A Mobile-Based Mindfulness Intervention for Chronic Pain

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A THESIS SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OFARTS

Graduate Program in
CLINICAL PSYCHOLOGY
York University
Toronto, Ontario
August 2017

ABSTRACT

Very little is known about effective interventions for chronic pain in young adults. Available treatments are often inaccessible and unaffordable. The present study tested the effects of a newly developed 12-minute mobile-based mindfulness application on mood, pain intensity and present-awareness in four groups of university students (n=180) with chronic pain, symptoms of depression/anxiety, and condition-free controls with and without a mobile application. Results revealed that anxiety, distress, and anger were significantly reduced post intervention in participants with chronic pain and mood/anxiety symptoms. Pain intensity and present awareness remained unaffected post intervention. This study was one of the first to show the effectiveness of a brief mobile-based intervention in altering unpleasant mood states in young adults with chronic pain and depression/anxiety. These findings have highlighted the potential benefits of using technological interventions to improve mental health symptoms in individuals with chronic pain and symptoms of depression and anxiety.

ACKNOWLEDGMENTS

First, I would like to express my deepest thanks and sincere appreciation to my supervisor, Dr. Joel Katz, for his relentless support and mentorship. This project would have not been possible without his kind guidance and inspiration.

I would also like to thank my supervisory committee member, Dr. Karen Fergus, for her valuable comments, feedback and encouragement throughout this process.

In addition, I would like to thank my other committee members, Dr. Christo El Morr and Dr. Rebecca Pillai Riddell, for their time, knowledge and feedback.

I would also like to thank my lab colleague, Muhammad Abid Azam, for our insightful conversations, creative ideas, and fruitful collaborations.

And finally, thanks to my husband, son, parents, sisters, and brother in-law for their endless love, support and encouragement.

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Introduction

A recent survey of 41 Canadian post-secondary institutions with 44,000 respondents revealed that Canadian students are more stressed than ever. One in every five students has been diagnosed with a mental health condition by a healthcare professional. Specifically, 14% of students were diagnosed with depression, 19% with anxiety, and 11% with both (National College Health Assessment, 2016). Stress, depression and anxiety have been identified as the most common factors affecting students' academic performance. In the 12 months prior to the survey, 64.5% felt overwhelming anxiety, 44% felt so depressed that it was difficult to function, and 13% seriously considered suicide (National College Health Assessment, 2016). The reasons behind these alarming statistics remain unknown. Some blame the struggling economy and job insecurity in the market (McGee & Thompson, 2015). Others point to helicopter parenting as a potential contributor (Schiffrin et al., 2014). Yet others cite the rise of addictive technologies and social networks as contributing factors to individuals' low self-esteem, social isolation and depression (Andreassen et al., 2016). As with many socio-cultural-psychological phenomena, the causes seem to be complex, multifaceted, and often intertwined (Twenge, 2014).

On top of the alarming rates of mood and anxiety disorders in young people, there is a "silent minority" of young adults who suffer from chronic pain. They often feel invalidated by family and friends and isolated among their condition-free peers. They are more reluctant to seek help in order to avoid the stigma that comes with the term "disability" (APA, 2013; Kapoor, 2015). Regrettably, they are also more likely to suffer from depression, anxiety, and other mood disorders, which predisposes them to poorer clinical outcomes than having each condition alone (Castro et al, 2011). Unfortunately, they are one of the most understudied groups among chronic pain sufferers (Kapoor, 2015).

The aim of this research project was to better understand young adults with chronic pain and tap into their existing relationships with technology in order to build solutions to reduce distress, depression and anxiety, resulting, potentially, in improved overall functioning and quality of life. In a time when young adults are spending an average of 90 minutes a day on a popular dating app, and browsing their social media sites for an additional 50 minutes, it seems more important than ever to build technological tools that are economically viable, sustainable and "can actually enhance the world outside the device in our hand" (Bilton, 2014; O'Brian, 2016, p.1; Stewart, 2016; Stossel, 2016). The goal of this study was to make a small step in that direction.

Chronic Pain Definition

The International Association for the Study of Pain defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (Merskey & Bogduk, 1994, p. 250). This definition suggests that the experience of pain is complex and involves sensory, emotional, cognitive and social processes (Katz & Seltzer, 2009; Melzack & Katz, 2012; Williams & Craig, 2016). Traditionally, pain has been classified as either acute or chronic, with acute pain being short lived, biologically adaptive and responsive to existing biomedical treatments. Chronic pain, on the other hand, may be more resistant to biomedical treatments, and tends to last longer than three to six months, or "the time expected for normal healing" (Conn, 2005; Grichnik & Ferrante, 1991; Katz, Page, Fashler, Rosenbloom, & Asmundson, 2014). In fact, the median time of experiencing chronic pain is seven years (Goldberg & Mcgee, 2011).

Chronic Pain – Basic Epidemiology and Impact

Despite many advances in chronic pain research, it remains a clinical enigma and the multifactorial mechanisms behind it are still not fully understood (Neil & Macrae, 2011). The major causes of chronic pain are cancer, arthritis, injuries, surgeries, and spinal problems (Goldberg & Mcgee, 2011). However, it is not clear why some individuals cease to experience pain shortly after a triggering event, while others continue to suffer for a long period of time (Neil & Macrae, 2011). Research shows that pain severity is impacted by multiple inter-related aspects including pathological mechanisms (e.g., nerve injury, inflammation, disease), social factors (e.g., level of support), cognitive factors (e.g., coping style), and emotional factors (e.g., degree of anxiety) (Turk, Wison, & Cahana, 2011). Furthermore, it has been shown that genetic factors play an important role in pain perception, and can be triggered by environmental factors in individuals with a genetic predisposition (Buskila, 2007).

Despite its uncertain etiology, chronic pain is widespread and has immense social and economic impacts with between 20% and 29% of Canadians suffering from the condition (Boulanger, Clark, Squire, Cui, & Horbay, 2007; Moulin, Clark, Speechley, & Morley-Forster, 2002). The estimated direct and indirect cost of chronic pain in Canada is valued at $45 billion per year, more than cancer, heart disease and HIV combined (Canadian Pain Society, 2014). In Ontario alone, the annual incremental cost of health care for patients with chronic pain is 50% higher than for those without it (Hogan, Taddio, Katz, Shah, & Krahn, 2016).

Chronic pain has serious effects including a diminished ability to work, social dysfunction and poor quality of life (Goldbreg & Mcgee, 2011). In addition, chronic pain is associated with comprised mental health including depression, anxiety, poor quality of sleep, fatigue, reduced libido, as well as alcohol and drug dependency (Fishbain, Rosomoff, &

Rosomoff, 1992; Fishbain, Cutler, Rosomoff, & Rosomoff, 1997; Kashikar-Zuck et al., 2014; Morin, Gibson, & Wade, 1998). These added stressors are also linked to marital and family problems (Flor, Turk, & Scholz, 1987). Moreover, individuals who suffer from chronic pain are at increased risk for suicide ideation and attempt (Braden, Sullivan, 2008; Smith, Edwards, Robinson, & Dworkin, 2004). It has been found that overall quality of life in individuals with mild chronic pain is substantially lower than those with other common chronic diseases (Hogan, Taddio, Katz, Shah, & Krahn, 2017).

It can be seen from the data that the disability caused by this silent epidemic is extensive due to its high prevalence and devastating impact on people's lives (Sessle, 2012; Wall & Jones, 2013). Of particular concern is the fact that chronic pain is on the rise and is "not diminishing in its proportions, its duration, or the scale of the suffering that it causes" (Wall & Jones, 1991 p.12). The prevalence of chronic pain is projected to increase over the coming years due to an aging population. In Canada, people over 65 years of age represent the fastest growing age group (Public Health Agency of Canada, 2014). Individuals in this age group are most likely to suffer from chronic pain and use health services frequently (Molton & Terrill, 2014; Wall & Jones, 1991. This projected growth and the associated chronic illnesses will have a large impact on individuals, the health care system and Canadian society in general (Hootman & Helmick, 2006).

Chronic Pain in Young Adults

Very little is known about the prevalence of chronic pain in young adults. This is, in part, because most population-based studies do not provide separate estimates for this age group but also possibly because this age group is presumed overall to be healthy, vibrant and pain-free (APA, 2013; Mallen, Peat, Thomas & Croft, 2005). Indeed, the few studies that examined this

issue estimated chronic pain prevalence to be between 4% and 14% (Mallen, Peat, Thomas & Croft, 2005).

Nevertheless, young adults' physical and mental health issues merit attention. This age period, defined in the literature as the time from late teens through twenties, is considered to be of great importance. During this period many young adults form meaningful relationships and obtain education, training and skills that will impact their adult lives. This stage in one's life is frequently used for exploration of issues pertaining to love, work and worldviews, all of which lay the foundation for healthy individuals and society (Arnett, 2000). Experiencing chronic health challenges, and chronic pain in particular, may adversely affect these processes and impact an individual's ability to function at their optimal level (Kapoor, 2015).

Furthermore, stigmatizing or denying the experience of chronic pain in young adults may lead to delays in receiving treatment, resulting in negative long-term health outcomes. Research has shown that young adults with chronic pain experience greater depression, impaired quality of life, instability and negativity, and fewer hours of sleep compared to their condition-free counterparts. It was also found that illness invalidation and stigmatization perpetuated further psychological distress and pain perception in this age group (Kapoor, 2015). Chronic pain in this group, therefore, can have a serious impact on people's quality of life and hence warrants further research.

Status of Chronic Pain Treatments

Despite projections of growth in chronic pain prevalence, treatment options remain generally unsatisfactory and include a wide array of pharmaceutical, surgical, rehabilitative, psychological and alternative options with a focus on managing rather than curing the condition (Rod, 2016; Turk, Wison, & Cahana, 2011). However, a review of existing treatments concluded

that “currently available treatments provide modest improvements in pain and minimum improvements in physical and emotional functioning” (Turk, Wilson, & Cahana, 2011, p. 2226).

In addition to an incomplete understanding of the underlying chronic pain mechanisms, barriers to effective pain management include: clinician barriers, patient-related barriers and health care system barriers. Clinicians’ gaps in knowledge and negative attitudes towards chronic pain may begin in medical school, with 88% of clinicians describing their education in pain management as “poor”, and 78% feeling a sense of “low competence” in pain assessment (Glajchen, 2011; Von Roenn, Cleeland, Gonin, Hatfield, & Pandya, 1993). Patient-related barriers include communication and psychological issues. Experiences such as anxiety, distress, depression, anger, and dementia, as well as a fear of pain and medications may impact patients’ readiness to report pain and comply with a treatment regimen (Glajchen, Fitzmartin, Blum, Swanton, 1995; Glajchen, 2011). Finally, health care system barriers include long wait-times, along with a lack of training and financing for pain specialists. In Europe, two thirds of sufferers report dissatisfaction with available treatments, one third are not being treated at all, and only 2% are treated by a pain management specialist (Brejvik, Collett, Vebtafridda, Cohen, & Gallacher, 2006). The trends in North America are equally alarming. In the U.S., only 43% seek medical treatment for their pain, 44% believe it is best to “just keep going”, and only 15% seek help from a pain specialist (Hart, 2013). In Canada, it is estimated that there is one pain treatment facility for every 52,000 chronic pain patients, with a median wait time of 180 days for public facilities (Fashler et al., 2016; Peng et al., 2007). After their first visit to the doctor, which leaves 41% of chronic pain patients dissatisfied, the average wait is 18 months for an official diagnosis (Canadian Pain Coalition, 2014).

Further barriers to accessing chronic pain treatments include stigma, financial constraints, and geographic unavailability (Canadian Institute for the Relief of Pain and Disability, 2014; Canadian Mental Health Association, 2014; Lynch, Schopflocher, Taenzer, & Sinclair, 2009). For many people, the cost of treatments serves as a significant barrier to proper care. With limited government funding and restricted insurance coverage, people with chronic pain are often limited in their ability to pay for medication, physical and psychological therapies, and costs associated with the loss of workdays. These financial struggles often add an unwelcomed stress and hinder the battle with chronic pain (Jerant, Von Friederichs-Fitzwater, & Moore, 2005; Rod, 2016). These findings suggest that it is crucial to continue researching accessible and effective treatments, assess the combination of treatments, and strive to find solutions that target not only the pain itself, but also the associated factors that impact the individual's ability to participate fully in society (Turk, Wison, & Cahana, 2011).

Mindfulness-Based Interventions for Chronic Pain

Following the limited effectiveness of the traditional medical and psychological treatments, which have failed to eliminate pain and its correlates for the majority of patients, a new wave of mindfulness-based interventions that target the mind-body connection have emerged (Chiesa & Serretti, 2011; Turk, 2002; Kabat-Zinn, 2003; McCracken& Vowles, 2014).

Mindfulness has been defined as "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003, p. 145). Mindfulness practices encourage individuals to attend to inner experiences, such as body sensations, thoughts and feelings, and external experiences, such as sights and sounds. These experiences are accepted with a non-judgmental stance, thus, they are "not evaluated as good or bad, true or false, healthy or sick, or important or trivial" (Baer,

2003, p. 125). The attending person approaches these experiences with curiosity, openheartedness, and compassion (Kabat-Zinn, 2003). This ability to 'decenter', or view experiences with increased objectivity, may facilitate a tendency to respond to internal and external experiences with less emotional reactivity (Feldman, Greeson & Senville, 2010; Shappiro et al., 2006).

One way to cultivate mindfulness is through mindful breathing, a core meditation practice that embodies the central features of mindfulness – the ability to return attention to the present (Feldman, Greeson, & Senville, 2010). During this meditation, which has been in use for more than 1,500 years, participants attend to the inhalation and exhalation of their breath, as well as the experience of the body as the breath flows in and out (Chiesa & Malinowsky, 2011; Levinson, Stoll, Kindly, Merry, & Davidson, 2013). When thoughts, feelings and sensations arise, the meditator is encouraged to experience them in their bare form, without elaborating on any of the associated memories, opinions, thoughts and feelings, and then return their attention to their inhalation and exhalation (Chiesa & Malinowsky, 2011).

The practice of bringing attention back to an internal sensory stimulus, the breath, trains the meditator to regulate attention, teaches them to distinguish between thinking about physical sensations versus experiencing them directly, and to refrain from automatic, habitual responses to such experiences (Daubenmier, Sze, Kerr, Kemeny, & Mehling, 2013; Williams, 2010). This ability may be especially important in cases of chronic pain as mindfulness produces "a spontaneous (and momentary) uncoupling of the sensory component of the pain from the affective and cognitive dimensions (alarm reaction)" (Kabat-Zinn, 1982, p. 35). This detached attention may decouple the emotional and cognitive components from the pain experience, even when the sensory component remains present (Kabat-Zinn, 1982). This may result in reduction

of stress, improvement of mood, and better pain tolerance overall, leading to an enhanced quality of life (Kabat-Zinn, Lipworth, & Burney, 1985; Leung, Han, Martin, & Ktoecha, 2015). Furthermore, since the processes involved in mindful attention are theoretically in conflict with the type of cognitive processes involved in pain catastrophizing, such as interpretation, conceptual processing and judgment, it may lead to a reduction in pain-related catastrophic thinking (Schutze, Rees, Preece, & Schutze, 2010; Sullivan, Lynch, & Clark, 2005).

The effects of mindfulness-based interventions have been examined on medical conditions such as depression, anxiety, heart disease, cancer, eating disorders, Type 2 diabetes and attention disorders (Cullen, 2011). Improvements have been reported in depressive and anxiety symptoms, quality of life, mood states, stress symptoms, quality of sleep, brain function and immunity (Grossman, Niemann, Schmidt, & Walach, 2004; Carlson, Speca, Patel, & Goodely, 2004; Praissman, 2008; Smith, Richardson, Hoffman, & Pilkington, 2005; Tacon, McComb, Caldera, & Randoph, 2003).

Promising results have been also reported for chronic pain conditions. For example, a study on the effects of a Mindfulness Based Stress Reduction (MBSR) program in patients with fibromyalgia, a debilitating chronic pain condition, found greater benefits compared to controls on most pain-related measures such as pain intensity, quality of life, coping with pain, anxiety, depression and somatic complains. These benefits were sustained at a three-year follow up (Grossman, Tiefenthaler-Gilmer, Raysz, & Kesper, 2007).

Similarly, another mindfulness-based intervention, Acceptance and Commitment Therapy (ACT), has been found to have strong research support for chronic pain management. Specifically, improvements have been reported in functioning and mood (Society of Clinical Psychology, 2012). However, more recent reviews warn that current evidence on the effects of

mindfulness-based interventions for chronic pain is insufficient and further, better-designed studies are needed (Bawa et al., 2015; Chiesa & Serretti, 2011; Song, Lu, Chen, Geng, & Wang, 2014).

