "complex feature/image may be too large of a file format which causes a lagging movement to the prototype." Preferred aspects of this design include the relaxing quality of the water/ocean imagery, the animation, the slow pacing and subtle quality, and the natural forms to emphasize focus on breathing. One user liked the imagery "was more than just coloring." Another stated it "felt serene." Less preferred aspects included the static quality of the water image, the brightness and desaturation of the sky, the lack of fluid motion, and overly literal. One participant stated "the water didn't come up high enough" and another added that they "started to get sea

sick." One insightful comment suggested, "I didn't experience this but as a person afraid of water, I could see the concept of a screen filling up with water as resembling a room filling up with water – potential for signaling claustrophobia, and drowning fears. The waves flowing forward and back is more like a calming ocean or lake."

Prototype 4: Diffused Orb

The fourth prototype of Part III included a motion design of a diffused orb (Figure 20). The respiratory rate for the animation was set to 10 seconds with 4 seconds for inhalation and 6 seconds for exhalation.

Figure 20. Part III: Diffused Orb

75% (6/8) strongly agreed that visual was easy to breathe along with. 63% (5/8) strongly agreed that they felt present with this visual. One participant scored this visual as lower on ease of breathing with visualization and presence. Color may have played a role in their opinion as they remarked they found it "off-putting." The participant that rated the design as neutral also due to the color. Positive remarks on the design include the simple movement, non-distracting imagery,

the circle representing breathing, the option to close their eyes and focus on breathing internally, a singular and fluid focal point, and subtle and less literal imagery. One user stated, "I was able to focus on my breathing and hold my attention on it." 50% of users compared the design to the sun. Another person stated the visualization was "easy on the eyes." Negative remarks were few, though three users suggested changing the color. Another requested that the words stay up, "even very faintly."

Preferred Design Questionnaire

Immediately following the testing of all of the prototypes, users were asked to select their preferred designs on improving their focus on breathing (Table 17), creating the greatest feeling of relaxation (Table 18), and creating the greatest feeling of mental relief (Table 19).

Table 17. Phase III: Focus on Breathing. "Out of the 4 prototypes, which one did you feel most enhanced your focus on your breathing?"

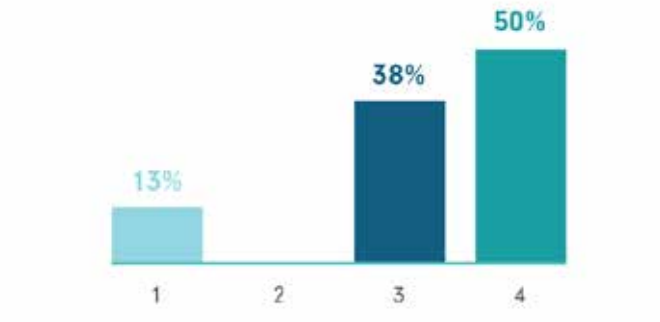

Table 18. Phase III: Relaxation. "Out of the 4 prototypes, which design created the greatest feeling of relaxation?"

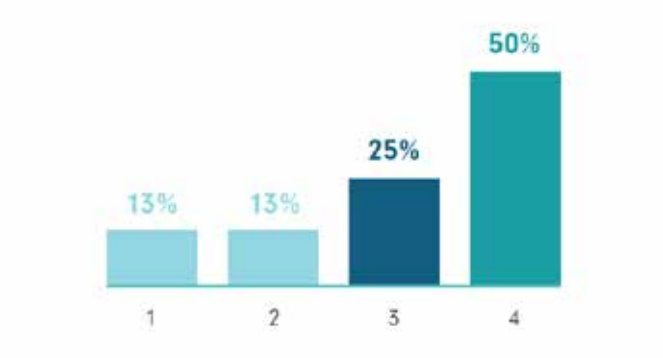

Table 19. Phase III: Mental Relief. "Out of the 4 prototypes, which design created the greatest feeling of mental relief (reducing cognitive overload)?"

50% of participants (4/8) selected the final diffused orb design as their preferred design for enhanced focus on breathing, greatest feeling of relaxation, and greatest feeling of mental relief. The human representation and geometrical design received the least votes. The second highest preferred design was the natural scene. One user stated, "I think natural images that I'm familiar with (water, sun, etc.) are the most relaxing for me. There's a very subtle amount of friction present when I'm expected to breathe along with something I haven't seen yet, like a series of line."

Results

Following each prototype user testing, individuals were asked to rate each prototype based on ease (Table 20), breathing with imagery (Table 21), and presence (Table 22) using a Likert scale of 0(strongly disagree)–4(strongly agree). The tables below illustrate the rating comparison between each of the four prototypes.

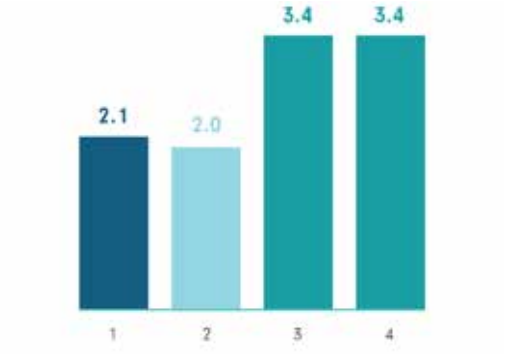

Table 20. Phase III: Ease. "It was easy to breathe along with this visualization."

