INVESTIGATION OF BREATH COUNTING, ABDOMINAL BREATHING AND PHYSIOLOGICAL RESPONSES IN RELATION TO COGNITIVE LOAD WITH UNIVERSITY STUDENTS

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Dedication

To the memory of sư thầy đại đức hòa thượng Thích Giác Tâm (Cattamalo Bhikkhu)

known to some as Reverend Chuck Mike Truman

(1938-2012)

Untitled photograph of Reverend Truman

n.d. Photographer unknown. Adopted from estate print.

Acknowledgments

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Abstract

Computers and mobile electronic devices in college and university learning environments present opportunity and risk. Paradoxically, such devices can add unprecedented value to the learning process while simultaneously presenting the risk of causing or exacerbating stress. College and university student populations have historically displayed high stress levels. Given this confluence of technology and stress with college and university students, understanding and mitigating stress related to computer and mobile device use is a worthwhile endeavor. Breathing activities are potential means of mitigating stress, including stress related to activities performed on computers and electronic devices. Some breathing activities have long histories of being used for self-regulation, and such activities might be useful to college students for stress management. The author used a within-subject, repeated measures, quasi-experimental interrupted time-series design to investigate this topic. Ninety-six students from a state university completed an activity sequence comprised of periods of quiet sitting, computer-mediated Stroop color-word activities and breathing activities. The author randomly assigned participants to three groups: (a) breath counting, (b) abdominal breathing and (c) combined: both breath counting and abdominal breathing. Participants also completed surveys designed to gather information regarding their impressions of the breathing activities, the perceived subjective norms related to the importance of breathing activities to their peers, family and culture, as well as their stage of change for stress management, breath attention and abdominal breathing. Evidence from this study suggests all three breathing activities are equally effective in enabling students to manage stress caused by a computer-mediated task. This study builds upon a previously published work in progress (Brumback, 2017) and pilot study (Brumback, 2018).

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Abbreviations and Symbols

AIC	Akaike information criterion
BIC	Schwarz's Bayesian information criterion
BPM	Beats per minute
BrPM	Breaths per minute
BrRatio	Breath ratio
CO_2	Carbon dioxide
ICC	Intraclass correlation coefficient
ECG	Electrocardiogram
EDA	Electrodermal activity—formerly known as Galvanic skin response (GSR)
GSR	Galvanic skin response—now known as electrodermal activity (EDA)
HR	Heart rate
ms	Milliseconds
µs	Microsiemens
µv	Microvolts
pH	Potential hydrogen
QRS	ECG heartbeat complex composed of Q, R and S waves
RR	Respiratory rate
SC	Skin conductance
TPB	Theory of Planned Behavior—also seen as TOPB
TRA	Theory of Reasoned Action
UV	Ultraviolet

Chapter 1

Introduction

Background

Individuals in college and university student populations are particularly vulnerable to stress caused by a variety of factors (American College of Health Association, 2018b, 2018c, 2018a; Auerbach et al., 2018; Liu, Stevens, Wong, Yasui, & Chen, 2019; Ribeiro et al., 2018). Due to this stress exposure and the potential for stress to lead to more serious health problems, Liu et al. (2019) note "an urgent need for strategies that inoculate students against stress during this developmental period" (p. 15). Some stress that students experience can be caused or exacerbated by using computers or mobile devices, the use of which can cause interruptions to and irregularities in breathing (Lin & Peper, 2009; Peper, Harvey, & Tylova, 2006; Rosen, Carrier, Miller, Rokkum, & Ruiz, 2016).

This matter is relevant to the field of educational psychology because equipping students with basic and effective stress management strategies can potentially enhance the learning process at multiple levels. At the basic level, if students learn the skill of breath awareness, they may periodically notice that they are pausing or reducing their breath while concentrating—including while using computers and mobile devices in educational settings. At a more advanced level, students could choose to adopt breathing activities to manage stress, to improve their ability to concentrate or to improve their health.