Mobile-based Interventions for Chronic Pain

With an increasing demand for health services outpacing supply, governments and health-care providers are searching for innovative cost-effective solutions that will help patients better manage their chronic diseases, including chronic pain (Australian Government Department of Health and Aging, 2012; Rod, 2016). One such innovation involves mobile technologies. It is estimated that 78% of Canadian households have a cell- phone, and at least half use mobile applications on their phones (Canadian Wireless Telecommunication Association, 2014). The global penetration rate of mobile phones is estimated at 96% (Hall, Cole-Lewis, & Nernhardt, 2015; International Telecommunication Union, 2014).

Advantages of mobile-based health interventions include higher accessibility, scheduling flexibility, anonymity, reduced stigma, increased availability in remote locations as well as high rates of adherence with interventions, low rates of dropouts, and high intervention acceptability (Dennis, & O'Toole, 2014; Jibb et al., 2014). Interventions delivered via mobile technologies have been shown to be efficacious for managing a variety of conditions such as weight loss, anxiety, diabetes, eating disorders, alcohol use, healthy eating and physical activity (Heron & Smyth, 2010).

Unfortunately, the majority of existing apps on the market are designed for the general public and not for clinical use. One of the major limitations of most existing mobile applications marketed for chronic pain is that they rarely adhere to scientific guidelines and evidence-based concepts, meaning that the reliability and validity of their content remains undetermined (De la

Vega & Miró, 2014; Rosser & Eccleston, 2011; Vardeh, Edwards, Jamison, & Eccleston, 2013; Wallace & Dhingra, 2014). Another limitation often cited in review studies of chronic pain applications, is that clinicians were rarely involved in the development of these apps, making it irrelevant in clinical settings (Alexander & Joshi, 2016). For example, a recent review of patient-targeted smartphone applications for pain management found that of 279 apps that met inclusion criteria, only 8.2% had the involvement of a health-care professional, and only one application underwent a scientific evaluation (Lalloo, Jibb, Rivera, Agarwal, & Stinson, 2015). Other reviews found similar results (Reynoldson et al., 2014; Rosser & Eccleston, 2011).

Despite existing drawbacks, well-researched patient-facing apps have the potential to help chronic pain patients by engaging them between doctor's visits and empowering them to take a more active role in the management of their condition (Alexander & Joshi, 2016). Research on the potential benefits of mobile-based interventions for chronic pain is still in its infancy, but preliminary results have shown positive outcomes. Kristjánsdóttir et al. (2013) studied the effects of a 4-week mobile-based intervention with written diaries and therapist feedback on catastrophizing and functioning levels in women with widespread pain following inpatient rehabilitation in a randomized controlled trial. The intervention group showed less catastrophizing and functional impairment post-intervention and at a 5-month follow-up. Another study, on the feasibility of mobile technologies for symptom-tracking in patients with fibromyalgia, found that 80% of the patients reported that symptom-tracking using a mobile phone was convenient, and 65% felt that the device helped them manage their symptoms more efficiently and gave them greater control over their condition (Vanderboom, Vincent, Luedtke, Rhudy, & Bowles, 2014; Vardeh, Edwards, Jamison, & Eccleston, 2013). Regrettably, these

studies are scarce, suggesting that more research is desperately needed (Rosser& Eccleston, 2011; Weinrib et al., 2017).

The Present Study

The aim of this study was to expand on the aforementioned knowledge and contribute to the ongoing investigation of a mobile phone-based app for mindfulness meditation for chronic pain in young adults. Specifically, the study aimed to examine the effects of a mobile-based mindfulness task on measures of pain, mental health, and mood in three groups of young adults: those with chronic pain, mood/anxiety symptoms, and condition-free controls. In addition, a fourth, condition-free group was assigned to meditation without a mobile application. The process of classification into groups is described in the methods sections.

Hypotheses

Based on the literature reviewed above, it was hypothesized that:

1. Participants in all groups will experience a reduction in anxiety, depression, and distress post intervention.
2. Participants in the chronic pain and mood/anxiety groups will benefit more from the intervention than controls. Specifically, it is hypothesized that individuals in the clinical groups will have greater improvement in symptoms of anxiety, depression, distress, and mood than healthy controls. This is based on the assumption that symptoms of anxiety, depression and distress are not expected to be significantly elevated at baseline for healthy controls and therefore there may be less room for improvement.
3. Participants with chronic pain will report reduced pain intensity following the mindfulness intervention.

4. Healthy participants in the app condition will have greater improvement in mindfulness and present awareness than healthy participants in the no-app condition. This is based on the assumption that the mobile application is a useful tool for cultivating mindfulness in naïve meditators.

Methods

Participants

Male and female participants, between the ages 18-65 years, from diverse ethnic backgrounds were recruited from the York Undergraduate Research Participant Pool (URPP). When students first created their URPP account, they were asked to answer several prescreening questions about their background, demographics and mental health status. These questions are designed to help researchers target students based on their answers. In this study, students were included if they reported existing depression, anxiety, chronic pain, or no existing diagnosis of mental illness and chronic pain on their pre-screening questionnaires, or if they signed up for a time slot with specific inclusion criteria (for example, "only for people with current depressive symptoms"). One hundred and eighty people completed the study and received a course credit for their participation. Twenty participants were excluded prior to group classification and data analysis (see Figure 1). After participation, participants were classified into four groups based on their questionnaire results.

Participants were classified into the chronic pain group if they reported having a current pain condition diagnosed by a healthcare professional (Mdn=6-12 months). Participants were classified into the mood/anxiety group if they reported severe depressive symptoms on the Center for Epidemiologic Studies Depression Scale (≥ 21), severe anxiety symptoms on the Beck Anxiety Inventory (≥ 36), or both (Beck, Epstein, Brown, Steer, 1988; Radloff, 1997). Participants were classified as condition free app (CF- App) if they did not meet cutoff scores on these measures, did not have a chronic pain condition, and completed the mobile-based intervention. Participants were classified as condition-free no-app (CF-No App) if they did not meet criteria for any of the groups above, and did not complete the mobile based-intervention.

Three participants were excluded from the No App group because they scored within the severe range of the aforementioned measures of depression, anxiety or both. Figure 1 depicts the process of enrollment, exclusions and group classification.

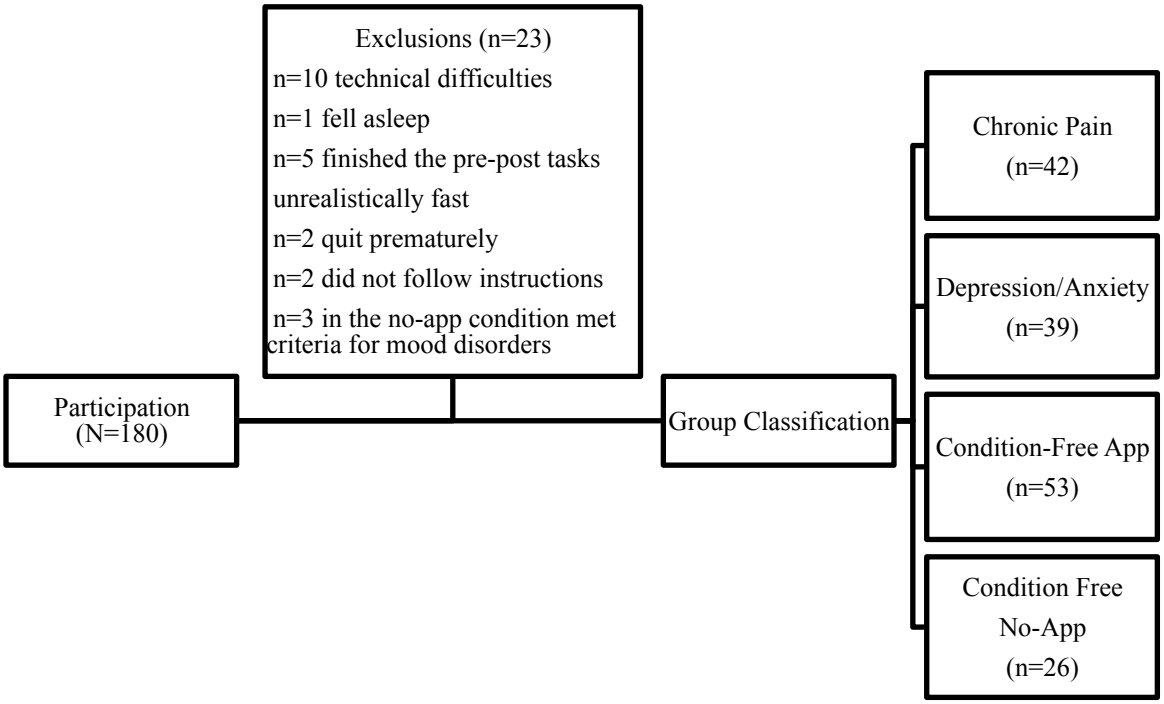

Figure 1: Enrollment, exclusions and group classification.

Procedure

The study was reviewed and approved by the research ethics board (Human Participants Review Subcommittee) at York University before recruitment began. Participants started the experiment by receiving a brief explanation about the procedure and signing a consent form. Then, participants were given instructions and asked to complete 13 computer-based questionnaires, followed by six brief mobile-based questionnaires. This part of the testing session lasted approximately half an hour. Participants were then given instructions for the mobile-based Breath Awareness Task, which took 12 minutes to complete. The task involves paying attention

to the flow of breath and pressing ‘breath’ or ‘other’ buttons on a mobile phone at the sound of a tone. The No App control group was instructed to meditate for 12 minutes without the use of the mobile-based Breath Awareness Task. The meditation instructions were identical for both groups; the app groups received additional instructions on how to use the application. The meditation instructions can be found in the appendix. Following the task, participants completed three mobile-based and four computer-based questionnaires. This part took approximately 15 minutes to complete. Finally, participants were thanked and debriefed. Each testing session took approximately one hour. The study protocol, task instructions and consent form can be found in the Appendix.

Materials

The following questionnaires, described below, were administered pre-intervention: Numeric Pain Rating Scale, Pain Catastrophizing Scale, Pain Vigilance and Awareness Questionnaire, Brief Pain Inventory-SF, Present Awareness Rating Scale, The Five-Factor Mindfulness Scale, Mind-Wandering Questionnaire, Imaginal Processes Inventory-SF, Mindful Attention Awareness Scale, Subjective Units of Distress Scale, Patient Health Questionnaire for Depression and Anxiety, Beck Anxiety Inventory, Center for Epidemiological Studies Depression Scale, The Anxiety Sensitivity Index-3, Profile of Mood States, State Trait Anxiety Inventory-SF, Socially Desirable Response Set-5.

Post-intervention questionnaires included: Numeric Pain Rating Scale, Subjective Units of Distress Scale, Present Awareness Rating Scale, Mind Wandering Inventory, Toronto Mindfulness Scale, Profile of Mood States-SF, State Trait Anxiety Inventory-SF. The pre and post questionnaires are presented in Table 1.

Table 1: Pre and post questionnaires

Pre-Questionnaires	**Post-Questionnaires**
H1&H2: Subjective Units of Distress Scale	**H1&H2: Subjective Units of Distress Scale**
Patient Health Questionnaire for Depression and Anxiety	
Beck Anxiety Inventory	
Center for Epidemiological Studies Depression Scale	
The Anxiety Sensitivity Index-3	
H1&H2: Profile of Mood States	**H1&H2: Profile of Mood States**
H1&H2: State Anxiety Inventory	**H1&H2: State Anxiety Inventory**
Socially Desirable Response Set Five-Item Survey	
H3: Numeric Pain Rating Scale	**H3: Numeric Pain Rating Scale**
Pain Catastrophizing Scale	
Pain Vigilance and Awareness Questionnaire	
Brief Pain Inventory	
H4: Present Awareness Rating Scale	**H4: Present Awareness Rating Scale**
The Five-Factor Mindfulness Scale	Toronto Mindfulness Scale
Mind-Wandering Questionnaire	Mind-Wandering Inventory
Short Imaginal Processes Inventory	
Mindful Attention Awareness Scale	

***H1= Hypothesis 1, H2= Hypothesis 2, H3= Hypothesis 3, H4=Hypothesis 4.

Breath-Awareness Task Application

In order to cultivate mindfulness, a Breath Awareness Task (BAT), based on Burg, Wolf and Michalak's (2012) Mindful Breathing Exercise (MBE) was used. "The MBE assesses the participants' ability to mindfully stay in contact with the bodily sense of the breath during an exercise aligned with breathing meditation" (Burg, Wolf, & Michalak, 2012, p. 135). Participants were instructed to sit in their chair with their back straight and rest both thumbs on the mobile phone. They were given detailed instructions on how to mindfully attend to their breath (instructions can be found in the Appendix). At the sound of a tone, participants were asked to press 'breath' if in that moment they were attending to their breath, or 'other' if they were attending to other experiences. Participants were instructed to return their attention to mindful breathing after pressing one of the two buttons on the screen. Participants were given an opportunity to practice for one minute before starting the 12-minute-long task. The task involved a total of 24 silent phases consisting of six different durations (5 seconds, 15 seconds, 25 seconds, 35 seconds, 45 seconds and 55 seconds) randomly presented four times each and followed by the presentation of the tone.

The task was delivered via a mobile phone in a mobile application format. The Breath Awareness application was developed for the purposes of the present study using JavaScript and installed on an IPhone 4s, which has a 3.5 inch widescreen multi-touch display, with a 960 by 640 pixel resolution at 326 pixel per inch. The phone is 4.5 inches in height, 2.31 inches in width, 0.3 inches in depth, and weighs 4.9 ounces.

Pain Questionnaires

Numeric Pain Rating Scale (NPRS). The NPRS is an 11-point rating scale, ranging from 'no pain' to 'worst pain possible', which aims to assess pain intensity in adults. It is one of

the most popular pain rating scales in clinical settings. The test has good psychometric properties, with high test re-test reliability (r=.96), and high correlation with the Visual Analogue Scale (VAS) (r=.94) (Williamson & Hoggart, 2005).

Pain Catastrophizing Scale (PCS-4). The PCS is one of the most widely used measures of pain-related catastrophic thinking. The PCS-4 is an abbreviated version. Participants are asked to report the degree to which they experienced pain-related thoughts and feelings on a 5-points scale ranging from "not at all" to "all the time". Higher scores imply greater pain catastrophizing. The test has good internal consistency (α=.86) and correlates highly with the original PCS (r=.96) (Bot et al., 2014; Sullivan, Bishop, & Pivik, 1995). Internal consistency for the PCS-4 in the present study was acceptable (α=0.79)

Pain Vigilance and Awareness Questionnaire (PVAQ). The PVAQ is a 16-item questionnaire designed to assess awareness, vigilance, preoccupation, and observation of pain. Respondents are asked to report the frequency of different pain-related behaviors in the last two weeks on a six-point scale from 'never' to 'always'. The PVAQ demonstrated good internal consistency (α=.86) and adequate test-retest reliability (r=.80) (McCracken, 1997). Internal consistency for the PVAQ in the present study was excellent (α=0.91).

Brief Pain Inventory (BPI-SF). The BPI is a 16-item, self-report questionnaire that measures pain interference in seven daily activities including general activity, walking, work, mood, enjoyment of life, relations with others and sleep. The test has good internal consistency (α=.85) and high test-retest reliability (r=.93) (Cleeland, 1989; Mendoza et al., 2004). Internal consistency for the BPI-SF in the present study was excellent (α=0.92).

Mindfulness and Mind-Wandering Questionnaires

Present Awareness Rating Scale (PARS). The PARS is a 5-item questionnaire developed specifically for this study. Participants were asked to rate their level of awareness of different aspects of present moment experiences, such as thoughts and feelings. The scale was used in this study for validation purposes, as there are no existing scales looking at present awareness. Internal consistency for the PARS in the present study was good (α=0.83).

Toronto Mindfulness Scale (TMS). The TMS is a 13-item state measure of mindfulness with two factors; curiosity and decentering. Curiosity is defined as awareness of present moment experience. Decentering is defined as awareness qualified by separation from current experience. Reponses to items such as "I was curious about my reactions to things" are recorded on a 5-point scale ranging from "not at all" to "very much". The TMS has good internal consistency (α=.95). Current research demonstrates that the TMS is a reliable and valid measure of mindfulness that accurately measures curiosity and decentering (Lau et al., 2006). Internal consistency for the TMS in the present study was good (α=0.83).