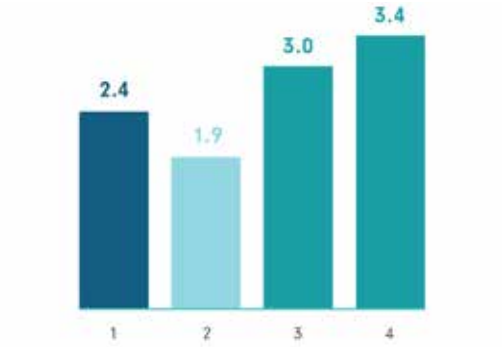

Table 21. Phase III: Breathing with Imagery. "Did the visual imagery diminish or enhance your breathing experience?"

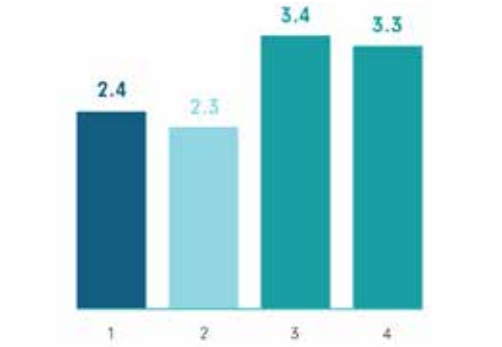

Table 22. Phase III: Presence. "I felt present while breathing along with this visualization."

Visual representation can be effective, especially using natural forms, but the meaning of the experience needs to be thoroughly considered. For example, the natural imagery of water moving up and down, while calming and serene for some, could trigger drowning fears for others. A more successful imagery of water might include water flowing in and out smoothly from side to side, although testing would need to be done to determine if this would be associated with breathing. A calming image is not necessarily one that will best facilitate the process of breathing, though it seems the imagery itself must be calming. The results are inconclusive where unfamiliar, or complex imagery can be used. Thoughtful consideration and testing must go into designs that move in this direction. Breathing awareness seems to be a somewhat vulnerable, expansive state and designs that are unfamiliar can cause a viewer to be unsettled. Designs that are unnecessarily

complex can be distracting. One participant added that they thought the "fluidity and a consistent visual cue is an important element that allows better focus and relief from our busy lives."

In reviewing the feedback from the previous three phases, preference has been given to designs that encompass more of the qualities in the left column below (Table 23).

MINDFUL VISUALS facilitates relaxed alertness and cognitive relief	MINDLESS VISUALS promotes stress and cognitive overload
expansive	constricting
minimizes distraction	distracting
simplified	complex/busy
fluid movements	jarring movements
soft/subtle	bold/harsh
positive associations	negative associations
singular focal point	multiple focal points
ease	difficulty

Table 23. Qualities of Mindful vs. Mindless Visuals

CHAPTER 6

Phase IV

The final phase of prototypes took into consideration data acquired from the first three phases. Users were asked to assess their mindfulness level before starting their day using a self-reported mindfulness questionnaire. A link directed users to the prototype, where they were requested to use the tool a minimum of 5 times over the course of one work day. At the end of their day, users were instructed to reassess their mindfulness levels. This phase primarily assessed how using a breath-awareness visualization within a browser influenced their overall quality of mindfulness. With some users preferring warm designs and other users preferring cooler designs, users were provided with the choice of color each time the tool is accessed. Users were not required to breathe for a minimal amount of time to allow users to decide their completion. For the final phase, the prototype (Figure 21) included fading buttons in the lower right-hand corner for changing the color, expanding to fill the screen, or turning cues on/off. Due to success in previous prototypes with pacing, the respiratory rate for all three animations was set to 10 seconds with 4 seconds for inhalation and 6 seconds for exhalation. This decision was supported by the research on the pacing of resonant breathing exercises. The softness of the designs provided the user with flexibility in stopping and beginning each inhalation and exhalation.

Procedures

Rather than finishing in one sitting, users were requested to use the tool for the duration of one day—preferably during an extended period of using a desktop computer (minimum of three hours). Testing over one full day, in their natural environment, will allow insights about how this type of tool can exist within one's day-to-day life.

Figure 21. Part IV: Extended Usage in Context.

The steps of this phase were broken down into the following:

- ***In the morning***: Complete a short 2-minute survey (See Appendix K).
- ***During the day***: Users were asked to open the prototype link and leave it open in a browser tab throughout the day. During some of the times they utilize a browser (to check email, browsing, doing a search), they were requested to breathe along with the tool. All participants were asked to use the tool a minimum of 5 times through the day for any length of time that feels good to them. There was no min/max time because they were to interact with the tool as they would throughout a normal day.
- ***End of day***: Complete a final 15-minute survey (See Appendix L).

10 participants completed the initial questionnaire, but only 7 completed the final questionnaire. To keep the information anonymous, Network IDs were tracked using Typeform to connect the two surveys; however, one participant may have completed their last survey from a separate location and on a different day, which made their mindfulness level data unable to be used for the purpose of the change in mindfulness state. 6 participants were able to be assessed on their before/after state changes.