Breathing activities in educational settings have received attention in academic literature, but many studies employ a combination of techniques, including breathing activities, for stress management (or other objectives). This approach can make any positive outcome difficult to attribute to a particular breathing activity. Another challenge evident in some studies is the exclusive use of qualitative research methods to examine the effects of breathing activities. These factors do not diminish these well-intentioned studies, but presents opportunities to study breathing activities in educational settings from different, but complementary approaches.

As noted previously (Brumback, 2017, 2018) the relationship between breathing and stress is well established (Cacioppo, Tassinary, & Berntson, 2017; Chaitow, Gilbert, & Bradley, 2014; Fried, 1993; Haruki, Homma, Umezawa, & Masaoka, 2001; Lehrer, Woolfolk, & Sime, 2007; B. H. Timmons & Ley, 1994), and the use of breathing for various aspects of self-regulation has a longstanding traditional history (A. C. Bhaktivedanta Swami Prabhupāda, 2011; Ali-Shah, 1998; Ānandajoti Bhikkhu, 2011; Anyen Rinpoche & Zangmo, 2013; Douglas-Klotz, 1997; Eifring, 2013; Nakamura, 1981; Narada Mahā Therā, 1980; Rosenberg, 2004). These scientific and traditional approaches inform contemporary studies related to breath use for stress management in today's college and university environments. Two methods that have been adopted from these traditions and applied to stress management in educational settings are breath counting (Britton et al., 2014; Hooker & Fodor, 2008) and abdominal breathing (Dvořáková et al., 2017; Gold et al., 2010; Goldin & Gross, 2010; Kabat-Zinn, 2003; Lichtenstein, 2016; Paul, Elam, & Verhulst, 2007; Peper, Miceli, & Harvey, 2016).

Purpose

This project extends the author's previous work on this topic (Brumback, 2017, 2018) and seeks to gather and analyze information related to the following research questions: (a) Can college students regulate physiological responses caused by computer use by using a five-minute breathing activity? and (b) Are there significant differences in physiological responses between individuals performing quiet sitting and the breathing activities of breath counting, abdominal breathing or combined breath counting and abdominal breathing? (Brumback, 2018).

Additionally, this project also seeks to gather and analyze information about student participants' (a) stress levels, (b) demographics, (c) perceptions of the breathing activity they were exposed to, (d) perceived time costs of breath awareness and activities, (e) perceived subjective norms: importance of breath awareness and activities to one's self, peers, family and culture, (f) experience with breath awareness and activities, (g) use or planned use of stress management, (h) use or planned use of breath awareness, (i) use or planned use of abdominal breathing activities and (j) perceptions regarding their participation in the study.

Importance

This study attempts to begin to address a gap in the literature related to breathing activity use by college and university students. Most existing studies related to these topics have gained insight about the effectiveness of breathing activities with college and university students primarily through qualitative data collection. Additionally, many of these studies have used a variety of techniques in addition to breathing activities, which makes it difficult to attribute any positive effects to specific breathing activities (Brumback, 2017). By gathering data from empirical and qualitative sources, the author hopes to combine objective physiological measurements with participants' subjective perspectives and reported experience in order to find evidence related to the research questions.

Statement of Problem

College and university students can experience high degrees of stress and can benefit from effective stress management strategies. Breathing activities are strategies that some have advocated for this purpose. As with any proposed intervention, it is imperative to first establish its effectiveness and suitability for the population for which it is intended.

Effectiveness can be determined subjectively and objectively. If individuals believe breathing activities are useful for managing stress, one may consider this a subjective aspect of effectiveness. If breathing activities cause a positive change in physiological measures such as skin conductance (SC), heart rate (HR), respiratory rate (RR) and the magnitude and ratio of abdominal and thoracic breathing, one may consider these objective measures of effectiveness. Both subjective and objective measures of effectiveness can be combined to provide a more holistic picture of breathing activities in this context.