The Five-Factor Mindfulness Scale (FFMS). The FFMS is a 39-item Likert-based scale that assesses five aspects of mindfulness: non-reactivity to inner experience, acting with awareness, describing, non-judging of inner experience, and observing. Participants are asked to rate whether statements are true for them on a 5-point scale ranging from "never true" to "always true". Research has demonstrated the FFMS to be valid in community and student samples with good internal consistency (α >.90) (Bohlmeijer, Peter, Fledderus, Veehof, & Baer, 2011). Internal consistency for the FFMS in the present study was good (α=0.85).

Mind-Wandering Questionnaire (MWQ). The MWQ is a 5-item scale that assesses the frequency of mind-wandering events. The questionnaire aims to measure trait mind-wandering

and includes questions such as “I have difficulty maintaining focus on simple or repetitive work”. The MWQ has demonstrated high internal consistency (α = .85) and convergent validity with other measures of mind-wandering and task-unrelated thought (Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013). Internal consistency for the MWQ in the present study was good (α=0.86).

Mind-Wandering Inventory (MWI). The MWI is a non-standardized 5-point Likert-based questionnaire designed to assess the frequency of different types of mind-wandering events the respondent experienced during the intervention. This questionnaire was designed for this study to better understand the nature of mind wandering that might occur during the Breath Awareness Task. Internal consistency for the MWI in the present study was good (α=0.82).

Short Imaginal Processes Inventory (SIPI). The SIPI is a 45-item questionnaire that assesses different aspects of daydreaming such as present orientation in daydreams, acceptance of daydreaming, and mind-wandering. It encompasses three scales: positive-constructive daydreaming, guilt and fear-of-failure daydreaming, and poor attentional control. Participants are asked to indicate the extent that each statement about mind-wandering applies to them on a 5-point scale from “strongly uncharacteristic of me” to “strongly characteristic of me”. The inventory has demonstrated adequate test-retest reliability (r=.73) and construct validity (α=.86) (Huba, Singer, Aneshensel, & Antrobus, 1982; Tanka & Huba, 1986). Internal consistency for the SIPI in the present study was good (α=0.80).

Mindful Attention Awareness Scale (MAAS). The MAAS is a 15-item 7-point scale ranging from “almost always” to “almost never”, designed to assess awareness and attention to present events. The scale has demonstrated good test re-test reliability (r=.80) and internal consistency (α=.90). The scale has been validated with college students and community adults. It

is associated with a variety of self-regulation and well-being constructs (Brown & Ryan, 2003). Internal consistency for the MAAS in the present study was good (α=0.88).

Mood Questionnaires

Subjective Units of Distress Scale (SUDS). The SUDS scale is widely used in anxiety research. Respondents are asked to rate their level of current distress from 0 (no distress) to 10 (extreme distress). Kaplan, Smith and Coons (1995) found that the measure is highly associated with lengthier anxiety measures such as State Trait Anxiety Inventory (r=.69) and Multiple Affective Adjective Checklist (r=.53) (Kaplan, 1995; Wolpe, 1958).

Patient Health Questionnaire for Depression and Anxiety (PHQ4). The PHQ4 is a brief, four-item screening tool for depression and anxiety, rated on a four-point Likert scale ranging from "not at all" to "nearly every day". Participants are asked to reflect on their feelings of anxiety and depression over last two weeks. Higher scores are indicative of more severe anxiety and depression symptoms. The test has good internal consistency (α=.86) (Kroenke, Spitzer, Williams, & Löwe, 2009). Internal consistency for the PHQ-4 in the present study was excellent (α=0.92).

Beck Anxiety Inventory (BAI). The BAI is a 21-question, multiple-choice, self-report questionnaire designed to measure anxiety severity by assessing common symptoms of anxiety. Higher total scores indicate more severe anxiety symptoms. The test has demonstrated good psychometric properties including internal consistency (α=.92) and test-retest reliability (r=.75) (Leyfer, Ruberg, Woodruff-Borden, 2006). Internal consistency for the BAI in the present study was excellent (α=0.94).

Center for Epidemiological Studies Depression Scale (CESD). The CESD is a 20-item screening test for frequency of depressive symptoms over the last two weeks. The scale measures

symptoms of depression in nine groups: sadness, loss of interest, appetite, sleep, thinking, concentration, guilt, fatigue, movement, and suicide ideation. Higher scores indicate higher depressive symptoms and aid in identifying individuals with possible clinical depression. The test has good internal consistency (α=.91) and test-retest reliability (r=.85) (Lewinsohn, Seeley, Roberts, & Allen, 1997; Radlof, 1977). Internal consistency for the CESD in the present study was excellent (α=0.92).

The Anxiety Sensitivity Index-3 (ASI-3). The ASI-3 is an 18 item, self-report questionnaire designed to assess concern about anxiety-related symptoms, rated on a five-point Likert scale ranging from "very little" to "very much". The ASI-3 assesses three dimensions of anxiety sensitivity: fear of physical symptoms, fear of cognitive symptoms, and fear of publically observable symptoms. Several studies provided support for its reliability and convergent, discriminant, criterion-related, and construct validity. The scale has good internal consistency (α=.88) (Taylor et al., 2007). Internal consistency for the ASI-3 in the present study was excellent (α=0.92).

Profile of Mood States (POMS-SF). The POMS-SF is a 37-item questionnaire designed to assess global distress as well as six mood states: Fatigue, Vigor-Activity, Tension-Anxiety, Depression, Anger-Hostility, and Confusion-Bewilderment. Participants are asked to indicate the degree to which they have experienced different mood states in the past week. The scale has good internal consistency (α=.91) and test-retest reliability (r=.74) Higher total scores represent greater total mood disturbance (Curran, Andrykowski & Studs, 1995). Internal consistency for the POMS-SF in the present study was excellent (α=0.91).

State Anxiety Inventory (STAI-6). The STAI is one of the most frequently used measures of anxiety in research. The STAI-6 is a brief, 6-item self-rating scale designed to assess

state and trait anxiety in adults. Participants are asked to rate how they feel right now about statement such as "I feel calm" on a 4-point scale ranging from "not at all" to "very much". Higher scores indicate greater state anxiety. The internal consistency for six items is α=.81. Test-retest reliability could not be calculated due to the transient nature of state anxiety (Marteau & Bekker, 1992). Internal consistency for the STAI-6 in the present study was good (α=0.82).

Other Questionnaires

Socially Desirable Response Set Five-Item Survey (SDRS-5). The SDRS-5 is a brief self-report measure designed to evaluate a respondent's tendency to give socially desirable responses. Participant are asked to rate the truthfulness of each statement (e.g., "I am always courteous even to people who are disagreeable") on a 5-point scale ranging from "definitely true" to "definitely false". The test has adequate internal consistency (α=.68) and good test re-test reliability (*r*=.75) (Hays, Hayashi, & Stewart, 1989). Internal consistency for the SDRS-5 in the present study was poor (α=0.56).

Data Preparation and Analyses

Data was double-checked for accuracy. Demographic, questionnaires, and other variables were analyzed using the descriptive and explore functions of SPSS (version 21).

Hypotheses 1 and 2 were tested by a 2-way (2 x 4) mixed factor ANOVA using Time (baseline, post intervention) as the repeated measures factor and Group (chronic pain, mood, condition free app, condition free no app) as the independent samples factor to evaluate differences in anxiety, depression, distress, and mood states depicted in the POMS subscales.

Hypothesis 3 was tested by a dependent *t*-test comparing pain intensity in the pain group pre and post intervention.

Hypothesis 4 was tested by a two-way mixed factor ANOVA using Time (baseline, post

intervention) as the repeated measures factor and Group (CF-App, CF-No App) as the independent samples factor to evaluate differences in present awareness.

Results

Demographic and Clinical Variables

One hundred and fifty seven participants were included in this study. Participants' ages ranged from 17 to 38 years (*M*=20.31, *SD*=3.5), with 34% males, 65% females, and 1% who identified as "other". Participants came from diverse ethnic backgrounds with 26% identifying as Caucasian, 16% West Asian, 10% Black-African, 4% Black-Caribbean, 4% Chinese, 3% Hispanic, 3% Latin-American, 2% Indo-Caribbean, and 1% Aboriginal. Thirty one percent identified as "other" or chose not to disclose this information. Participants had completed an average of 12.6 years of education, which is equivalent to first year of university (*M*= 12.6, *SD*=1.26). Sixty six percent of the participants reported having been previously diagnosed with a psychological condition by a clinical psychologist, psychiatrist or other mental health professional. Among those, 41% had been diagnosed with anxiety disorders, 33% with depressive disorders, 9% with eating disorders, 6% with Post-Traumatic-Stress-Disorder (PTSD), 6% with Attention Deficit Disorders (ADD/ADHD), 4% with substance use disorder, and 1% with schizophrenia. Twenty seven percent of the participants reported a chronic pain diagnosis, with a median duration of 6-12 months. Out of those, 36% reported migraines/tension headaches, 26% reported chronic back pain, 19% reported chronic joint pain, 14% reported 'other' chronic pain (e.g. Crohn's disease), 3% reported Fibromyalgia, and additional 3% reported neuropathic pain. Majority of participants were naïve to meditation. Sixty four percent stated that they never meditate, followed by 20% who reported meditating monthly, 11% weekly, and 5% daily.

Baseline demographic and clinical variables for the four groups were analyzed by Chi-squared tests and one-way ANOVAs followed by Bonferroni post-hoc analyses. Results and

statistics for the four groups are presented in Table 1. Overall, the groups were comparable on age, gender, ethnicity, years of completed education, meditation frequency, social desirability, and baseline scores on the Five-Facets of Mindfulness Scale: Observing, Describing, Acting with Awareness, Non-Judging of Inner Experience, and Non-Reactivity to Inner Experience.

As shown in Table 2, the groups differed significantly on the clinical scales. As expected, the mood/anxiety group scored significantly higher than the chronic pain and the condition free controls on the BAI (*M*=36.07, *SD*=12.3), CESD (*M*=35.84, *SD*=9.32), and PHQ-4 (*M*=7.4, *SD*=2.5). The chronic pain group scored significantly higher on the BAI (*M*=21, *SD*=12.56), CESD (*M*=23.3, *SD*=10.2), and PHQ-4 (*M*=5, *SD*=2.66) than condition free controls (CF-App, CF-No App), who performed similarly on these measures. The chronic pain and mood/anxiety groups received comparable scores on measures of pain including pain catastrophizing, pain interference, pain intensity and worst pain in the last 24-hours, but differed significantly from condition free controls who reported little to no pain.

Table 2: Demographic and clinical variables at baseline for the four groups of study participants**.**

	Chronic Pain	Mood/ Anxiety	Condition-Free App	Condition-Free-No-App	Test Statistic
N	42	39	53	23	
Age (yrs)	21 (4.4)	19.6 (2.6)	20.6 (3.8)	19.34 (1.2)	$F(3,153)=1.84$, p=NS
Gender (M/F/O)					
Male	29%	28%	42%	39%	$\chi^2=5.58$, p=NS
Female	71%	69%	58%	61%	
Other		3%			
Ethnicity					
Aboriginal	2%	0%	0%	0%	$\chi^2=23.08$, p=NS
Black – African	12%	15%	4%	9%	
Black – Caribbean	7%	0%	6%	4%	
Chinese	2%	3%	4%	0%	
Hispanic	2%	0%	2%	0%	
Indo – Caribbean	5%	0%	0%	0%	
Latin American	0%	3%	4%	0%	
West Asian	17%	21%	11%	17%	
White	14%	23%	30%	30%	

Other/NA	38%	33%	50%	21%	
Education (yrs)	12.6 (1.2)	12.4(1.1)	12.5 (1.2)	12.6 (1.4)	$F(3,153)=0.19$, p=NS
Meditation Frequency					
Daily	5%	3%	6%	9%	$\chi^2=6.68$, p=NS
Weekly	14%	10%	11%	4%	
Monthly	29%	21%	13%	17%	
Never	52%	67%	70%	70%	
FFMS					
Non-Reactivity	20.2(4.7)	18.3(4.9)	19(4.2)	17.3(5.4)	$F(3,149)=2.08$, p=NS
Observing	26.15(6)	26.8(6.3)	24.7(6.6)	24.1(6.7)	$F(3,149)=1.3$, p=NS
Awareness	23.6(7.6)	23.5(6.6)	21.8(6.7)	22.3(7.9)	$F(3,149)=0.68$, p=NS
Describing	23.5(4.4)	23.2(4.9)	22.9(4.2)	22.5(3.3)	$F(3,149)=0.3$, p=NS
Non-Judging	25.6(7.1)	24.5(7.3)	23.1(7.4)	24.3(7.3)	$F(3,149)=0.89$, p=NS
Socially Desirable Response Set	52.2(19.4)	57.7(19.9)	60(18.9)	59.1(13.6)	$F(3, 153)=1.36$, p=NS
BAI	21 (12.5)	36 (12.3)	11 (8.1)	8.2 (6.5)	$F(3,153)=55.06$, $p<.001$ Pain vs. Mood, $p<.001$ Pain vs. CF App, $p<.001$ Pain vs. CF No-App, $p<.001$ CF App vs. CF No App, p=NS
CESD	23.3 (10.2)	35.8 (9.3)	12.5 (6.5)	14.2 (6.4)	$F(3,153)=64.58$, $p<.001$ Pain vs. Mood, $p<.001$ Pain vs. CF App, $p<.001$ Pain vs. CF No-App, $p<.001$ CF App vs. CF No App, p=NS
PHQ-4	5(2.6)	7.4(2.5)	2.9(2.4)	2.2(2)	$F(3,153)=31.77$, $p<.001$ Pain vs. Mood, $p<.001$ Pain vs. CF App,

					p<.001 Pain vs. CF No-App, *p*<.001 CF App vs. CF No App, *p*=NS
PCS-4	7.1(3.4)	7.6(4.8)	3.8(3.3)	2(2.4)	*F*(3,153)=17.08, *p*<.001 Pain vs. Mood, *p*=NS Pain vs. CF App, *p*<.001 Pain vs. CF No-App, *p*<.001 CF App vs. CF No App, *p*=NS
Pain Interference	9.3(5.8)	11.3(7.3)	4.7(4.7)	3(3)	*F*(3,153)=16.98, *p*<.001 Pain vs. Mood, *p*=NS Pain vs. CF App, *p*<.001 Pain vs. CF No-App, *p*<.001 CF App vs. CF No App, *p*=NS
Pain Intensity	2.6(2.3)	2.1(2)	0.9(1.1)	0.57(1.1)	*F*(3,153)=10.71, *p*<.001 Pain vs. Mood, *p*=NS Pain vs. CF App, *p*<.001 Pain vs. CF No-App, *p*<.001 CF App vs. CF No App, *p*=NS
Worst Pain in 24h	4 (2.3)	3.5 (3)	2 (1.9)	2.3 (2)	*F*(3,153)=7.10, *p*<.001 Pain vs. Mood, *p*=NS Pain vs. CF App, *p*<.001 Pain vs. CF No-App, *p*<.001 CF App vs. CF No App, *p*=NS

Main Analyses

Test of Hypotheses 1 and 2

Hypothesis one predicted that participants in all groups would experience reduction in anxiety depression, and distress post intervention. Hypothesis two predicted a greater improvement for the clinical groups in symptoms of anxiety, depression, distress, and mood. For hypotheses one and two, 10 two-way mixed ANOVAs with Group (Chronic Pain, Mood/Anxiety, Condition-Free App, Condition-Free No App) and Time (Baseline, Post-Task) were used to test changes in Fatigue, Vigor-Activity, Tension-Anxiety, Depression, Anger-Hostility, Esteem-related Affect, Confusion- Bewilderment, Total Mood Disturbance, State-Trait Anxiety, and Distress. For all omnibus tests significance was set at $p < 0.05$. Bonferroni adjusted alpha levels were used for pairwise comparisons.

The analyses revealed a main effect of Group for Fatigue, $F(3,152)=19.80$, $p<.001$, $\eta p2=.28$, , Tension-Anxiety, $F(3,152)=23.56$, $p<.001$, $\eta p2=.31$, Depression, $F(3,152)=24.59$, $p<.001$, $\eta p2=.32$, Anger, $F(3,152)=15.60$, $p<.001$, $\eta p2=.23$, Esteem, $F(3,152)=10.92$, $p<.001$, $\eta p2=.17$, Confusion, $F(3,152)=24.59$, $p<.001$, $\eta p2=.32$, Total Mood Disturbance, $F(3,152)=41.04$, $p<.001$, $\eta p2=.38$, State-Trait Anxiety, $F(3,152)=20.37$, $p<.001$, $\eta p2=.28$, and Distress, $F(3,152)=14.19$, $p<.001$, $\eta p2=.21$.