Initial Questionnaire

The initial 2-minute questionnaire was to be completed at the start of their day or time working in front of the computer. The goal of the initial questionnaire was to evaluate the initial state of mindfulness of the user (Appendix K). Mindfulness was evaluated in the final phase using the condensed 5-item, state version of the Mindful Attention Awareness Scale (MAAS) (Brown & Ryan, 2003).

Final Questionnaire

5/6 participants that were able to be assessed for the mindfulness state portion of the final phase saw an improvement in their mindfulness state score (Table 24). The lower the score between 0–6, the higher their mindfulness state.

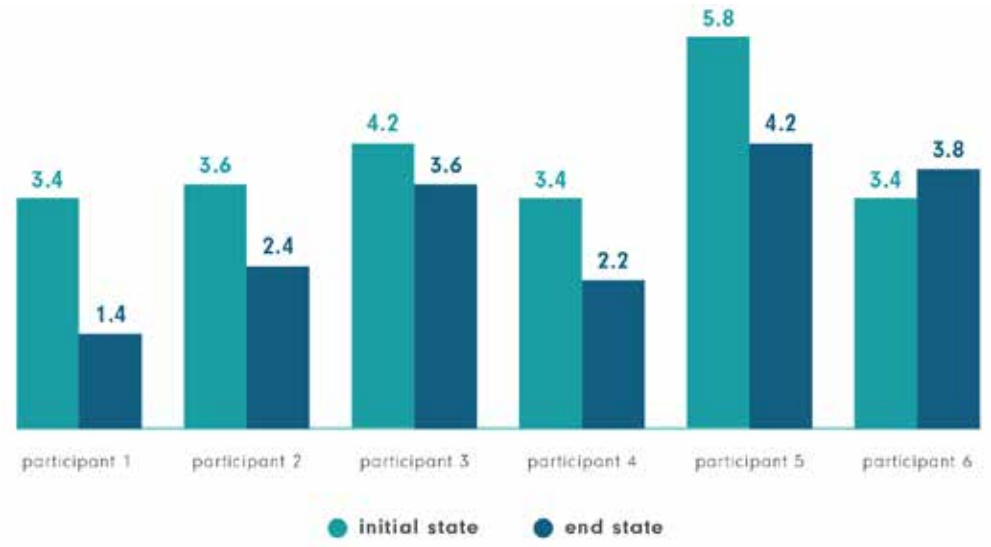

Table 24. Before and After Mindfulness State Change

Results

57% (4/7) participants tested over a duration of 5–6 hours, 29% (2/7) tested for 7–8 hours, and 14% (1/7) user tested over a period of 3–4 hours. Users reported as using the tool a total of

5 (3/7), 6 (3/7), and 8 times (1/7). Participants were also asked to select approximately how long each breathing session was. All sessions were reported as being under 2 minutes and some as short as 10–30 seconds. In regards to the timespan, one participant stated that the duration was influenced by his stress levels at work. When stressed they broke away from their work task and "used the tool to calm down and get my head back on track."

Participants were asked questions regarding their experience breathing along with the visuals (Table 25–26), as well as using the tool within the context of their daily environment (Table 27). Regarding pacing, 5/7 participants felt the speed of the pacing was just right. However, 1/7 felt the speed was too slow. 1/7 felt the speed was too choppy (Table 28). Reviewing the results, it seems one user may have experienced technical difficulties with loading the animation as it appeared choppy on their end. More testing would need to be done to minimize these effects for later rounds of development.

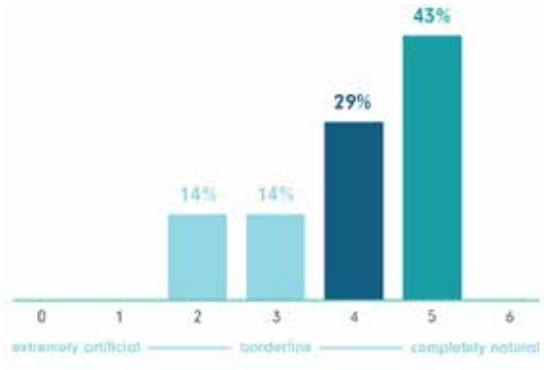

Table 25. Phase IV: Natural Breathing. "How natural did your breathing along with the visualization seem?"

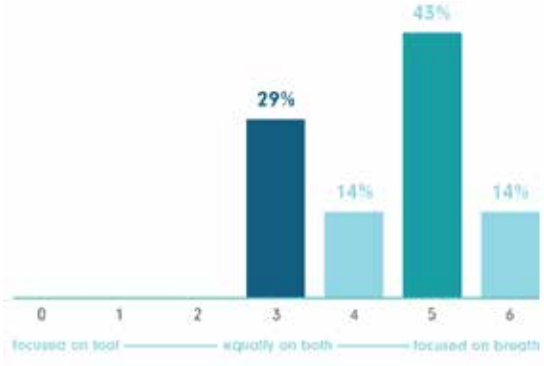

Table 26. Phase IV: Tool vs. Breath. "When breathing with the tool, did you feel more focused on the tool or on your breath?"