One must also consider the suitability of the breathing activities for college and university students. It is important to establish individual perceptions of ease of use, time cost, and congruence with individual experience, values and culture. For the ideal breathing activity, individuals would find it easy to use and also believe it would not take an excessive amount of time to practice on a regular basis. Furthermore, the ideal activity would be equivalent or similar to something the individual already had experience with as well as be congruent with one's values and culture. As effective as a breathing activity might be for stress management in the lab, the activity may not be adopted by students if it is not compatible with individual experiences, values and preferences.

Ultimately, the author is seeking evidence regarding the effectiveness of a five-minute breathing activity that is easy for college and university students to do on their own, that is physiologically effective and is perceived by participants as useful in helping manage stress. Before attempting to promote any breathing activities for stress management with this population, evidence supporting the activity effectiveness and suitability must be established. If nothing else, exposing individuals to breathing activities can initiate breath awareness, which could serve as an initial foundation for future use of breathing activities for stress management.

Theoretical Framework

Education-related stress and breathing. Self-regulation is an essential expectation in the educational milieu for students and teachers alike, and breath-related activities for self-regulation are gaining popularity in today's classrooms. These activities are diverse and are often a facet of larger mindfulness-related interventions. Of the various self-regulatory activities one could demonstrate or learn, an advantage of using breath for self-regulation is that it is a biological process that is both voluntary and reflexively controlled; and is one of the few bodily functions that has the capacity to influence the somatic and autonomic nervous systems.

Peper (1979) notes that when one puts forth effort (also called striving) one sometimes inadvertently hold one's breath. Breath holding of this sort may originate from the primitive concealment response during which breath is suspended to help focus sensory attention, prepare for action, while at the same time attempting to remain undetectable (Chaitow et al., 2014). In homeostasis, apnea naturally occurs between breaths, automatically, at regular intervals (Calais-Germain, 2006). Pathological apnea results in irregular breathing, which can lead to anxiety (Chaitow et al., 2014). Pathological apnea in educational environments could occur in a variety of educational scenarios such as a student unknowingly holding one's breath in anticipation of being called upon by the teacher or while intently focused on learning tasks.

Breath awareness. Breath awareness is a basic breathing behavior in which one begins the process of establishing and maintaining awareness of one's own (or another person's) breath at selected times. Two of the activities in this study can be used to establish breath awareness: breath counting and abdominal breathing. Both breath counting and abdominal breathing often appear in the literature under the broad and diverse construct of mindfulness.

Breath counting. Breath counting is a basic meditation technique in which one focuses one's attention on counting one's breaths (Hooker & Fodor, 2008; Hoshiyama & Hoshiyama, 2013; Lehmann et al., 2012; Nakamura, 1981). Breath counting has been advocated for use in educational settings (Hooker & Fodor, 2008; Sessa, 2007). It is seen by some as a behavioral measure of mindfulness as well as a means of improving mindfulness (Levinson, Stoll, Kindy, Merry, & Davidson, 2014).

Abdominal breathing. Abdominal breathing is another breathing technique with meditative origins (Hoshiyama & Hoshiyama, 2013), in which one relaxes one's abdomen and breathes slowly and deeply while permitting one's abdomen to naturally expand and contract in concert with the deliberate movement of one's diaphragm (Biggs, Kelly, & Toney, 2003; Chaitow et al., 2014). Like breath counting, some have advocated abdominal breathing for use with students (Fonseca, Montero, Guenaga, & Mentxaka, 2017; Kajander & Peper, 1998; Paul et al., 2007; Peper, Miceli, et al., 2016; Sellakumar, 2015; Terai, Shimo, & Umezawa, 2014). As noted in previous publication, it is referred to by a variety of terms (Brumback, 2017) including belly breathing (Jerath, Edry, Barnes, & Jerath, 2006; Kajander & Peper, 1998), deep breathing (Ramacharaka, 1905), deep abdominal breathing (Pekala & Forbes, 1990), deep and slow breathing (Busch et al., 2012), diaphragmal breathing (Busch et al., 2012), diaphragmatic breathing (Biggs et al., 2003; Hymes & Nuernberger, 1991; Kajander & Peper, 1998;

Ramacharaka, 1905; Terai et al., 2014), low breathing (Ramacharaka, 1905) and slow-deep breathing (Sellakumar, 2015).