In addition, a main effect of Time was revealed for Fatigue, $F(1,152)=22.81$, $p<.001$, $\eta p2=.13$, Vigor $F(1,152)=13.55$, $p<.001$, $\eta p2=.08$, Tension-Anxiety, $F(1,152)=36.54$, $p<.001$, $\eta p2=.19$, Depression, $F(1,152)=30.20$, $p<.001$, $\eta p2=.16$, Anger, $F(1,152)=33.66$, $p<.001$, Confusion, $F(1,152)=43.81$, p<.001, $\eta p2=.22$, Total Mood Disturbance, $F(1,152)=47.12$, $p<.001$, $\eta p2=.23$, State-Trait Anxiety, $F(1,152)=62.30$, $p<.001$, $\eta p2=.29$, and Distress, $F(1,152)=12.17$, $p=.001$, $\eta p2=.07$.

A significant Group x Time interaction effect was found for Tension-Anxiety, F(3,152)=3.14, p=.027, $\eta p2$=.05, Anger, F(3,152)=3.85, p=.011, $\eta p2$=.07, and Distress, F(3,152)=4.01, p=.009, $\eta p2$=.07, demonstrating that some groups benefited from the intervention more than others.

Figure 2 shows the means and standard errors on the POMS Tension-Anxiety subscale for the four groups at both time points. For Tension-Anxiety, the simple main effect of Group was significant at baseline, F(3, 152)=19.29, p<.001, $\eta p2$=.27 and post-intervention, F(3, 152)=19.83, p<.001, $\eta p2$=.28. At baseline, the mood/anxiety and chronic pain groups had similarly high levels of Tension-Anxiety, which were significantly different from condition-free app and condition-free no-app groups (p<.001). At post-intervention, Tension-Anxiety in the chronic pain group dropped to levels similar to those in the condition free groups, while the mood/anxiety group remained significantly higher than the other groups (p<.001). Simple main effects of Time were significant for chronic pain, F(1, 152)=36.28, p<.001, $\eta p2$=.19, mood, F(1, 152)=7.81, p=.006, $\eta p2$=.04, and condition-free app, F(1, 152)=8.98, p=.003, $\eta p2$=.05, but was not significant for the no-app group.

Figure 3 shows the means and standard errors on the POMS Anger subscale for the four groups at both time points. For Anger, the simple main effect of Group was significant at baseline, F(3, 152)=14.83, p<.001, $\eta p2$=.22, and post-intervention, F(3, 152)=9.57, p<.001, $\eta p2$=.15. At baseline, the mood/anxiety and chronic pain groups had similar levels of Anger, which were significantly higher than condition-free app and condition-free no-app groups (p<.05). Post intervention, the chronic pain group's anger levels dropped to those of condition free controls, while the mood/anxiety group's anger levels remained significantly higher than the rest (p<.05). Simple main effects of Time were significant for chronic pain, F(1, 152)=27.90,

$p<.001$, $\eta p2=.15$ and mood/anxiety group, $F(1, 152)=15.06$, $p<.001$, $\eta p2=.09$, but were not significant for the condition free app and no-app groups.

Figure 4 shows the means and standard errors on the POMS Distress subscale for the four groups at both time points. For Distress, the simple main effect of Group was significant at baseline, $F(3, 152)=16.08$, $p<.001$, $\eta p2=.24$, and post-intervention, $F(3, 152)=7.01$, $p<.001$, $\eta p2=.12$. Chronic pain and mood/anxiety groups were similarly distressed, but significantly more than condition free controls ($p<.05$). Post intervention, Distress levels in the chronic pain group dropped and were no longer significantly different from condition-free controls. Distress levels in the mood/anxiety group remained significantly higher than controls ($p<.05$), despite a significant decline between baseline and post intervention, as was demonstrated by the significant simple main effect of Time, $F(1, 152)=14.45$, $p<.001$, $\eta p2=.08$. Simple main effects of Time were also significant for the chronic pain group, $F(1, 152)=12.87$, $p<.001$, $\eta p2=.07$, but not the condition free groups.

Test of Hypothesis 3

Hypothesis 3 predicted that pain intensity would be reduced in the chronic pain group following the intervention. To test the third hypothesis, a paired samples *t*-test was conducted to examine changes in pain intensity in the pain group pre and post intervention. The paired *t*-test did not show a significant difference in pain intensity pre ($M=2.61$, $SD=2.37$) and post ($M=2.07$, $SD=2.4$) intervention, $t(41)=1.73$, $p=.09$.

Test of Hypothesis 4

Hypothesis 4 predicted that condition-free participants in the app group would experience greater present-awareness than those who were assigned to mindfulness without the mobile application. To test the fourth hypothesis two-way mixed ANOVAs with Group (C-F App, C-F

No App) and Time (Baseline, Post-Task) were used to test changes in present awareness as measured by the PARS scale. The were no significant effects of Group, $F(1,74)=0.98$, p=.32 Time, $F(1,74)=1.97$, $p=.16$, and Group by Time interaction, $F(1,74)=.47$, $p=.49$.

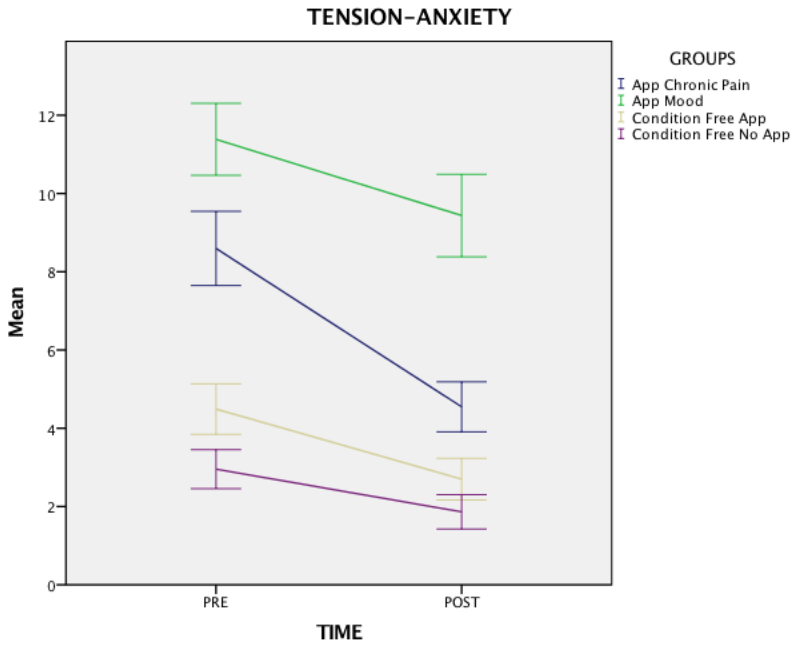

Figure 2: Mean tension-anxiety scores pre and post intervention.
Pre: Pain vs. CF-App ($p=.001$), Pain vs. CF-No App, ($p<.001$), Mood vs. CF-App ($p<.001$), Mood vs. CF-No App ($p<.001$).
Post: Pain vs. Mood ($p<.001$), Mood vs. CF-App (p<.001), Mood vs. CF- No App (p<.001).
Pain: T1 vs. T2 ($p<.001$), **Mood**: T1 vs. T2 ($p=.006$), **CF-App**: T1 vs. T2 ($p=.003$).

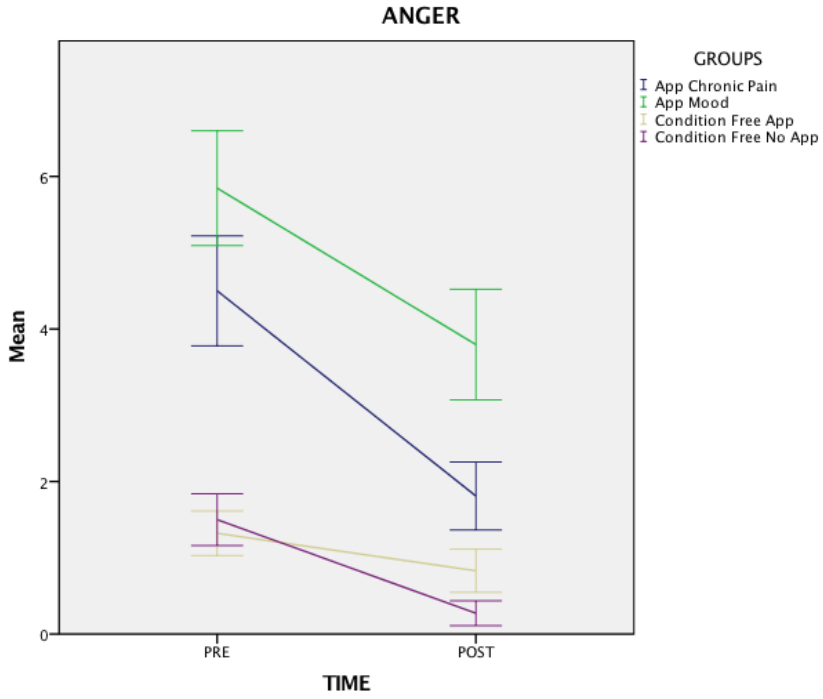

Figure 3: Mean anger scores pre and post intervention.
Pre: Pain vs. CF-App (p<.001), Pain vs. CF-No App, (p=.013), Mood vs. CF-App (p<.001), CF-No App (p<.001).
Post: Pain vs. Mood (p=.019), Mood vs. CF-App (p<.001), Mood vs. CF- No App (p<.001).
Pain: T1 vs. T2 (p<.001), **Mood**: T1 vs. T2 (p<.001).

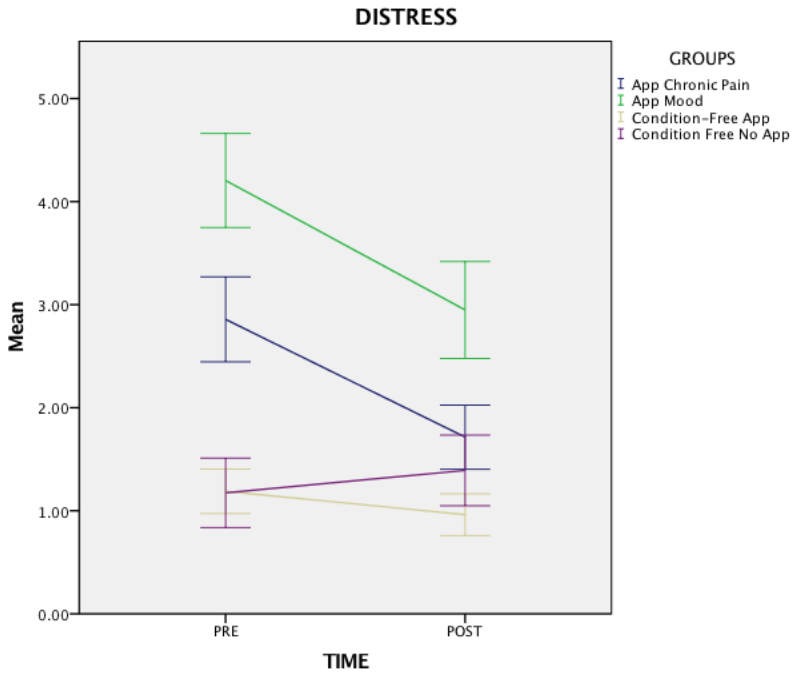

Figure 4: Mean distress scores pre and post intervention.
Pre: Pain vs. CF-App (p=.003), Pain vs. CF-No App, (p=.029), Mood vs. CF-App (p<.001), Mood vs. CF-No App (p<.001).
Post: Mood vs. CF-App (p<.001), Mood vs. CF- No App (p=.031).
Pain: T1 vs. T2 (p<.001), **Mood**: T1 vs. T2 (p<001).

Discussion

This study examined the effects of a mobile-based mindfulness intervention for young adults with chronic pain, those with symptoms of anxiety, depression, or both, and condition-free controls. It was anticipated that the intervention would alleviate symptoms of depression, anxiety and distress in all groups, with greater improvements in the mood/anxiety and chronic pain groups due to their initially elevated symptoms. It was also hypothesized that pain intensity would decrease post-intervention in the chronic pain group. Finally, it was anticipated that condition-free participants in the app condition would show greater improvement in present awareness than controls. The results lent some support to the first two hypotheses, but no evidence was found to support the last two.

Regarding Hypotheses 1 and 2, analyses revealed that post-intervention distress was significantly reduced for participants with chronic pain and symptoms of mood/anxiety disorders, but not for condition-free controls with or without the mobile application. The high baseline levels of distress in individuals with symptoms of mood/anxiety disorders and those with chronic pain are consistent with earlier research showing elevated distress levels in these groups (Angst, 2010; Taylor, Lorentzen, & Blank, 1990). Findings of significant decline post-intervention are particularly meaningful given the adverse implications of psychological distress, which has been defined as "the unique discomforting, emotional state experienced by an individual in response to a specific stressor or demand that results in harm, either temporary or permanent, to the person" (Ridner, 2004, p. 539). Research has found that psychological distress is a predictive factor in overall disability and disability caused by cardiovascular disease, depression, unspecified low back and shoulder disorders and musculoskeletal injuries (Manninen, Heliövaara, Riihimäki, & Mäkelä, 1997). Furthermore, high levels of distress have

been associated with an increased risk for diabetes, all-cause mortality, cardiovascular mortality, and cancer mortality (Mommersteeg, Herr, Zijlstra, Schneider, & Pouwer, 2012; Russ, 2012; Stewart et al., 2017). Given the adverse impact of distress on health, reducing it is a welcomed outcome. While it is unlikely that a one-time intervention will have a long-lasting effect, it is possible that daily practice can. The absence of a significant difference in post-intervention distress levels between the two condition-free groups is likely due to a floor effect (i.e., baseline levels were already so low leaving little-to-no room for a further decline).

Similar to distress, POMS tension-anxiety scores declined significantly in the condition groups. These findings are particularly meaningful given the high prevalence of anxiety symptoms in individuals with chronic pain and the role of anxiety in pain perception and coping (Asmundson & Katz, 2009; Linton, Melin, & Stjernlöf, 1985). Unlike distress, however, anxiety also declined significantly in the condition-free app group, but not in the condition-free no app-group, indicating that the app may be more beneficial to reducing anxiety than a 12-minute mindfulness meditation without an app. Previous research has shown that anxiety can be reduced with mindfulness in individuals with chronic pain, mood/anxiety symptoms and condition-free groups (Hofmann, Sawyer, Witt, & Oh, 2010; Kim, 2015). This study was among the first to show the added benefits of a mobile-based mindfulness training compared to self-directed mindfulness in condition-free controls.

POMS anger levels, which were substantially higher at baseline for condition groups compared to controls, were significantly reduced following the intervention in the chronic pain and mood/anxiety groups. The relationship between chronic pain and anger has been long established and documented (Fernandez & Turk, 1995; Trost, Vangronsvled, Linton, Quartana, & Sullivan, 2012). Anger in people with chronic pain has been linked to poor sleep quality,

relationship difficulties, and experiences of anxiety and depression (Trost, Vangronsvled, Linton, Quartana, & Sullivan, 2012). Some researchers have suggested that repressed anger exacerbates the experience of pain, while others argued that it is the presence of pain that leads to anger (Gaskin, Greene, Robinson, & Geisser, 1992; Kerns, Rosenberg, & Jacob, 1994). Regardless of its specific etiology, research has shown that both anger inhibition and anger expression can lead to increased pain sensitivity and intensity (Burns et al., 2015). Regulating anger may be a desirable goal as part of chronic pain treatment (Fernandez & Turk, 1995).

One interesting finding was that, despite a significant reduction in anger and anxiety in the chronic pain and mood/anxiety groups, the mood/anxiety group continued to endorse elevated levels of anger and anxiety post-intervention while the chronic pain group's levels of anxiety and anger dropped to those of healthy controls. It is not clear why one group was more responsive to the intervention than the other, despite similar levels of anger and anxiety at baseline. One explanation for these results is that symptoms of anxiety and anger may be more persistent overtime in individuals with mood/anxiety, especially because participants who were classified into the mood/anxiety group fell within the severe range of the BAI and CESD scores (Lovibond, 1998; Muntingh et al., 2011). Research has shown that people with mood and anxiety disorders report higher levels of anger and anger suppression (Busch, 2009; Moscovitch, McCabe, Antony, Rocca, & Swinson, 2008). Psychodynamic theories suggest that depressed individuals may struggle with angry feelings and fantasies due to heightened sensitivity to loss and rejection stemming from early experiences, leading to self-directed anger, guilt, and further depression (Busch, 2009). However, these theories have not been validated (Riley, Treiber, & Woods, 1989). Neuropsychological research studies have pointed to heightened serotonergic dysregulation as a potential contributor to elevated depression and anger in people with mood

disorders (Fava & Rosenbaum, 1998). This may be another reason why anger and anxiety were less malleable in the mood/anxiety group, as they may require a different, potentially intensified or prolonged, intervention (Bystritsky, Khalsa, Cameron, & Schiffman, 2013).