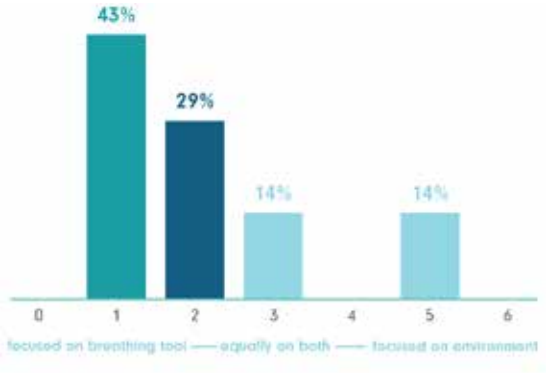

Table 27. Phase IV: Tool vs. Environment. "When breathing with the tool, did you feel more focused on breathing with the tool or more focused on your external environment (workspace, desk, etc.)?

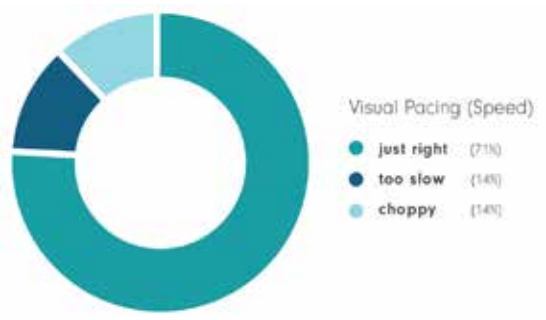

Table 28. Phase IV: Visual Pacing (Speed).

In exploring functionality that would enhance breath awareness, users were asked whether they had a desire for a timer functionality. 7/7 user stated they did not feel a timer was necessary and would be distracting. One user postulated that it might be nice to have a timer that popped up after extended periods of time to show elapsed seconds. A participant poignantly stated that a timer would defeat the purpose. Another added, "I felt like these breaks were the few times in my day where I didn't need to complete with a clock."

This round included the ability to change the interfaces colors and text-based cues. Users were asked following testing how this functionality enhanced or diminished their experience. The color option received mostly positive remarks. One stated, "when I was feeling cold, it was nice

to have warm colors. When I needed to focus, I went with the blue." Another added, "I switched colors each time I used the tool. I believe that it added a sense of control over it that was lacking in previous versions." One user did not use this option much because they felt they did not need a new color. Another did not care for two of the colors and most preferred the teal-blue color. Users were also asked to select which color was easiest to breathe along with (Table 29), as well as enhance presence (Table 30). In regards to cue (instructions of "breathe in" and "breathe out"), what most enhanced your awareness of breathing? Preference for turning on and off text-based cues varied with fewer individuals wanting them for their entire session (Table 31).

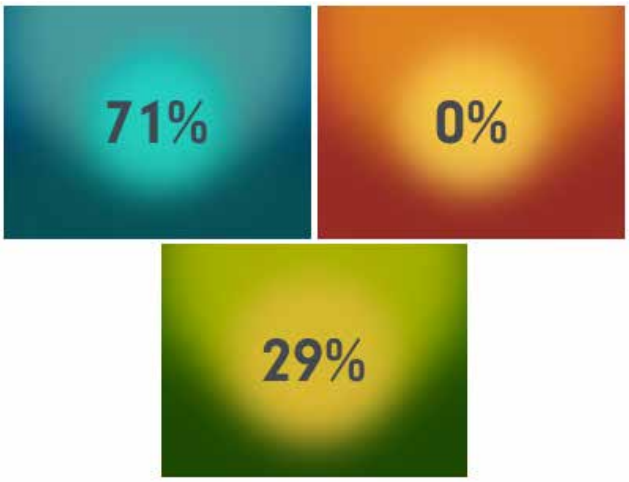

Table 29. Phase IV: Ease. "Out of the 3 colors, which one did you feel most enhanced your focus on your breathing? "

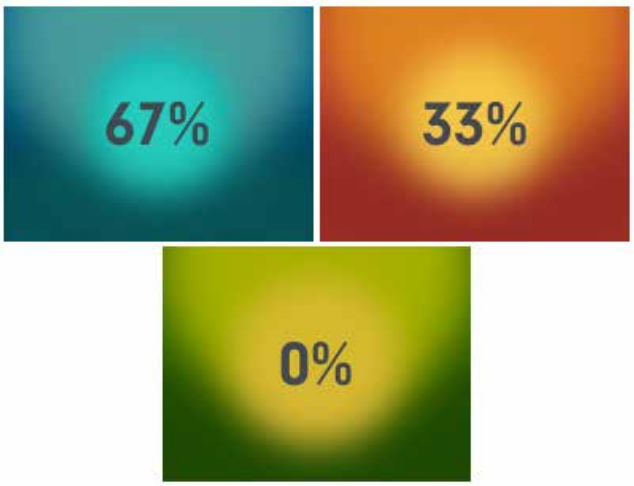

Table 30. Phase IV: Relaxation. "Out of the 3 colors, which one did you feel most enhanced your feeling of relaxation?"

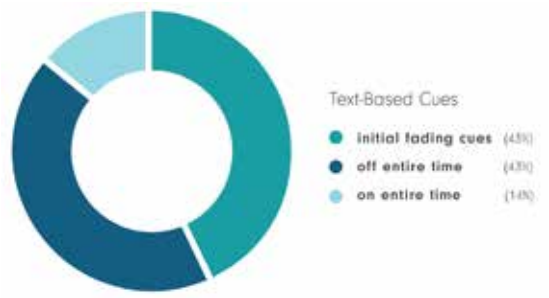

Table 31. Phase IV: Text-Based Cues.