Breathing and stress. The human body requires acid-base homeostasis and maintains it through balanced pH (Hamm, Nakhoul, & Hering-Smith, 2015). Breathing is an essential mechanism for pH regulation (Fried, 1993; Gilbert, 2014; Javaheri, 2005), enabling the body to acquire oxygen and expel carbon dioxide. In healthy humans at sea level, oxygen levels in the blood remain relatively constant. If the blood is already oxygen saturated, higher breathing rates will not put more oxygen into the blood, but will reduce carbon dioxide. Breathing has a substantial effect on the amount of carbon dioxide in the blood, which helps control blood pH. Deficient levels of carbon dioxide in the blood caused by breathing (hyperventilation) is known as respiratory acidosis, which raises the blood pH, making it more acidic. Conversely, excessive levels of carbon dioxide in the blood caused by breathing (hypoventalation) is known as respiratory alkalosis, which decreases the blood pH, making it more basic. Both these conditions alter homeostasis and cause a series of complex and interrelated physiological effects controlled by the autonomic nervous system, to restore balance (Fried, 1993; Gilbert, 2014; Naifeh, 1994). Persistent interruptions to homeostatic breathing patterns can cause or exacerbate stress, which can further affect breathing, perpetuating a cycle of imbalance.

Physiological measurement. Certain changes in physiological signals can indicate physiological arousal, and may be viewed as corresponding to stress and cognitive load. Stress and cognitive load can be regarded as complex and overlapping constructs (Chen et al., 2016). As a result, cognitive load and stress are arguably challenging to precisely define and measure. Because physiological signals have been used by some researchers attempting to measure cognitive load (Chen et al., 2016) and stress (Cacioppo et al., 2017), the author of this study selected the following physiological signals to determine if there was any change in participant physiological measures that corresponded to events in the experimental activity sequence.

Electrodermal activity (EDA). Skin conductance (SC) is measured in microsiemens (μs) and is an aspect of EDA that measures the electrical constructiveness of the skin's surface (Dawson, Schell, & Filion, 2017). Changes in SC are caused by the secretions of the eccrine sweat glands, which are predominantly controlled by the sympathetic nervous system and are believed to be more responsive to physiological stimuli (Dawson et al., 2017). Changes in skin conductance can correspond with the presentation of novel stimuli, but also can be evoked by body movements, including deep breaths (Dawson et al., 2017). Increases skin conductance can correspond with increased physiological arousal (Dawson et al., 2017; Potter & Bolls, 2012; Stern, Ray, & Quigley, 2000).

Electrocardiogram (ECG). Heart rate (HR) is measured in beats per minute (BPM) and is established by counting cardiac cycles (Berntson, Quigley, Norman, & Lozano, 2017). The most distinctive electrophysiological feature of the ECG waveform is the QRS complex, which shows Q, R and S waves of the heartbeat (Berntson et al., 2017; Stern et al., 2000). Increases in HR can correspond with increased in physiological arousal (Potter & Bolls, 2012).

Respiration. Respiratory rate (RR) is measured in breaths per minute (BrPM) and is established by counting respiratory cycles, each cycle being composed of one inspiration and one expiration (Chaitow et al., 2014; Lorig, 2017). The amplitude of the breathing signal waveform corresponds with the depth (or shallowness) of the breath. If the amplitude of the abdominal breathing signal is compared with the amplitude of the thoracic breathing signals, one may categorize breathing style by calculating breath ratio (Boiten, Frijda, & Wientjes, 1994; Peper, Groshans, Johnston, Harvey, & Shaffer, 2016). "When the ratio of the abdominal and thoracic standard deviations exceeds 1.0, this indicates abdominal dominance, and when it falls below 1.0, it signals thoracic dominance" (Peper, Groshans, et al., 2016, p. 101). Abdominal and thoracic breathing relative amplitude are one of the most significant aspects of respiration for determining psychophysiological states (B. Timmons, Salamy, Kamiya, & Girton, 1972).