The analyses also revealed that there were no significant changes in pain intensity following the intervention. These results, while disappointing, are plausible given the intervention's brief duration and chronic pain's complex nature (Katz & Melzack, 1999). In fact, a recent meta-analysis of mindfulness interventions found insufficient evidence that mindfulness interventions reduce pain intensity (Song, Lu, Chen, Geng, & Wang, 2014). Even opioids, which are considered one of the most effective if somewhat controversial medications for chronic pan, only reduce pain intensity by approximately 30% (Rosenblum, Marsch, Joseph, & Portenoy, 2008); recently, there have been voices calling for better measures of successful treatment. It has been proposed that a decrease in pain intensity may not be required for, or predictive of, improvement in functioning (Vowles, Witkiewitz, Levell, Sowden, & Ashworth, 2017). Ballantyne and Sullivan (2015) suggest that pain intensity is the wrong metric and stated: "when pain is chronic, its intensity is not a simple measure of something that can be easily fixed. Multiple measures of the complex causes and consequences of pain are needed to elucidate a person's pain and inform multimodal treatment" (p. 2099). Another possible explanation for the lack of significant changes in pain intensity pre and post intervention is the relatively mild pain scores at baseline in the chronic pain group. This may be due to the fluctuating nature of pain, particularly in conditions such as migraines and back pain, which were prevalent in this sample. When asked about the worst pain in the last 24 hours, participants in the chronic pain group reported moderate levels of pain, supporting the notion that pain may be variable in nature.

Another finding that did not lend support to the initial hypothesis was that the two

condition-free groups did not differ in their present–awareness as measured by PARS. The PARS was developed specifically for this study in order to measure awareness of the present moment, an important component of mindfulness (Coffey, Hartman, & Fredrickson, 2010; Kabat-Zinn, 2003). In the scientific literature, mindfulness is often viewed and assessed as either a state or a trait (Medvedev, Krägeloh, Narayanan, & Siegert, 2017). However, most existing measures are written in the past tense, refer to specific past events, and do not provide a comprehensive assessment of all aspects of mindfulness (Coffey, Hartman, & Fredrickson, 2010). Thus, a decision was made to create a measure that would assess people's awareness of their feelings, thoughts, and sensations in the moment as they are completing the questionnaire. The assumption was that the mobile app would serve as a helpful tool to increase present awareness due to the presence of the tone, which served to re-orient the participant to attend to the task. This has not been supported by the results, which showed no differences in PARS scores between pre and post intervention. Nevertheless, findings pertaining to the questionnaire should be interpreted with caution because the questionnaire has not been validated and there is no information about its psychometric properties. Therefore, the question of whether the application is capable of increasing present awareness in condition-free subjects remains unanswered. A plan for a validation process is underway, using a larger sample size.

This study had important implications given the alarming psychological distress in university students in general, and in students with mood/anxiety and chronic pain in particular. It aimed to better understand young adults with chronic pain, a group that has been stigmatized, understudied, and misunderstood by the medical and academic communities, and find ways to alleviate their distress by integrating with their every-day behaviors, while keeping it brief, cost-effective, and accessible. This study showed that mobile technologies have the advantage of

delivering interventions at critical points, helping to reduce distress, anxiety and anger, when other types of help may not be readily available. The integration of this research with an existing behavior of young adults, mobile phone usage, increased the ecological validity of this study and served as an important step towards more approachable support tools for young adults.

This study has a number of limitations that warrant attention. A lack of random assignment and relevant control groups raise the possibilities of bias and non-specific factors as explanations for the present results. Specifically, although we had a no app control group for the condition-free participants, they were not randomly assigned to groups. In addition, we did not have no app control groups for each of the other groups. The lack of randomization and appropriate control conditions made it difficult to assess the true effectiveness of the mobile application versus 12-minute meditation.

Given that baseline levels of distress, anxiety, depression and other symptoms of psychopathology in the condition-free groups were quite low to begin with, there were limited opportunities to measure group differences and potential benefits of the app. Furthermore, reliance on a self-report of a chronic pain diagnosis, as well as self-report questionnaires to assess psychopathology symptoms, raise questions about the reliability and validity of these conditions. Additionally, the decision to combine people with self-reported symptoms of anxiety with those with depression meant that we were unable to determine if those who have only symptoms of anxiety or depression are different from those who have both. As previously mentioned, another limitation was the lack of a valid pre- and post-measure of mindfulness. Without it, there was no way of knowing whether mindfulness levels changed at least temporarily due to the intervention, or if mindfulness played a role in participants' symptom improvement. Also, a lack of a follow-up procedure meant it is unknown whether the results are

short or long-lived. In addition, the results may not be generalized to other groups, particularly clinical populations and other age groups, due to the decision to use only young, undergraduate university students. Furthermore, the intervention itself may be more beneficial to those who are tech-savvy and early adopters as opposed to those who are unfamiliar or uncomfortable with technology.

Overall, despite the limitations, the study achieved promising results. It was one of the first studies to date to show the effectiveness of a mobile-based mindfulness intervention for young adults with chronic pain and symptoms of depression and anxiety. Specifically, it showed that a significant reduction in distress, anxiety, and anger can be achieved after only 12 minutes of a mindfulness intervention delivered via a mobile phone. While the duration of these effects remains unknown, this study identified the potential of brief interventions in altering unpleasant mood states, which is becoming more important as distress in young-adults is growing while access to mental-health services remains restricted and unaffordable (National College Health Assessment, 2016). It is recommended that future research should examine the implications and experiences of chronic pain in this age group, as well as continue to research the effects of mobile-interventions for health and well-being.

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Appendix

Informed Consent Form- Present Awareness Study

Purpose of the Research: The aim of the present study is to evaluate the efficacy of a mobile-based 'mindful breathing task'. Specifically, the study aims to examine individuals' present awareness and mind-wandering skills.
What You Will Be Asked to do in the Research: You will be asked to complete a few mobile- and paper-based questionnaires, as well as a brief breathing task administered via a mobile app. The administration of these tests will take place over a single session, which will last about an hour and a half.
Risks and Discomforts: We do not foresee any risks or discomfort from your participation in the research.
Benefits of the Research and Benefits to You: There are no major benefits that may reasonably be expected to result from this study, except the knowledge that you are contributing to graduate education and the advancement of science.
Voluntary Participation: Your participation in the study is completely voluntary and you may choose to stop participating at any time. Your decision not to volunteer will not influence your relationship with York University, the researchers, or any other group associated with the project.
Withdrawal from the Study: You can stop participating in the study at any time, for any reason, if you so decide. If you decide to stop participating, you will still be eligible to receive the promised credit for agreeing to be in the project. Your decision to stop participating, or refusal to answer particular questions, will not affect your relationship with the researchers, York University, or any other group associated with this project. In the event you withdraw from the study and you do not wish the investigators to use your data, please let them know and the data will be destroyed.
Confidentiality: All information you supply during the research will be held in confidence and unless you specifically indicate your consent, your name will not appear in any report or publication of the research. Questionnaire data will anonymized (will not contain personal identifying information) and will be stored on a password protected laptop with TrueCrypt encryption software under a password accessible partition on the hard disk. The mobile app data will be anonymized with a 3 digit number representing each unique participant, and no identifying information will be entered into the mobile app. All paper-based data will be safely stored in a locked facility and only research staff will have access to this information. Data will be securely stored for 5 years after publication of study results. Confidentiality will be provided to the fullest extent possible by law.
Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Dr. Katz either by telephone at [redacted] extension [redacted] by e-mail [redacted] This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, York Research Tower, York University (telephone [redacted] or e-mail [redacted]

Legal Rights and Signatures:
I_____, consent to participate in _____conducted by_____. I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

Signature_____ **Date**_____
Participant

Signature_____ **Date**_____
Person obtaining consent

Pre-Questionnaires

Breath Attention Study Questionnaire

1. Demographics

* 1. Participant ID

* 2. Please enter your URPP ID (enter N/A if not applicable)

* 3. What is your gender?

- Female
- Male
- Other

* 4. Year of Birth (YYYY):

* 5. What is your current age? (in years)

* 6. Level of education (please selected the highest level of education you have completed).

- High School
- College Degree/Diploma
- Bachelor's Degree
- Master's Degree
- Doctorate Degree

* 7. Study Major:

* 8. Year of study:

- ◯ First Year
- ◯ Second Year
- ◯ Third Year
- ◯ Fourth Year
- ◯ Fifth Year

Other (please specify)

* 9. Please select an ethnicity you identify with (select all that apply.)

- ☐ Aboriginal (Inuit, Metis, North American Indian)
- ☐ West Asian (e.g., Armenian, Egyptian, Iranian, Iraqi, Lebanese, Moroccan)
- ☐ Black – African (e.g., African, Somali etc.)
- ☐ Black – Caribbean (e.g., Haitian, Jamaican etc.)
- ☐ Indo – Caribbean (e.g., Guyanese, Trinidadian etc.)
- ☐ White (Caucasian – European/American)
- ☐ Hispanic
- ☐ Latin American
- ☐ Chinese
- ☐ Japanese
- ☐ Korean
- ☐ South Asian (e.g., Indian, Pakistani, Bangladeshi, Sri Lankan etc.)
- ☐ South East Asian (e.g., Filipino, Thai, Cambodian, Malaysian, Indonesian etc.)
- ☐ Other (please specify)

* 10. Have you ever been clinically diagnosed with a psychological condition by a clinical psychologist, psychiatrist, or other mental health professional? Please select all that apply.

- [ ] Depression (e.g. Major Depressive Disorder, Bipolar I/II, Cyclothymia)
- [ ] Anxiety (e.g. Generalized Anxiety Disorder, Panic Disorder, Social Anxiety Disorder, Specific Phobia)
- [ ] Post-traumatic Stress Disorder
- [ ] Schizophrenia/Schizoaffective
- [ ] Substance Abuse
- [ ] Eating Disorder
- [ ] Attention Deficit Disorder
- [ ] Not Applicable

Other (please specify)

* 11. Do you have a history of a depressive disorder?

- [ ] Yes, current
- [ ] Yes, in the past
- [ ] Never

* 12. Do you have a history of an anxiety disorder?

- [ ] Yes, current
- [ ] Yes, in the past
- [ ] Never

* 13. Have you ever been diagnosed with a chronic health condition by a physician or other health professional? Please select all that apply.

- ◯ Diabetes
- ◯ Cancer
- ◯ Hypertension
- ◯ Parkinson's Disease
- ◯ Multiple Sclerosis
- ◯ Coronary Artery Disease
- ◯ Epilepsy
- ◯ Not applicable
- ◯ Other (please specify)

* 14. Have you ever been clinically diagnosed with a chronic pain condition by a physician or other health professional? Please select all that apply.

- ◯ Migraine/Tension Headaches
- ◯ Neuropathic (Nerve) Pain (e.g. sciatica, diabetic neuropathy, spinal cord injury)
- ◯ Chronic Joint Pain (e.g. osteoarthritis, rheumatoid arthritis)
- ◯ Chronic Back Pain (e.g. slipped or bulging discs, scoliosis, soft tissue damage)
- ◯ Fibromyalgia
- ◯ Not applicable
- ◯ Other (please specify)

* 15. How long have you had a chronic pain condition?

- ◯ Less than 3 months
- ◯ 3-6 months
- ◯ 6-12 months
- ◯ 1+ years
- ◯ Not applicable

* 16. What medications are you currently taking? Please provide your answer with the name of the medication and the condition for which you are currently using it. If you are not taking any medications, please type N/A for not applicable.

Breath Attention Study Questionnaire

2. Meditation

* 17. Do you engage in any type of meditation practice(s)?

- ◯ Daily
- ◯ Weekly
- ◯ Monthly
- ◯ Never

* 18. Please indicate the timeline you've engaged in your current, or past, meditation practice(s) (select NA if you have never practiced)

- ◯ 0 - 6 months
- ◯ 6 - 12 months
- ◯ 1 - 3 years
- ◯ > 4 years
- ◯ Not applicable

* 19. What is a typical length of your meditation session? (select NA if you do not practice)

- ◯ < 5 minutes
- ◯ 5 - 20 minutes
- ◯ 20 - 30 minutes
- ◯ 30 - 60 minutes
- ◯ > 60 minutes
- ◯ Not applicable

20. If you answered yes to question #19, please indicate which type(s) of meditation you have practiced (check all that apply).

- ◯ Mindfulness Meditation
- ◯ Transcendental Meditation
- ◯ Vipassana
- ◯ Body Scan Meditation
- ◯ Other (please specify)

Breath Attention Study Questionnaire

3. Abbreviated POMS (Revised Version)

* 21. Below is a list of words that describe feelings people have. Please CIRCLE THE NUMBER THAT BEST DESCRIBES HOW YOU FEEL RIGHT NOW.

	Not At All	A Little	Moderately	Quite a lot	Extremely
Tense	○	○	○	○	○
Angry	○	○	○	○	○
Worn Out	○	○	○	○	○
Unhappy	○	○	○	○	○
Proud	○	○	○	○	○
Lively	○	○	○	○	○
Confused	○	○	○	○	○
Sad	○	○	○	○	○
Active	○	○	○	○	○
On-edge	○	○	○	○	○
Grouchy	○	○	○	○	○
Ashamed	○	○	○	○	○
Energetic	○	○	○	○	○
Hopeless	○	○	○	○	○
Uneasy	○	○	○	○	○
Restless	○	○	○	○	○
Unable to concentrate	○	○	○	○	○
Fatigued	○	○	○	○	○
Competent	○	○	○	○	○
Annoyed	○	○	○	○	○
Discouraged	○	○	○	○	○
Resentful	○	○	○	○	○
Nervous	○	○	○	○	○
Miserable	○	○	○	○	○
Confident	○	○	○	○	○

	Not At All	A Little	Moderately	Quite a lot	Extremely
Bitter	○	○	○	○	○
Exhausted	○	○	○	○	○
Anxious	○	○	○	○	○
Helpless	○	○	○	○	○
Weary	○	○	○	○	○
Satisfied	○	○	○	○	○
Bewildered	○	○	○	○	○
Furious	○	○	○	○	○
Full of Pep	○	○	○	○	○
Worthless	○	○	○	○	○
Forgetful	○	○	○	○	○
Vigorous	○	○	○	○	○
Uncertain about things	○	○	○	○	○
Bushed	○	○	○	○	○
Embarrassed	○	○	○	○	○

Breath Attention Study Questionnaire

4. STAI Short Form Version

* 22. A number of statements which people have used to describe themselves are given below. Read each statement and then circle the most appropriate number to the right of the statement to indicate how you feel right now, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	Not at all	Somewhat	Moderately	Very much
I feel calm	◯	◯	◯	◯
I am tense	◯	◯	◯	◯
I feel upset	◯	◯	◯	◯
I am relaxed	◯	◯	◯	◯
I feel content	◯	◯	◯	◯
I am worried	◯	◯	◯	◯

Breath Attention Study Questionnaire

5. The Five-Facet Mindfulness Scale (FFMS)

* 23. Please rate each of the following statements with the number that best describes your own opinion of what is generally true for you.