Reasons users were prevented from or pulled away from using the visualization:

- The animation was choppy at times
- User felt done and ready to get back to work
- Distraction of coworkers, work, and the environment
- Distraction of other content on screen

Reasons users were prevented from using the tool on a daily basis:

- Forgetting (need for a reminder)
- Meetings
- Busyness
- "My job wondering why I'm taking breaks to look at a screen"
- "I liked having flexibility to do it when I had time – adding it to my schedule as yet another chore to do would actually decrease my likelihood of using it."
- Technical difficulties and browser compatibility
- Lack of audio options

Comments on what users liked most about using the tool throughout the day:

- "In stressful times, I loved having the ability to switch tabs and utilize a tool that relaxed me, helped me re-focus, and cleared my mind."

- "I enjoyed the serenity and non-geometric shape of it. I found it relaxing to have it open in a smaller window where I could see some of what was happening on the desktop. If I had full screened it, I may have gotten anxious and worried about what I should be doing that I was neglecting for the 30 seconds of my break."
- "I liked the reminder to focus on breathing. I liked the calming color."
- "It was very simple and inviting."
- "I actually broke away from doing mindless work and really focused on getting a few good breaths of air in me. It's very rare I think these days that we actually breath how we should be because a lot of people work jobs where you have so much to concentrate on instead of yourself."
- "It was a welcome break where I could clear my head - usually I take a break from my work by finding something else to think about (e.g., sports, hobbies)."

Comments on what users disliked most about using the tool throughout the day:

- Leaving a tab open all day
- Using the tool without coworkers noticing
- The desire to relax but being unable to due to distractions (outside the tool)

Comments on anything missing from the tool:

- That the controls not disappear completely
- A method to turn off the looping animation
- Music – "calming, meditative music I could plug in to assist my breathing"
- "I didn't want a speed adjustment, but I can see why some people might"

CHAPTER 7

Discussion

The results of this study challenged the initial assumptions regarding needing a brighter focal point, as well as complex imagery and functionality to produce novelty. The notion that a brighter focal point would be preferred was only partially supported. While a brighter focal point was favored to a darker focal point, "too bright" of a focal point was not preferred and hard on the eyes. Another assumption was that tool would need increasing complexity to be effective, while the opposite proved to be true. Designs that were more complex were less forgiving for breath entrainment and could increase viewer stress. Users seemed to welcome a simplified, spacious break from the ongoing visual noise of long-term digital activity. Preference was given to designs that were expansive, minimized distraction, simplified, fluid, soft/subtle, embodied positive associations, and included a singular focal point. These mindful qualities facilitated less having to *try to* figure anything out and allowed more opportunity to relax into the awareness of their breath (Table 23).

Interactive Controls

Despite initial assumptions that a screen-based breath awareness tool may require more complexity in features, users leaned toward simplification. Requiring the user to think too heavily about *how* to customize a breathing tool pushes against the grain of the tool. Many of today's applications have countless options that promote mental overload and confusion. The challenge with designing breath awareness technologies is understanding the ideal parameters for each user while maintaining simplicity. Determining the ideal parameters for individual use was unattainable through the current prototype; however, patterns emerged that informed which options needed to be customizable.

In deciding what elements might be customizable, there needs to be a balance between simplicity and functionality. Too much cognition compromises the experience of internal spaciousness. Some options varied in their responses so heavily that customization would be necessary to a certain extent—color preference and text-based cues. This finding is in line with research by Pirhonon and colleagues (2011). They also suggested that parameters that have a lot of variation in their selected values, such as color preference, might be best met with customizable features. The customizable parameters included in the final phase of research included:

- 3 color variations account for variance in personal preferences. Color changing received position remarks for user experience.
- Inhale/Exhale cues: on | off | initial fading (Table 31).
- Full-screen functionality. Some participants enjoyed this option, while other liked the ability to leave the screen smaller so they would not miss incoming work messages.

This research was rooted in iterative prototyping which limited the ability to reduce all technical issues involved with remote testing. One user experienced technical difficulties with loading the animation as it appeared choppy on their end. Development of a refined tool would require more testing to reduce these effects significantly.

Suggestions for Future Research

The primary focus of this study remained on the rhythmic visualizations. Breathing sensors were not used which may provide real-time pacing information to more accurately assess the user's entrainment with the tool. Monitoring this data could help to elucidate additional pacing needs beyond the scope of this research. The integration of audio was intentionally omitted in this study to remain centered on breath awareness in connection with visuals within the context

of long-term screen users. Understanding the relationship of visual motion and the integration of sound may provide opportunities to heighten the user's entrainment with the tool. For this particular audience, there are pros and cons to including an audio-based sensory input. Some users may be surrounded by their working environment and find the audio to be distracting, embarrassing, or simply undesirable. For others, it may allow them to close their eyes one their breathing is entrained to the visual and take a break from the constant visual input. Future testing would be needed in this area to more fully understand user needs.