Intently focusing one' attention or performing a demanding task can cause changes in RR (Boiten et al., 1994; Grassmann, Vlemincx, von Leupoldt, Mittelstädt, & Van den Bergh, 2016; Peper, 1979). Increases in RR can indicate increases in physiological arousal (Lorig, 2017). Abdominal breathing dominance has been associated with positive emotional states and relaxation, while thoracic breathing dominance has been associated with anxiety, tension or negative affect (Boiten et al., 1994).

Feldt's college student stress scale. To determine participant overall stress levels, this study makes use of Feldt's (2008) 11-item college student stress scale (CSSS), which has demonstrated reliability (Feldt & Koch, 2011) and gender invariability (Feldt & Updegraff, 2013). The questionnaire asks participants how often within the last week they have experienced feeling anxious or distressed about (a) personal relationships, (b) family matters, (c) financial matters, (d) academic matters, (e) housing matters, (f) being away from home, (g) events not going as planned; questioning one's ability to (h) handle difficulties in one's life, (i) attain one's goals; feeling (j) as though one was no longer in control of one's life and (k) overwhelmed by difficulties in one's life. Responses to each statement are recorded on a five-point scale labeled (a) never—1, (b) rarely—2, (c) sometimes—3, (d) often—4 and (e) very often—5. One adds scores from the 11 items to determine an individual's overall stress score. The CSSS questions composed the first part of Questionnaire 1 (Appendix A).

Cognitive load. Cognitive load can be defined as "a multi-dimensional construct representing the load imposed on the working memory during the performance of a cognitive task" (Chen et al., 2016; Paas, Tuovinen, Tabbers, & Van Gerven, 2003; Paas & Van Merriënboer, 1994). In the human factors physiological domain, the idea of cognitive load has been superseded by the construct of mental load (Chen et al., 2016). Reducing cognitive load to improve student learning outcomes is a key objective for applying the Cognitive Load Theory (Chandler & Sweller, 1991; Sweller, 1988, 1989, 1994). Assessing and minimizing cognitive load is also an important aspect of human-computer interaction (Chen et al., 2016). For computer-based activities, cognitive load might be assessed by measuring physiological response (Ferreira et al., 2014; Haapalainen, Kim, Forlizzi, & Dey, 2010; Ikehara & Crosby, 2005; Wijsman, Grundlehner, Liu, Hermens, & Penders, 2011). Physiological responses due to cognitive load may be difficult to differentiate from stress-induced physiological response (Chen et al., 2016). Perceptions of and responses to cognitive load vary between individuals (Martin, 2014; Paas & Van Merriënboer, 1994). Martin (2014) notes that direct and objective measures of cognitive load remain elusive.

This study used a cognitively demanding computer-mediated activity to simulate computer use in an educational setting. Participants were required to conduct a novel activity according to specific instructions while paying close attention to information displayed on a computer screen and responded by pressing the individual key on the computer keyboard which corresponded with the correct answer. Given this approach, this study does not seek to specifically measure cognitive load used cognitive load levied by the computer activity as a laboratory stressor to elicit physiological responses from the participants.

Stroop color-word task. In 1935, J. Ridley Stroop described delayed participant response that occurs when one presents incongruent stimuli of a color word that does not match color the word is printed in when compared to the congruent stimuli of a color word that matches the color the word is printed in (Stroop, 1934/1992). The interference of the competing stimuli cannot be individually regulated (Kahneman, 1973) and practice effects only emerge after prolonged exposure to Stroop activities (Gul & Humphreys, 2015; MacLeod, 1991). The Stroop effect has been extensively studied, initially in relation to human attention (MacLeod, 1991), later to examine cognitive load (Grassmann et al., 2016; Gwizdka, 2010) and to study stress (Crabb et al., 2016; P. Karthikeyan, Murugappan, & Yaacob, 2014; Palanisamy Karthikeyan, Murugappan, & Yaacob, 2012; Prinsloo, Derman, Lambert, & Rauch, 2013; Prinsloo et al., 2011; Wallén, Held, Rehnqvist, & Hjemdahl, 1997). Stroop activities can be used to induce cognitive load (Chen et al., 2016) and are effective laboratory stressors (Renaud & Blondin, 1997). Computer-based Strop color-word tasks can cause definitive changes in skin conductance, heart rate, and respiration measures (Brumback, 2018). This study employed a previously-used (Brumback, 2018) adaptation of a computer-based Stroop color word activity (Yang, 2005), which was published with a Creative Commons Attribution-NonCommercial-ShareAlike License.