	Never or very rarely true	Rarely true	Sometimes true	Often true	Very often or always true
When I'm walking, I deliberately notice the sensations of my body moving. (OBS)	○	○	○	○	○
I'm good at finding words to describe my feelings. (D)	○	○	○	○	○
I criticize myself for having irrational or inappropriate emotions. (NJ-R)	○	○	○	○	○
I perceive my feelings and emotions without having to react to them. (NR)	○	○	○	○	○
When I do things, my mind wanders off and I'm easily distracted. (AA-R)	○	○	○	○	○
When I take a shower or bath, I stay alert to the sensations of water on my body. (OBS)	○	○	○	○	○
I can easily put my beliefs, opinions, and expectations into words. (D)	○	○	○	○	○
I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted. (AA-R)	○	○	○	○	○
I watch my feelings without getting lost in them. (NR)	○	○	○	○	○

	Never or very rarely true	Rarely true	Sometimes true	Often true	Very often or always true
I tell myself I shouldn't be feeling the way I'm feeling. (NJ-R)	○	○	○	○	○
I notice how foods and drinks affect my thoughts, bodily sensations, and emotions. (OBS)	○	○	○	○	○
It's hard for me to find the words to describe what I'm thinking. (D-R)	○	○	○	○	○
I am easily distracted. (AA-R)	○	○	○	○	○
I believe some of my thoughts are abnormal or bad and I shouldn't think that way. (NJ-R)	○	○	○	○	○
I pay attention to sensations, such as the wind in my hair or sun on my face. (OBS)	○	○	○	○	○
I have trouble thinking of the right words to express how I feel about things. (D-R)	○	○	○	○	○
I make judgments about whether my thoughts are good or bad. (NJ-R)	○	○	○	○	○
I find it difficult to stay focused on what's happening in the present. (AA- R)	○	○	○	○	○
When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it. (NR)	○	○	○	○	○
I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing. (OBS)	○	○	○	○	○
In difficult situations, I can pause without immediately reacting. (NR)	○	○	○	○	○

	Never or very rarely true	Rarely true	Sometimes true	Often true	Very often or always true
When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words. (D-R)	○	○	○	○	○
It seems I am "running on automatic" without much awareness of what I'm doing. (AA-R)	○	○	○	○	○
When I have distressing thoughts or images, I feel calm soon after. (NR)	○	○	○	○	○
I tell myself that I shouldn't be thinking the way I'm thinking. (NJ-R)	○	○	○	○	○
I notice the smells and aromas of things. (OBS)	○	○	○	○	○
Even when I'm feeling terribly upset, I can find a way to put it into words. (D)	○	○	○	○	○
I rush through activities without being really attentive to them. (AA-R)	○	○	○	○	○
When I have distressing thoughts or images, I am able just to notice them without reacting. (NR)	○	○	○	○	○
I think some of my emotions are bad or inappropriate and I shouldn't feel them. (NJ-R)	○	○	○	○	○
I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow. (OBS)	○	○	○	○	○
My natural tendency is to put my experiences into words. (D)	○	○	○	○	○
When I have distressing thoughts or images, I just notice them and let them go. (NR)	○	○	○	○	○

	Never or very rarely true	Rarely true	Sometimes true	Often true	Very often or always true
I do jobs or tasks automatically without being aware of what I'm doing. (AA-R)	○	○	○	○	○
When I have distressing thoughts or images, I judge myself as good or bad depending what the thought or image is about. (NJ-R)	○	○	○	○	○
I pay attention to how my emotions affect my thoughts and behavior. OBS)	○	○	○	○	○
I can usually describe how I feel at the moment in considerable detail. (D)	○	○	○	○	○
I find myself doing things without paying attention. (AA-R)	○	○	○	○	○
I disapprove of myself when I have irrational ideas. (NJ-R)	○	○	○	○	○

Breath Attention Study Questionnaire

6. Pain Vigilance and Awareness Questionnaire (PVAQ)

* 24. Consider your behaviour over the past 2 weeks and indicate how frequently each item is a true description. Please answer by circling one number on the scale from 0 (never) to 5 (always) for each item.

	0-Never	1	2	3	4	5-Always
I am very sensitive to pain	○	○	○	○	○	○
I am aware of sudden or temporary changes in pain	○	○	○	○	○	○
I am quick to notice changes in pain intensity	○	○	○	○	○	○
I am quick to notice effects of medication on pain	○	○	○	○	○	○
I am quick to notice changes in location or extent of pain	○	○	○	○	○	○
I focus on sensations of pain	○	○	○	○	○	○
I notice pain even if I am busy with another activity	○	○	○	○	○	○
I find it easy to ignore pain	○	○	○	○	○	○
I know immediately when pain starts or increases	○	○	○	○	○	○
When I do something that increases pain, the first thing I do is check to see how much pain was increased	○	○	○	○	○	○
I know immediately when pain decreases	○	○	○	○	○	○
I seem to be more conscious of pain than others	○	○	○	○	○	○
I pay close attention to pain	○	○	○	○	○	○
I keep track of my pain level	○	○	○	○	○	○
I become preoccupied with pain	○	○	○	○	○	○
I do not dwell on pain	○	○	○	○	○	○

Breath Attention Study Questionnaire

7. Brief Pain Inventory – Short Form

* 25. Throughout our lives, most of us have had pain from time to time (such as minor headaches, sprains, and toothaches). Have you had pain other than these every- day kinds of pain today?

- ◯ Yes
- ◯ No

* 26. Please rate your pain by circling the one number that best describes your pain at its worst in the last 24 hours.

- ◯ 0-No Pain
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10-Pain as bad as you can imagine

* 27. Please rate your pain by circling the one number that best describes your pain at its least in the last 24 hours.

- ◯ 0-No Pain
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10-Pain as bad as you can imagine

* 28. Please rate your pain by circling the one number that best describes your pain on the average.

- ◯ 0-No Pain
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10-Pain as bad as you can imagine

* 29. Please rate your pain by circling the one number that tells how much pain you have right now.

- 0-No Pain
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10-Pain as bad as you can imagine

* 30. What treatments or medications are you receiving for your pain?

* 31. In the last 24 hours, how much relief have pain treatments or medications provided? Please circle the one percentage that most shows how much relief you have received.

- 0%- No Relief
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%-Complete Relief

* 32. Circle the one number that describes how, during the past 24 hours, pain has interfered with your:

	0- Does not Interfere	1	2	3	4	5	6	7	8	9	10- Completely Interferes
A. General Activity	○	○	○	○	○	○	○	○	○	○	○
B. Mood	○	○	○	○	○	○	○	○	○	○	○
C. Walking Ability	○	○	○	○	○	○	○	○	○	○	○
D. Normal Work (includes both work outside the home and housework)	○	○	○	○	○	○	○	○	○	○	○
E. Relations with other people	○	○	○	○	○	○	○	○	○	○	○
F. Sleep	○	○	○	○	○	○	○	○	○	○	○
G. Enjoyment of life	○	○	○	○	○	○	○	○	○	○	○

Breath Attention Study Questionnaire

8. Mind Wandering Questionnaire (MWQ)

Please rate how frequently you experience the following:

1= almost never
2= very infrequently
3=somewhat infrequently
4=somewhat frequently
5=very frequently
6=almost always

* 33. I have difficulty maintaining focus on simple or repetitive work

almost never	very infrequently	somewhat infrequently	somewhat frequently	very frequently	almost always
○	○	○	○	○	○

* 34. While reading, I find I haven't been thinking about the text and must therefore read it again

almost never	very infrequently	somewhat infrequently	somewhat frequently	very frequently	almost always
○	○	○	○	○	○

* 35. I do things without paying full attention

almost never	very infrequently	somewhat infrequently	somewhat frequently	very frequently	almost always
○	○	○	○	○	○

* 36. I find myself listening with one ear, thinking about something else at the same time

almost never	very infrequently	somewhat infrequently	somewhat frequently	very frequently	almost always
○	○	○	○	○	○

* 37. I mind wander during lectures or presentations

almost never	very infrequently	somewhat infrequently	somewhat frequently	very frequently	almost always
○	○	○	○	○	○

Breath Attention Study Questionnaire

9. Beck Anxiety Inventory (BAI)

* 38. Below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the past month, including today, by circling the number in the corresponding space in the column next to each symptom.

	Not at all	Mildly but it didn't bother me	Moderately - it wasn't pleasant at times	severely - it bothered me a lot
Numbness or tingling	○	○	○	○
Feeling hot	○	○	○	○
Wobbliness in legs	○	○	○	○
Unable to relax	○	○	○	○
Fear of worst happening	○	○	○	○
Dizzy or lightheaded	○	○	○	○
Heart pounding/racing	○	○	○	○
Unsteady	○	○	○	○
Terrified or afraid	○	○	○	○
Nervous	○	○	○	○
Feeling of choking	○	○	○	○
Hands trembling	○	○	○	○
Shaky / unsteady	○	○	○	○
Fear of losing control	○	○	○	○
Difficulty in breathing	○	○	○	○
Fear of dying	○	○	○	○
Scared	○	○	○	○
Indigestion	○	○	○	○
Faint / lightheaded	○	○	○	○
Face flushed	○	○	○	○
Hot/cold sweats	○	○	○	○

Breath Attention Study Questionnaire

10. Center for Epidemiologic Studies Depression Scale (CES-D)

Date:

* 39. Below is a list of some of the ways you may have felt or behaved. Please indicate how often you've felt this way during the past week. Respond to all items.

Place a checkmark in the appropriate columns.

During the past week ...

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	All of the time (5-7 days)
1. I was bothered by things that usually don't bother me.	○	○	○	○
2. I did not feel like eating; my appetite was poor.	○	○	○	○
3. I felt that I could not shake off the blues even with help from my family.	○	○	○	○
4. I felt that I was just as good as other people.	○	○	○	○
5. I had trouble keeping my mind on what I was doing.	○	○	○	○
6. I felt depressed.	○	○	○	○
7. I felt that everything I did was an effort.	○	○	○	○
8. I felt hopeful about the future.	○	○	○	○
9. I thought my life had been a failure.	○	○	○	○
10. I felt fearful.	○	○	○	○
11. My sleep was restless.	○	○	○	○
12. I was happy.	○	○	○	○
13. I talked less than usual.	○	○	○	○

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	All of the time (5-7 days)
14. I felt lonely.	○	○	○	○
15. People were unfriendly.	○	○	○	○
16. I enjoyed life.	○	○	○	○
17. I had crying spells.	○	○	○	○
18. I felt sad.	○	○	○	○
19. I felt that people disliked me.	○	○	○	○
20. I could not "get going."	○	○	○	○

Breath Attention Study Questionnaire

11. Imaginal Processes Inventory- Short Form

We are asking your cooperation in responding to a questionnaire about your inner experiences, your images, dreams, and daydreams. There is no "official" definition for words like "daydream". Interpret these words in terms of their common meanings as they might apply to you. be careful to distinguish between thinking about something you are doing at the moment and daydreaming about something else. Thinking about a task while working on it is not daydreaming, although having thoughts about the task at other times, such as while getting ready for sleep or on a long bus ride, could be daydreaming.

Each statement says something about daydreams or daydreaming. Indicate to what extent each statement applies to you, or is true for you.

* 40. I tend to be wrapped up and interested in whatever I am doing.

- ◯ very true or strongly characteristic of me
- ◯ moderately true or characteristic of me
- ◯ neither particularly characteristic or uncharacteristic of me
- ◯ moderately untrue or uncharacteristic of me
- ◯ definitely untrue or uncharacteristic of me

* 41. A really original idea can sometimes develop from a really fantastic daydream

- ◯ very true or strongly characteristic of me
- ◯ moderately true or characteristic of me
- ◯ neither particularly characteristic or uncharacteristic of me
- ◯ moderately untrue or uncharacteristic of me
- ◯ definitely untrue or uncharacteristic of me

* 42. In my fantasies, a friend discovers that I have lied

- ◯ very true or strongly characteristic of me
- ◯ moderately true or characteristic of me
- ◯ neither particularly characteristic or uncharacteristic of me
- ◯ moderately untrue or uncharacteristic of me
- ◯ definitely untrue or uncharacteristic of me

* 43. I do not really "see" the objects in a daydream

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic or uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or uncharacteristic of me

* 44. I am the kind of person whose thoughts often wander

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic or uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or uncharacteristic of me

* 45. In my daydreams, I see myself as an expert, whose opinion is sought by all.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 46. Sometimes an answer to a difficult problem will come to me during a daydream.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 47. My mind seldom wanders from my work.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 48. I imagine myself failing those I love.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 49. I picture myself as I will be several years from now.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 50. I find that I easily lose interest in things that I have to do.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 51. My daydreams often contain depressing events which upset me.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 52. I am not easily distracted.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 53. In my daydreams, I show my anger towards my enemies.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 54. My fantasies usually provide me with pleasant thoughts.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 55. My ability to concentrate is not impaired by someone talking in another part of my house or apartment.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 56. The sounds I hear in my daydreams are clear and distinct.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 57. I imagine myself not being able to finish a job I am required to do.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 58. Daydreaming never solves any problems.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 59. No matter how hard I try to concentrate, thoughts unrelated to my work always creep in.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 60. In my daydreams, I am always afraid of being caught doing something wrong.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 61. My daydreams are often stimulating and rewarding.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 62. I can work at something for a long time without feeling the least bit bored or restless.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 63. In my daydreams I am always afraid of being caught doing something wrong.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 64. Faced with a tedious job, I notice all the other things I could be doing.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 65. I seldom think about what I will be doing in the future.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 66. In my fantasies I receive an award before a large audience.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 67. My daydreams offer me useful clues to tricky situations I face.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 68. I tend to be bored easily.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 69. Unpleasant daydreams don't frighten or bother me.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 70. The "pictures in my mind" seem as clear as photographs.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 71. In my daydreams, I fear meeting new responsibilities in life.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 72. I find it hard to read when someone is on the telephone in a neighboring room.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 73. I find myself imagining ways of getting even with those I dislike.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 74. I am seldom bored.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 75. My daydreams often leave me with a warm, happy feeling.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 76. I picture myself being accepted into an organization for successful individuals only.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 77. Daydreams do not have any practical significance for me.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 78. I find it difficult to concentrate when the TV or radio is on.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 79. I daydream about what I would like to see happen in the future.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 80. In my daydreams, I feel guilty for having escaped punishment.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 81. My thoughts seldom drift from the subject before me.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 82. I find my daydreams are worthwhile and interesting to me.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 83. I never panic as a result of a daydream.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

* 84. I have difficulty in maintaining concentration for long periods of time.

- very true or strongly characteristic of me
- moderately true or characteristic of me
- neither particularly characteristic nor uncharacteristic of me
- moderately untrue or uncharacteristic of me
- definitely untrue or strongly uncharacteristic of me

Breath Attention Study Questionnaire

12. The Anxiety Sensitivity Index-3 (ASI-3)

Enter the number from the scale below that best describes how typical or characteristic each of the 16 items is of you, putting the number next to the item. You should make your ratings in terms of how much you agree or disagree with the statement as a general description of yourself.

* 85. It is important for me not to appear nervous

very little	a little	some	much	very much
○	○	○	○	○

* 86. When I cannot keep my mind on a task, I worry that I might be going crazy.

very little	a little	some	much	very much
○	○	○	○	○

* 87. It scares me when my heart beats rapidly

very little	a little	some	much	very much
○	○	○	○	○

* 88. When my stomach is upset, I worry that I might be seriously ill.

very little	a little	some	much	very much
○	○	○	○	○

* 89. It scares me when I am unable to keep my mind on a task.

very little	a little	some	much	very much
○	○	○	○	○

* 90. When I tremble in the presence of others, I wonder what people might think of me.

very little	a little	some	much	very much
○	○	○	○	○

* 91. When my chest gets tight, I get scared that I won't be able to breathe properly.

very little	a little	some	much	very much
○	○	○	○	○

* 92. When I feel pain in my chest, I worry that I'm going to have a heart attack.

very little	a little	some	much	very much
○	○	○	○	○

* 93. I worry that other people will notice my anxiety.

very little	a little	some	much	very much
○	○	○	○	○

* 94. When I feel "spacey", or spaced out I worry that I may be mentally ill.

very little	a little	some	much	very much
○	○	○	○	○

* 95. It scares me when I blush in front of people.

very little	a little	some	much	very much
○	○	○	○	○

* 96. When I notice my heart skipping a beat, I worry that there is something seriously wrong with me.

very little	a little	some	much	very much
○	○	○	○	○

* 97. When I begin to sweat in a social situation, I fear people will think negatively of me.

very little	a little	some	much	very much
○	○	○	○	○

* 98. When my thoughts seem to speed up, I worry worry that I might be going crazy.

very little	a little	some	much	very much
○	○	○	○	○

* 99. When my throat feels tight, I worry that I could choke to death.

very little	a little	some	much	very much
○	○	○	○	○

* 100. When I have trouble thinking clearly, I worry that there is something wrong with me.

very little	a little	some	much	very much
○	○	○	○	○

* 101. I think it would be horrible for me to faint in public.

very little	a little	some	much	very much
○	○	○	○	○

* 102. When my mind goes blank, I worry there is something terribly wrong with me.

very little	a little	some	much	very much
○	○	○	○	○

Breath Attention Study Questionnaire

13. Socially Desirable Response Set Five-Item Survey (SDRS-5)

* 103. Listed below are a few statements about your relationships with others. How much is each statement TRUE or FALSE for you?

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
I am always courteous even to people who are disagreeable.	○	○	○	○	○
There have been occasions when I took advantage of someone.	○	○	○	○	○
I sometimes try to get even rather than forgive and forget.	○	○	○	○	○
I sometimes feel resentful when I don’t get my way.	○	○	○	○	○
No matter who I’m talking to, I’m always a good listener.	○	○	○	○	○

Breath Attention Study Questionnaire

14. Mindful Attention Awareness Scale

Below is a collection of statements about your everyday experience.Please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each item separately from every other item.