This research supported the design manifesto that *less is more* where the key is to find the threshold where nothing is lost or lacking in the simplification. More research is needed in the area of how much customization is necessary before it becomes a hindrance. Considering the user's experience, it is also important to give attention to which opportunity points require customization or further simplification. Being confronted with a complex panel of customizable options every time a change is desired may be overwhelming. One participant stated that they liked changing the color based on how they were feeling. Choice points where a user has to completely stop and think could be counter intuitive to the functionality of the tool. Moving forward, mindful design researchers can explore how tools can create and *hold space* for someone in a way that they can lean into rather than having to cognitively navigate. More exploration is needed on how users can easily flow into soft, open experiences in ways that are not abrupt in nature.

It is important to meet users where they are. As users are spending copious amounts of time using desktop/laptop devices anytime soon, the *initial* experience may need to begin there. There are various options for where this tool could live on a desktop: a website, application, browser

extension, etc.. Interrupting users through notifications can promote stress. The question arose how to remind users to breathe without distracting them. However, it is also worth mentioning that the solution for creating mindful experience for long-term desktop users may not be solely dependent on a single technological platform, but one that can to translate across multiple tools. The context of this tool for long-term desktop/laptop screen users tends to be a working environment, though the implications of this research are transferrable. As the research of this study is foundational to the visual components of mindful experiences, there are boundless opportunities for these findings to expand outward in varying directions. The mindful insights garnered here apply to the visuals of other mindful design endeavors.

Conclusion

Long-term screen users spend a good portion of their days looking at a digital box filled with complex visual content. By regarding the desktop computer space as a virtual landscape, designers can re-envision how those experiences are either pulling us away from or bringing us closer to mindful awareness. Connecting the visual components of rhythmic visualizations with the mindful awareness of breath, a mindful visual language has emerged. These guiding principles can be used to inform designers that prioritize mindfulness. While the locus of attention always remains with the individual, technology can function as a seamless reminder that our attention was elsewhere—away from well-being, things that truly matter, or even our breath. The goal of mindful design centers upon the conscious awareness it generates. This study demonstrates both an intrinsic need and positive response for tools and systems that allow people to return to themselves—and the implications are worth *paying attention to*.

APPENDIX A

Research Introduction

Breath Awareness Design Research Study

You are being invited for screening to participate in a design research study being conducted for my MFA thesis in Visual Communication Design at Kent State University. The results of this form will also help me to better understand user needs. If you are selected for future phases, I will be in touch (by email) over the coming weeks to discuss more details about the user testing.

This research introduction, informed consent, and anonymous survey will take approximately 15 minutes to complete.

Purpose: The purpose of this study is to gain valuable feedback for the purpose of developing a web-based tool to facilitate mindfulness, through breath awareness, while interacting with desktop / laptop screens for prolonged periods of time.

Opportunity: The opportunity for this design research is in response to what Linda Stone, technology consultant, calls "screen apnea," or the experience of shallow breathing or breath holding while doing email, or while working or playing in front of a screen. According to Stone, 80% of people do not breathe properly when using screen devices and the implications are increased stress levels, diminished emotional well-being and attitude, as well as reduced productivity. Mindfulness-based design, or mindful design, creates opportunities for users to become more attentive to their present state of awareness. A growing body of scientific evidence recognizes the potential mindfulness has to reduce stress, manage pain, and improve overall well-being.

Location and Phases: The research will unfold in multiple phases—still to be determined—

that will primarily focus on remote user testing of prototypes. As this tool is context-dependant, the testing will take place remotely while working in your native environment.

Technical Requirements: All participants must have access to a laptop or desktop computer with internet browser access during user-testing sessions.

Voluntary Participation: Your participation is strictly voluntary and you may withdraw your participation at any time without penalty. You will not be charged or paid anything to participate in this study. All participants must be over the age of 18.

Length of Time: This study will be conducted through March 2017, with each phase lasting a different amount of time. During each phase, you will be given instructions with the anticipated amount of time to complete. Participation is always voluntary and you may withdraw your participation at any time.

Thank you for your time,

Cassandra Reese

APPENDIX B

Informed Consent and Non-Disclosure Agreement

Thank you for participating in this survey. Your feedback is valuable and will shape the direction of the research. Please answer the following questions as honestly as possible. Any of the questions can be skipped if you do not wish to answer or if they do not apply to your life.
I do not anticipate taking this survey will contain any risk or inconvenience to you. Furthermore, your participation is strictly voluntary and you may withdraw your participation at any time without penalty.

Confidentiality of Your Data. All information collected will be used only for my research and will be kept confidential. There will be no connection to you specifically in the results or in future publication of the results. Your name or email address will not be included in any report of the results of this study. Data will be reported in the aggregate or, if any individual comments or data are included, they will be reported without naming the individual.

Confidentiality of Design Research. The content (questions, prototypes, designs, etc.) are intended to be confidential. Please do not share the information you see with anyone.

Once the study is complete, I would be happy to share the results with you if you desire. In the meantime, if you have any questions please email Cassandra Reese at cass.reese@gmail.com.

Informed Consent. By clicking "I accept" you are verifying that you have read the explanation of the study and that you agree to participate. You also understand that your participation in this study is strictly voluntary.