Ajzen's Theory of Planned Behavior. Ajzen's Theory of Planned Behavior (TPB, also seen as TOPB) (1985), expands the Fishbein and Ajzen's Theory of Reasoned Action (TRA) (2009) by adding the variable perceived behavioral control to the theoretical model in order to account for goal-oriented behavior. Regarding intended behavior, Ajzen (1985) warns that "intentions can only be expected to predict a person's attempt to perform a behavior, not necessarily its actual performance" (p. 29).

TPB states that three primary variables influence an individual's intention to perform a behavior: (a) attitude towards performing the behavior, (b) subjective norms for performing or not performing the behavior and (c) control over performing the behavior (Jaccard & Blanton, 2007). Ajzen (1985) explains that TRA and TPB are equivalent "when the subjective probability of success and the degree of control over internal and external factors reach their maximal values" (p. 36). Otherwise, when examining behavior, the TPB can be used to gauge perceived and actual behavioral control (Ajzen, 1985).

Attitude. Ajzen (1985) defines attitude toward the behavior as a personal factor as being "the individual's positive or negative evaluation of performing the behavior" (p. 13). In the context of this project, attitude describes participant subjective assessment of performing the behaviors related to breath attention and abdominal breathing as independent or combined activities. To measure this facet of the theory, this study uses Questionnaire 2 (Appendix B) Items 13 to 30 in the subcategories of usefulness and time cost.

Subjective norms. Ajzen (1985) defines subjective norm as "the person's perception of the social pressures put on him to perform or not perform the behavior in question" (p. 13). To measure this facet of the theory, this study uses Items 31 to 54 from Questionnaire 2 in the subcategories of individual, peer, family and cultural importance.

Control. Ajzen (1985) also describes two aspects of control: (a) perceived control and (b) actual control. He notes that the consistency between planned and actual behavior depends on an individual's belief in one's ability to control the behavior and one's actual control over the behavior. Ajzen (1985) also relates the importance of accuracy an individual's assessment of actual and perceived control since inaccurate assessments of control could cause an individual to attempt behaviors outside one's control or not attempt behaviors within one's control. To measure this facet of the theory, this study uses questions from Questionnaire 2 (Appendix B) Items 1 to 12 and Items 55 to 60 in the subcategories of ability, ease of use and existing experience

Transtheoretical Model of Health Behavior Change. Introduced by Prochaska and DiClemente (1984), to examine smoking cessation. Part of the model suggests "that health behavior change involves progress through six stages of change: precontemplation, contemplation, preparation, action, maintenance, and termination" (Prochaska & Velicer, 1997, p. 39). These stages of change have been applied to study smoking cessation and stress management, using the following stress management definition: "Stress management includes regular relaxation and physical activity, talking with others, and/or making time for social activities" (Evers et al., 2006, p. 523). The definition is presented with a list of stress management behaviors (Evers et al., 2006; Prochaska & Velicer, 1997), after which the respondent is asked if they perform stress management according to the definition or example(s). The five response options correspond with the first five stages of change (Table 1.1). This approach was used by Evangelia and Spiridon (2012) to study stress management with undergraduate students and also by Nigg (2016) to study exercise behavior.

The author combined Evangelia and Spiridon's (2012) stress management definition with the structure of Nigg's (2016) online short form to create the stress management stage of change questionnaire item. Since breath awareness and abdominal breathing can be considered health-related behaviors, the author constructed stage of change questionnaire items for these activities in the same manner; a definition of the behavior followed by the five-item stage of change response options (Appendix B, Items 61-66).