* 104. I could be experiencing some emotion and not be conscious of it until some time later.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 105. I break or spill things because of carelessness, not paying attention, or thinking of something else

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 106. I find it difficult to stay focused on what's happening in the present.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 107. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 108. I tend not to notice feelings of physical tension or discomfort until they really grab my attention.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 109. I forget a person's name almost as soon as I've been told it for the first time.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 110. It seems I am "running on automatic," without much awareness of what I'm doing.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 111. I rush through activities without being really attentive to them.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 112. I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 113. I do jobs or tasks automatically, without being aware of what I'm doing.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 114. I find myself listening to someone with one ear, doing something else at the same time.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 115. I drive places on "automatic pilot" and then wonder why I went there.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 116. I find myself preoccupied with the future or the past.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 117. I find myself doing things without paying attention.

Almost Always	Very Frequently	Somewhat Frequently	Some Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

* 118. I snack without being aware that I'm eating.

Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never
○	○	○	○	○	○

Post-Breath Attention Study Questionnaire

Participant ID

* 1. Participant ID

Post-Breath Attention Study Questionnaire

Mind Wandering Inventory

We are interested in your experiences while doing the breath awareness task. Please read each item and indicate the response that best represents how frequently you experienced it during the breath attention task. Please use the following 5-point scale when rating each item in the provided boxes.

1 – Never
2 – Rarely
3 – Sometimes
4 – Often
5 – Very often

* 2. I worried about things that might happen in the future

- ◯ Never
- ◯ Rarely
- ◯ Sometimes
- ◯ Often
- ◯ Very Often

* 3. I thought I should be doing better on the breath attention task

- ◯ Never
- ◯ Rarely
- ◯ Sometimes
- ◯ Often
- ◯ Very Often

* 4. I was aware of outside noises

- ◯ Never
- ◯ Rarely
- ◯ Sometimes
- ◯ Often
- ◯ Very Often

* 5. I was aware of my breath

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 6. I thought about the future

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 7. I thought about pleasant things that happened in the past

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 8. I was aware of pain in my body

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 9. I felt bored

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 10. I thought about pleasant things that might happen in the future

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 11. I had daydreams or fantasies involving others

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 12. I thought about pain in my body

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 13. I thought about solutions to my problems

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 14. I thought about unpleasant bodily sensations

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 15. I had conversations with my “inner voice”

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 16. I felt sleepy

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 17. I imagined having conversations with others

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 18. I thought about using my phone

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 19. I was aware of pleasant body sensations

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 20. I experienced images of colors/shapes or other non-verbal experiences

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 21. I was simultaneously aware of my breath and another experience(s)

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 22. I thought about how difficult it was to attend to my breath

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 23. I thought about things that I need to do

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 24. I was aware of unpleasant feelings/emotions

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 25. I wished I was doing something other than the breath attention task

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 26. I thought about past experiences

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 27. I noticed how awake I felt

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 28. I worried about things that happened in the past

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 29. I was aware of pleasant thoughts/emotions

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 30. I had daydreams or fantasies involving me

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 31. I thought about when the tone was going to occur next

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 32. I thought about my performance on the breath attention task

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 33. I counted to myself

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 34. I thought about using my computer

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 35. I was aware of experiences that I cannot label or describe

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 36. I thought about new ideas

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 37. I noticed how attentive I was

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 38. I “heard” music in my head

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 39. I thought about how easy it was to do the breath attention task

- Never
- Rarely
- Sometimes
- Often
- Very Often

* 40. Please list any other experiences you had during the breath attention task

Post-Breath Attention Study Questionnaire

Toronto Mindfulness Scale (Lau et al., 2006)

We are interested in what you just experienced. Below is a list of things that people sometimes experience. Please read each statement. Next to each statement are five choices: "not at all," "a little," "moderately," "quite a bit," and "very much." Please indicate the extent to which you agree with each statement. In other words, how well does the statement describe what you just experience, just now?

1 = A little 2 = Moderately 3 = Quite a bit 4 = Very much

* 41. I experienced myself as separate from my changing thoughts and feelings

- ◯ A little
- ◯ Moderately
- ◯ Quite a bit
- ◯ Very much

* 42. I was more concerned with being open to my experiences than controlling or changing them

- ◯ A little
- ◯ Moderately
- ◯ Quite a bit
- ◯ Very much

* 43. I was curious about what I might learn about myself by taking notice of how I react to certain thoughts, feelings or sensations

- ◯ A little
- ◯ Moderately
- ◯ Quite a bit
- ◯ Very much

* 44. I experienced my thoughts more as events in my mind than as a necessarily accurate reflection of the way things 'really' are

- A little
- Moderately
- Quite a bit
- Very much

* 45. I was curious to see what my mind was up to from moment to moment

- A little
- Moderately
- Quite a bit
- Very much

* 46. I was curious about each of the thoughts and feelings that I was having

- A little
- Moderately
- Quite a bit
- Very much

* 47. I was receptive to observing unpleasant thoughts and feelings without interfering with them

- A little
- Moderately
- Quite a bit
- Very much

* 48. I was more invested in just watching my experiences as they arose, than in figuring out what they could mean

- A little
- Moderately
- Quite a bit
- Very much

* 49. I approached each experience by trying to accept it, no matter whether it was pleasant or unpleasant

- A little
- Moderately
- Quite a bit
- Very much

* 50. I remained curious about the nature of each experience as it arose

- A little
- Moderately
- Quite a bit
- Very much

* 51. I was aware of my thoughts and feelings without over-identifying with them

- A little
- Moderately
- Quite a bit
- Very much

* 52. I was curious about my reactions to things

- A little
- Moderately
- Quite a bit
- Very much

* 53. I was curious about what I might learn about myself by just taking notice of what my attention gets drawn to

- A little
- Moderately
- Quite a bit
- Very much

Post-Breath Attention Study Questionnaire

Abbreviated POMS (Revised Version)

* 54. Below is a list of words that describe feelings people have. Please CIRCLE THE NUMBER THAT BEST DESCRIBES HOW YOU FEEL RIGHT NOW.

	Not At All	A Little	Moderately	Quite a Lot	Extremely
Tense	○	○	○	○	○
Angry	○	○	○	○	○
Worn Out	○	○	○	○	○
Unhappy	○	○	○	○	○
Proud	○	○	○	○	○
Lively	○	○	○	○	○
Confused	○	○	○	○	○
Sad	○	○	○	○	○
Active	○	○	○	○	○
On-edge	○	○	○	○	○
Grouchy	○	○	○	○	○
Ashamed	○	○	○	○	○
Energetic	○	○	○	○	○
Hopeless	○	○	○	○	○
Uneasy	○	○	○	○	○
Restless	○	○	○	○	○
Unable to concentrate	○	○	○	○	○
Fatigued	○	○	○	○	○
Competent	○	○	○	○	○
Annoyed	○	○	○	○	○
Discouraged	○	○	○	○	○
Resentful	○	○	○	○	○
Nervous	○	○	○	○	○
Miserable	○	○	○	○	○
Confident	○	○	○	○	○

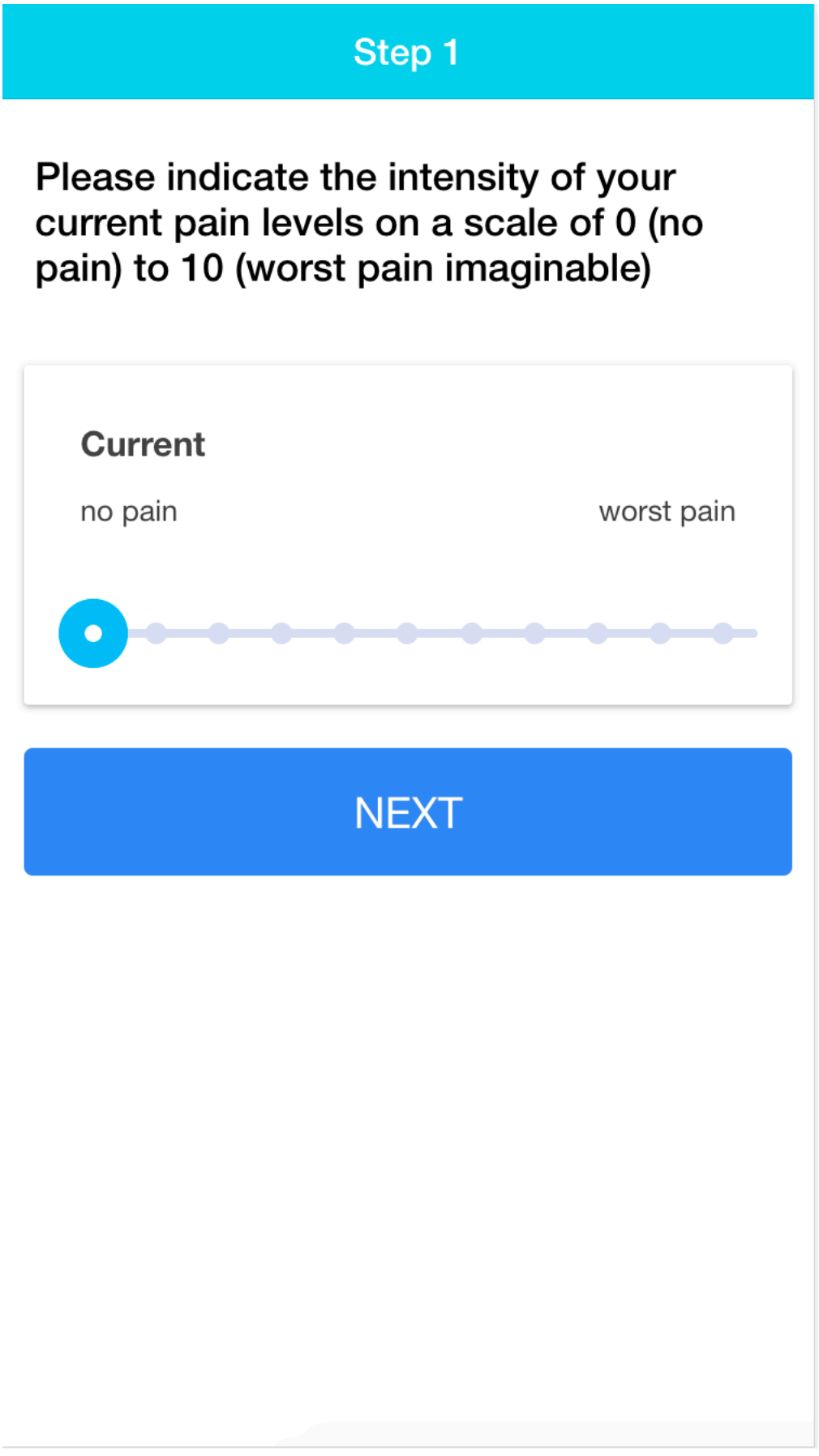
	Not At All	A Little	Moderately	Quite a Lot	Extremely
Bitter	○	○	○	○	○
Exhausted	○	○	○	○	○
Anxious	○	○	○	○	○
Helpless	○	○	○	○	○
Weary	○	○	○	○	○
Satisfied	○	○	○	○	○
Bewildered	○	○	○	○	○
Furious	○	○	○	○	○
Full of Pep	○	○	○	○	○
Worthless	○	○	○	○	○
Forgetful	○	○	○	○	○
Vigorous	○	○	○	○	○
Uncertain about things	○	○	○	○	○
Bushed	○	○	○	○	○
Embarrassed	○	○	○	○	○

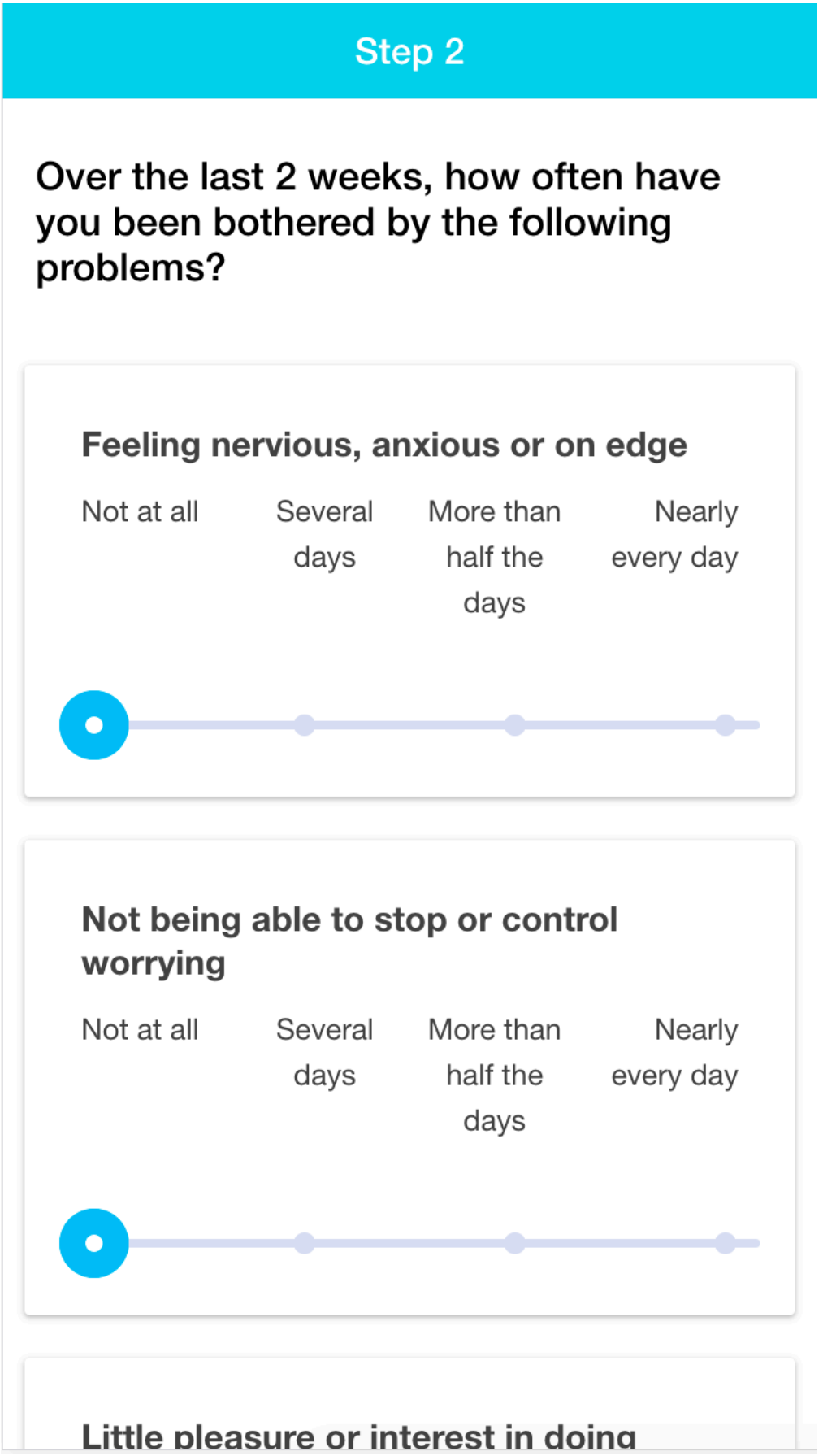
Post-Breath Attention Study Questionnaire