- □ I accept
- □ I don't accept

APPENDIX C

Initial Survey

1. On average, how many hours per week do you work on a desktop / laptop computer?

   □ Less than 10 hours
   □ 10–20 hours
   □ 20–30 hours
   □ more than 20 hours

2. During the time you spend on a desktop / laptop computer, how many of these hours per week do you utilize an internet browser (Chrome, Safari, Internet Explorer, Firefox, etc.)?

   □ approximately the entire time
   □ less than 10 hours
   □ 10–20 hours
   □ 20–30 hours
   □ more than 30 hours

3. When going to a new website in a browser, do you prefer:

   □ to open a new window
   □ to create a new tab
   □ to open the page in my current tab/window (avoid creating new tabs/windows)

4. If you prefer to create new tabs or windows, how many do you tend to have open at one time?

   □ 1
   □ 2–5
   □ 6–9
   □ 10–19
   □ 20+ tabs

5. Technostress is defined as stress or psychosomatic illness caused by working with computer technology on a daily basis. Do you experience technostress when working on computers for prolonged periods of time?

- □ I don't feel stressed at all
- □ Yes, but my stress is low
- □ Yes, but my stress is about the same when I'm off the computer
- □ Yes, my stress is higher than normal
- □ Yes, my stress is extremely high

6. If you do experience technostress, what factors have the greatest influence over your experience of stress? Choose as many as you like.

- □ I do not experience technostress
- □ inexperience with computers
- □ lack of training
- □ performance anxiety
- □ overworked
- □ information overload
- □ using multiple interfaces simultaneously
- □ fast pace of work day
- □ fast pace of technological change
- □ lack of breaks
- □ from technology
- □ other

7. Are there any other factors not listed that contribute to your experience of technostress?

8. **Mindfulness** is the secular practice of maintaining moment-by-moment awareness of our thoughts, feelings, bodily sensations, or surrounding environment. A growing body of scientific evidence recognizes the potential mindfulness has to reduce stress, manage pain, and improve overall well-being. Mindful technologies are tools created for the purpose of stimulating more awareness. Some examples include apps (Headspace, MyBreath), wearables / trackers (Spire, Bella Beat, Prana, Apple Watch), biofeedback devices (Resperate),

browser extensions (Breathe), etc. Do you have any experience using these tools? If so, please state what it was and your length of time using the device.

9. If you used a mindful technology in the past, please explain your perception of the tool. Did it serve any value to your life? If not, why?

10. What factors, if any, affected your decision to use a mindful technology?

Choose as many as you like.

- □ did not know they existed
- □ lack of interest
- □ lack of time
- □ novelty: lost interest over time
- □ price
- □ lack of value to my life
- □ distracting
- □ other

11. Are there any other factors not listed that may have impacted your limited use of mindful technologies?

Please rate the following statements:

strongly disagree (0) ——— (2) neutral ——— (4) strongly agree

12. I am interested in mindfulness.

13. I practice mindfulness on a daily basis.

14. I practice mindfulness on a weekly basis.

15. I pay attention to the quality of my breathing.

16. I am open to trying a tool that could improve my level of mindfulness.

APPENDIX D

Phase I Prototype Questionnaires 1–4

After testing each of the four prototype, each user was asked to answer the following questions.

1. It was easy to breathe along with the visualization.

   strongly disagree (0) ——— (2) neutral ——— (4) strongly agree

2. Why or why not?

3. I felt present while breathing along with this visualization.

   strongly disagree (0) ——— (2) neutral ——— (4) strongly agree

4. Why or why not?

5. Did the direction of the movement diminish or enhance your breathing experience?

   diminished experience (0) ——— (2) neutral ——— (4) enhanced experience

6. Did the simplicity of the animation diminish or enhance your overall experience?

   diminished experience (0) ——— (2) neutral ——— (4) enhanced experience

7. Comments:

APPENDIX E

Phase I Final Questionnaire

1. Out of the 5 prototypes, which one is your preferred design?

   strongly disagree (0) ——— (2) neutral ——— (4) strongly agree

2. Comments:

APPENDIX F

Phase II Prototype Questionnaire 1

1. Out of the four designs, which visualization felt the easiest to breathe along with?
2. Out of the four designs, which visualization did you feel the most present with?
3. Why did you select this design? *Please note if you did not experience any difference in presence or ease between the designs.*
4. Did you prefer a brighter (designs 1+3) or darker (designs 2+4) focal point?

   □ brighter focal point □ darker focal point

5. Comments:

APPENDIX G

Phase II Prototype Questionnaires 2–3

1. Out of the four designs, which visualization felt the easiest to breathe along with?
2. Out of the four designs, which visualization did you feel the most present with?
3. Why did you select this design? *Please note if you did not experience any difference in presence or ease between the designs.*
4. Comments:

APPENDIX H

Phase II Final Questionnaire

1. Did the direction of these movements diminish or enhance your breathing experience?

   diminished experience (0) ——— (2) neutral ——— (4) enhanced experience

2. Did the simplicity of these visualizations diminish or enhance your overall experience?

   diminished experience (0) ——— (2) neutral ——— (4) enhanced experience

3. Comments:

4. Please select which hue you are most drawn to for practicing a mindful breathing exercise.

5. Was there a reason you selected that particular color? If not, how does that color make you feel?

6. Comments:

APPENDIX I

Phase III Prototypes Questionnaire 1–4

1. It was easy to breathe along with this visualization.

   strongly disagree (0) ——— (2) neutral ——— (4) strongly agree

2. Why or why not?

3. I felt present while breathing along with this visualization.

   strongly disagree (0) ——— (2) neutral ——— (4) strongly agree

4. Did this visual imagery diminish or enhance your focus on breathing?

   diminished experience (0) ——— (2) neutral ——— (4) enhanced experience

5. What did you like about this imagery?

6. What did you dislike about this imagery?

7. Comments:

APPENDIX J

Phase III Final Questionnaire

1. **Out of the 4 prototypes, which one did you feel most enhanced your focus on your breathing?**
2. **Out of the 4 prototypes, which design created the greatest feeling of relaxation?**
3. **Out of the 4 prototypes, which design created the greatest feeling of mental relief (reducing cognitive overload)?**
4. **Comments:**

APPENDIX K

Phase IV Initial Survey

Welcome to the final phase of my breath awareness design research study. Please answer the following questions before beginning.

1. First, where are you planning to use this tool?

- □ At work
- □ While working from home
- □ Extended leisurely browsing
- □ Other

2. For each of the following statements, select a number from 0–6 that best describes what really reflects your experience of the first part of your day today (getting ready for work, driving to work, preparing breakfast, etc.)

not at all (0) ———— (3) somewhat ———— (6) very much

a. I was finding it difficult to stay focused on what was happening.

b. I was doing something without paying attention.

c. I was preoccupied with the future or the past.

d. I was doing something automatically, without being aware of what I was doing.

e. I was rushing through something without being really attentive to it.

Please leave the following tool open in a browser tab during the day (or in some way accessible) to simulate a browser extension. Access it five times throughout the day while utilizing your browser.

***Remember to take the final survey at the end of the day.**

APPENDIX L

Phase IV Final Survey

1. **For each of the following statements, select a number from 0–6 that best describes what really reflects your experience during the part of today you used the prototype.**

   not at all (0) ———— (3) somewhat ———— (6) very much

   a. **I was finding it difficult to stay focused on what was happening.**

   b. **I was doing something without paying attention.**

   c. **I was preoccupied with the future or the past.**

   d. **I was doing something automatically, without being aware of what I was doing.**

   e. **I was rushing through something without being really attentive to it.**

2. **Over how long of a period of time (from first prototype use to final prototype use) did you test this tool?**

   □ 3–4 hours

   □ 7–8 hours

   □ 5–6 hours

   □ Other

3. **How many individual sessions did you use the prototype over the entire span of time?**

   □ 5 □ 7 □ Other

   □ 6 □ 8

4. **Approximately how long did you breathe with the visualization for each session?**

   a. **Session 1**

   □ Under 10 seconds □ 10–30 seconds □ 30–60 seconds

□ 1–2 minutes □ 2–5 minutes □ Other

b. Session 2

□ Under 10 seconds □ 30–60 seconds □ 2–5 minutes

□ 10–30 seconds □ 1–2 minutes □ Other

c. Session 3

□ Under 10 seconds □ 30–60 seconds □ 2–5 minutes

□ 10–30 seconds □ 1–2 minutes □ Other

d. Session 4

□ Under 10 seconds □ 30–60 seconds □ 2–5 minutes

□ 10–30 seconds □ 1–2 minutes □ Other

e. Session 5

□ Under 10 seconds □ 30–60 seconds □ 2–5 minutes

□ 10–30 seconds □ 1–2 minutes □ Other

f. If you used the tool more than 5 times, please describe how long your additional sessions were?

g. While breathing, did you have any desire for a timer functionality to track your session?

5. How natural did your breathing along with the visualization seem?

extremely artificial (0) ———— (3) borderline ———— (6) completely natural

6. Did you desire the ability to slow down or speed up the speed of the visualization?

□ No, the speed was just right □ Yes, the speed was too slow

□ Yes, the speed was too fast □ Other

7. **While breathing with the tool, did you feel more focused on breathing with the tool or more focused on your external environment (workspace, desk, etc.).**

   focused on breathing tool (0) — (3) focused equally on both — (6) focused on environment

8. **While breathing with the tool, did you feel more focused on the tool or on your breath?**

   focused on tool (0) — (3) focused equally on both — (6) focused on breath

9. **How compelling or visually rich was the visualization to breathe along with?**

   not at all (0) ———— (3) somewhat ———— (6) very much

10. **Select any/all the colors you used for a breathing session?**

    □ blue/teal □ red/orange □ green

11. **Out of the 3 colors, which one did you feel most enhanced your focus on your breathing?**

    □ blue/teal □ red/orange □ green

12. **Out of the 3 colors, which one did you feel most enhanced your feeling of relaxation?**

    □ blue/teal □ red/orange □ green

13. **How did the ability to change the color improve or diminish your experience?**

14. **In regards to cue (instructions of "breathe in" and "breathe out"), what most enhanced your awareness of breathing?**

    □ initial cues that fade out □ cues off entire time

    □ cues on entire time □ Other

15. **What reasons prevented or pulled you away from using the visualization?**

16. **What did you most like about using this tool throughout the day?**

17. **What did you most dislike about using this tool throughout the day?**

18. **Was there anything missing that you wish the tool had?**

19. **What might prevent you from using this tool on a daily basis?**

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