Table 1.1

Stage of Change Questionnaire Response Options

Response	Stage	Score
1. Yes, I have been for MORE than 6 months.	Maintenance	1
2. Yes, I have been for LESS than 6 months.	Action	2
3. No, but I intend to in the next 30 days.	Preparation	3
4. No, but I intend to in the next 6 months.	Contemplation	4
5. No, and I do NOT intend to in the next 6 months.	Precontemplation	5

Research Questions

The first question the author seeks to answer is: (a) can college students regulate physiological responses caused by computer use by using a five-minute breathing activity? As computers are ubiquitous university and college contexts, gaining information related to this question is relevant to contemporary learning environments. The next question the author seeks to examine is: (b) Are there significant differences in physiological responses between individuals performing quiet sitting and the breathing activities of breath counting, abdominal breathing or combined breath counting and abdominal breathing? Because experience with an activity can affect behavior (Hartmann, 2009; Kaiser, Kaminski, & Foley, 2013) it is important to investigate any post-exposure behavioral change. The author is also interested in determining: (c) What factors contribute to student future use or non-use of breath counting and abdominal breathing? and (d) Does students' ability to use breath counting and abdominal breathing activities correlate with their existing stress levels and existing experience with breathing activities?

Hypotheses

H1. Breath counting and physiological response. Participants can use a breath counting activity to regulate physiological response due to cognitive load.

H1.1. The breath counting activity will cause a decrease in participant skin conductance.

H1.2. The breath counting activity will cause a decrease in participant heart rate.

H1.3. The breath counting activity will cause a decrease in participant respiratory rate.

H1.4. The breath counting activity will cause an increase in participant abdominal breathing magnitude.

H1.5. The breath counting activity will cause a decrease in participant thoracic breathing magnitude.

H2. Abdominal breathing and physiological response. Participants can use an abdominal breathing activity to regulate physiological response due to cognitive load.

H2.1. The abdominal breathing activity will cause a decrease in participant skin conductance.

H2.2. The abdominal breathing activity will cause a decrease in participant heart rate.

H2.3. The abdominal breathing activity will cause a decrease in participant respiratory rate.

H2.4. The abdominal breathing activity will cause an increase in participant abdominal breathing magnitude.

H2.5. The abdominal breathing activity will cause a decrease in participant thoracic breathing magnitude.

H3. Combined breathing activity and physiological response. Participants can use a combined breathing activity (breath counting and abdominal breathing) to regulate physiological response due to cognitive load.

H3.1. The combined breathing activity will cause a decrease in participant skin conductance.

H3.2. The combined breathing activity will cause a decrease in participant heart rate.

H3.3. The combined breathing activity will cause a decrease in participant respiratory rate.

H3.4. The combined breathing activity will cause an increase in participant abdominal breathing magnitude.

H3.5. The combined breathing activity will cause a decrease in participant thoracic breathing magnitude.

H4. Breathing activities and Stroop activities Exposure to breathing activities will cause a positive change in participants' breathing during subsequent computer-based tasks. Positive change is defined as (a) decreases in respiratory rate and thoracic breathing magnitude and (b) increases in abdominal breathing magnitude and breath ratio.

H4.1. Exposure to the breath counting activity will cause a positive change in participant breathing measures during the computer-based tasks following exposure to the breath counting activity when compared to breathing during computer-based tasks followed by periods of quiet sitting.

H4.2. Exposure to the abdominal breathing activity will cause a positive change in participant breathing measures during the computer-based tasks following exposure to the abdominal breathing activity when compared to breathing during computer-based tasks followed by periods of quiet sitting.

H4.3. Exposure to the combined breathing activity will cause a positive change in participant breathing measures during the computer-based tasks following exposure to the combined breathing activity when compared to breathing during computer-based tasks followed by periods of quiet sitting.