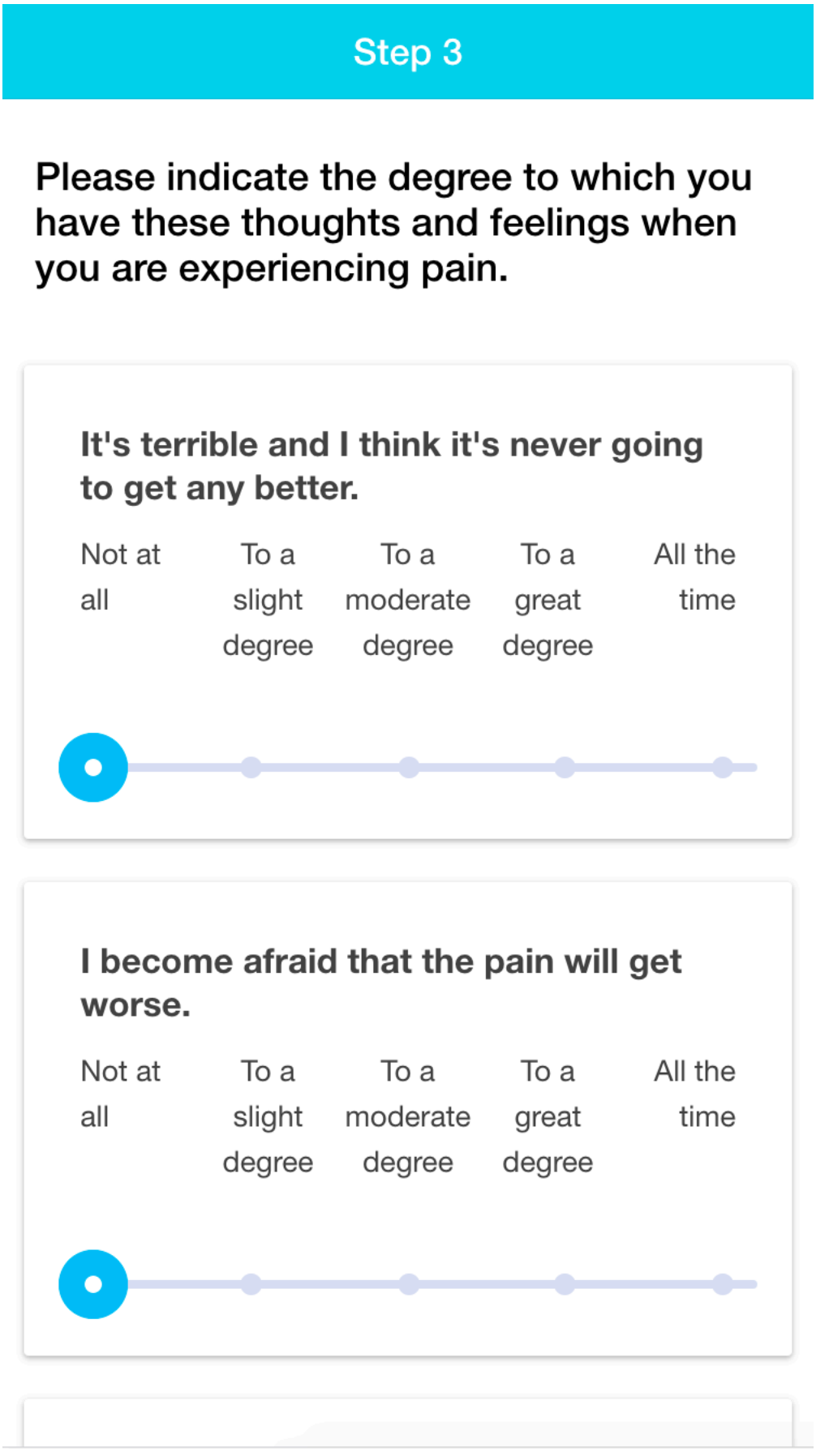
STAI Short Form version

* 55. A number of statements which people have used to describe themselves are given below. Read each statement and then circle the most appropriate number to the right of the statement to indicate how you feel right now, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	Not at all	Somewhat	Moderately	Very much	
I feel calm	○	○	○	○	○
I am tense	○	○	○	○	○
I feel upset	○	○	○	○	○
I am relaxed	○	○	○	○	○
I feel content	○	○	○	○	○
I am worried	○	○	○	○	○


Step 1
Please indicate the intensity of your current pain levels on a scale of 0 (no pain) to 10 (worst pain imaginable)
Current
no pain
worst pain
NEXT


Step 2
Over the last 2 weeks, how often have you been bothered by the following problems?
Feeling nervious, anxious or on edge
Not at all
Several days
More than half the days
Nearly every day
Not being able to stop or control worrying
Not at all
Several days
More than half the days
Nearly every day
Little pleasure or interest in doing


Step 3
Please indicate the degree to which you have these thoughts and feelings when you are experiencing pain.
It's terrible and I think it's never going to get any better.
Not at all
To a slight degree
To a moderate degree
To a great degree
All the time
I become afraid that the pain will get worse.
Not at all
To a slight degree
To a moderate degree
To a great degree
All the time

Step 4

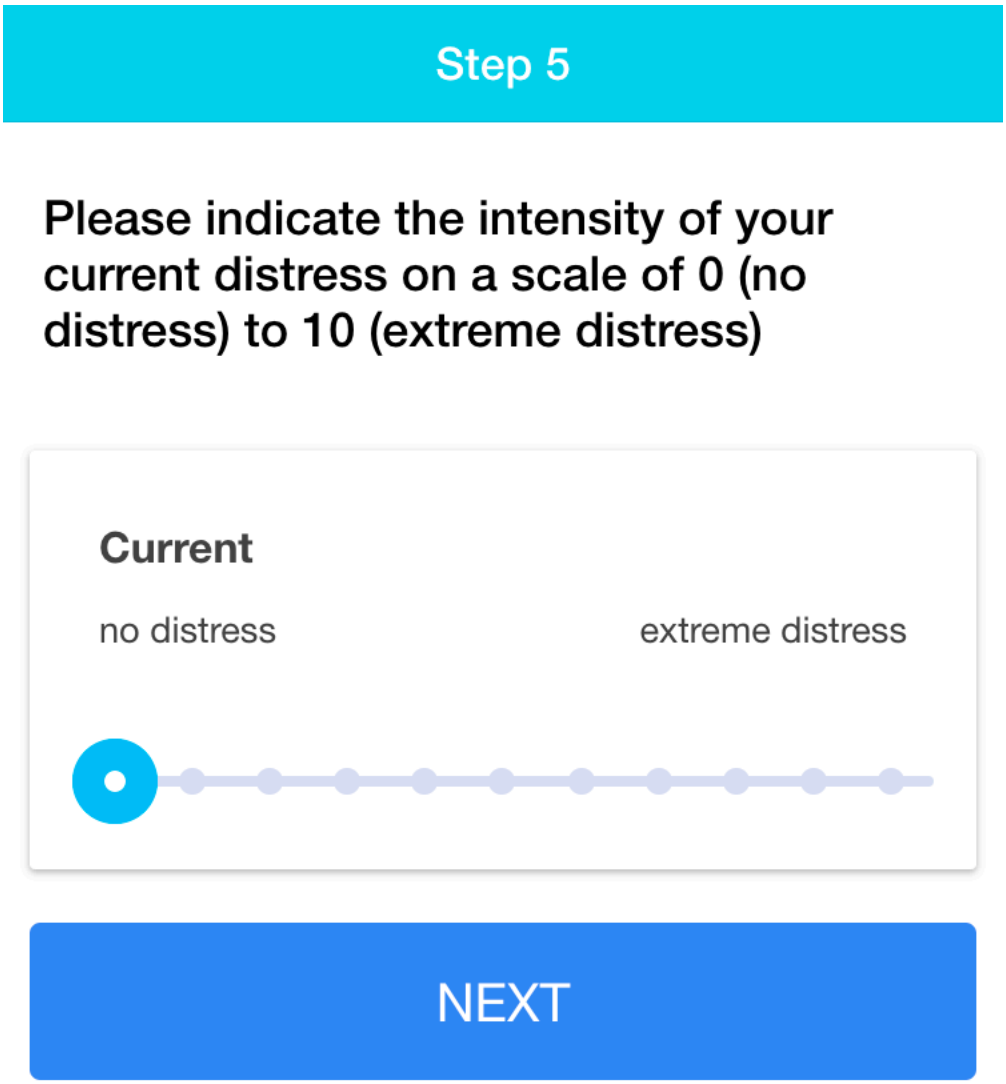
For each of the 7 categories of life activity listed, please select the number on the scale that describes the level of disability you typically experience. A score of 0 means no disability at all, and a score of 10 signifies that all of the activities in which you would normally be involved have been totally disrupted or prevented by your pain.

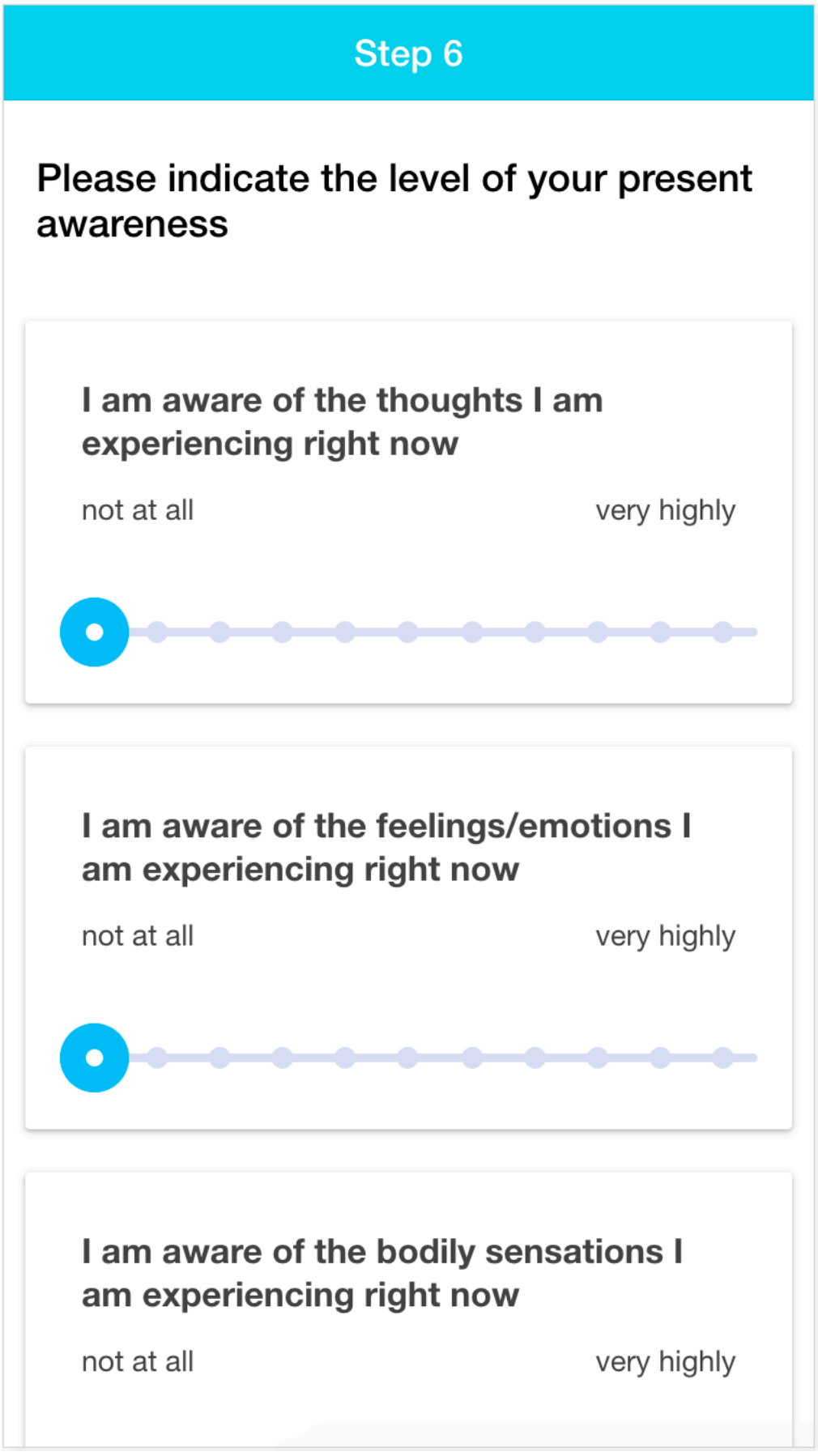
Family/home responsibilities

Not at all	To a slight degree	To a moderate degree	To a great degree	All the time

Recreation

Not at all	To a slight degree	To a moderate degree	To a great degree	All the time


Step 5
Please indicate the intensity of your current distress on a scale of 0 (no distress) to 10 (extreme distress)
Current
no distress
extreme distress
NEXT

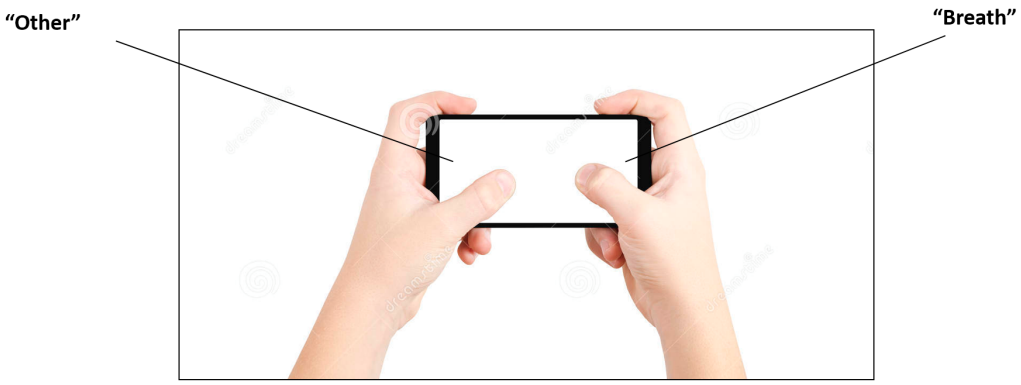

Step 6
Please indicate the level of your present awareness
I am aware of the thoughts I am experiencing right now
not at all
very highly
I am aware of the feelings/emotions I am experiencing right now
not at all
very highly
I am aware of the bodily sensations I am experiencing right now
not at all
very highly

Breath Awareness Task Instructions:

The purpose of the breath awareness task involves attending to your breathing, and noticing what you're attending to by pressing buttons indicating 'breath' or 'other' on a mobile phone at the sound of a tone.

1. Sit comfortably in your chair with your back straight. Your neck should be relaxed, with your chin slightly tucked in.

2. Hold the mobile phone with two hands resting comfortably on your lap, and place your thumbs above (but not touching) the screen as the image below displays:



3. Close your eyes.

4. For the duration of the task, try and be aware of your breathing sensations, including any or all of the following aspects of breathing:

- The feeling of the air passing through your nostrils and throat
- The movement of your in- and out-breath at your chest and torso
- The sound of the air as you breathe in and out
- The temperature (coolness or warmth) of the in- and out-breath

5. At various times, the phone will sound a tone. Press **'Breath'** if in that moment your attention was on your breath, and **'Other'** if in that moment your attention was on other experiences (e.g. thoughts, feelings, physical sensations).

6. Return your attention to your breath after pressing a button. This task will be 12 minutes long, please remain seated with your eyes closed until the end of the task.

7. At the end, there will be some questions to answer on the mobile app.

Trial Exercise: "First, let's start with a one minute practice to help you get used to pressing the buttons. Remember, press 'Breath' if you were aware of your breath in the moment you hear a tone, or 'Other' if you were attending to any thoughts, emotions, or sensory and physical experiences."

Breath Attention Control Task Instructions:

The purpose of the breath attention task involves attending to your breathing and noticing the object(s) of your attention at any given moment.

1. Sit comfortably in your chair with your back straight and both hands comfortably placed on your lap. Your neck should be relaxed, with your chin slightly tucked in.

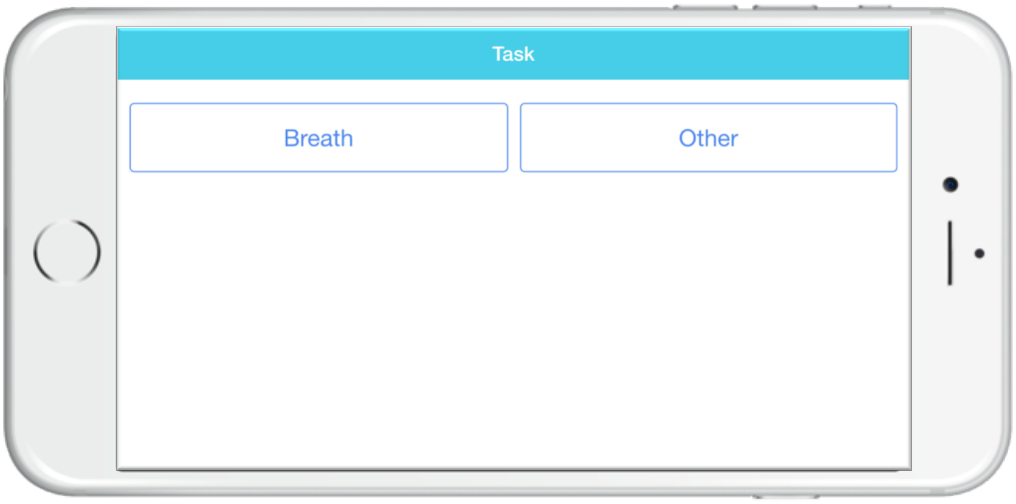
2. Close your eyes.

3. For the duration of the task, try and be aware of your breathing sensations, including any or all of the following aspects of breathing:

- The feeling of the air passing through your nostrils and throat
- The movement of your in- and out-breath at your chest and torso
- The sound of the air as you breathe in and out
- The temperature (coolness or warmth) of the in- and out-breath

4. Return your attention to your breath when you have noticed your attention has been elsewhere. This task will be 12 minutes long, please remain seated with your eyes closed until the end of the task.

5. At the end, there will be some questions to answer on the mobile app.


Task
Breath
Other