H5. Breathing and stress score In activities before breathing activity exposure, there will be correlations between participant breathing measures and participant stress score.

H5.1. In activities before breathing activity exposure, a participant with a higher stress score will have a higher mean respiratory rate (frequency) when compared to participants with lower stress scores.

H5.2. In activities before breathing activity exposure, a participant with a higher stress score will have a lower mean abdominal breathing magnitude when compared to participants with lower stress scores.

H5.3. In activities before breathing activity exposure, a participant with a higher stress score will have a higher mean thoracic breathing magnitude when compared to participants with lower stress scores.

H5.4. In activities before breathing activity exposure, participants with higher stress scores will display thoracic breathing dominance (abdominal/thoracic breathing ratio less than one) when compared to participants with lower stress scores.

H6. Breath awareness future use and behavioral beliefs Participant self-reported intended future use of breath awareness will show a positive correlation with participant behavioral beliefs towards breath awareness.

H6.1. Participant self-reported intended future use of breath awareness will show a positive correlation with perceived usefulness of breath awareness.

H6.2. Participant self-reported intended future use of breath awareness will show a positive correlation with perceived time cost of breath awareness.

H7. Abdominal breathing future use and behavioral beliefs Participant self-reported intended future use of abdominal breathing will a show positive correlation with participant behavioral beliefs towards conducting breathing activities.

H7.1. Participant self-reported intended future use of abdominal breathing will show a positive correlation with attitude towards breathing activities.

H7.2. Participant self-reported intended future use of abdominal breathing will show a positive correlation with perceived time cost of breathing activities.

H8. Breath awareness future use and subjective norms. Participant self-reported intended future use of breath awareness will show a positive correlation with perceived subjective norms related to conducting breath awareness. (For this study, subjective norms consist of Ajzen's (1985) aforementioned personal, peer, family and cultural beliefs.)

H8.1. Participant self-reported intended future use of breath awareness will show a positive correlation with one's personal beliefs regarding breath awareness.

H8.2. Participant self-reported intended future use of breath awareness will show a positive correlation with perceived beliefs of one's peers regarding breath awareness.

H8.3. Participant self-reported intended future use of breath awareness will show a positive correlation with the perceived beliefs of one's family regarding breath awareness.

H8.4. Participant self-reported intended future use of breath awareness will show a positive correlation with perceived beliefs of one's culture regarding breath awareness.

H9. Abdominal breathing future use and subjective norms. Participant self-reported intended future use of abdominal breathing will show a positive correlation perceived subjective norms related to breathing activities.

H9.1. Participant self-reported intended future use of abdominal breathing will show a positive correlation with one's personal beliefs regarding the breathing activities.

H9.2. Participant self-reported intended future use of abdominal breathing will show a positive correlation with perceived beliefs of one's peers regarding breathing activities.

H9.3. Participant self-reported intended future use of abdominal breathing will show a positive correlation with perceived beliefs of one's family regarding breathing activities.

H9.4. Participant self-reported intended future use of abdominal breathing will show a positive correlation with perceived beliefs of one's culture regarding breathing activities.

H10. Breath awareness future use and control. Participant self-reported intended future use of breath awareness will show a positive correlation with perceived behavioral control regarding breath awareness.

H10.1. Participant self-reported intended future use of breath awareness will show a positive correlation with one's breath awareness ability.

H10.2. Participant self-reported intended future use of breath awareness will show a positive correlation with one's perceived ease of use of breath awareness.

H10.3. Participant self-reported intended future use of breath awareness will show a positive correlation with one's breath awareness prior experience.

H11. Abdominal breathing future use and control. Participant self-reported intended future use of abdominal breathing will show a positive correlation with behavioral control regarding the breathing activity.

H11.1. Participant self-reported intended future use of abdominal breathing will show a positive correlation with one's perceived breathing activity ability.

H11.2. Participant self-reported intended future use of abdominal breathing will show a positive correlation with one's perceived ease of use of the breathing activity.

H11.3. Participant self-reported intended future use of abdominal breathing will show a positive correlation with one's breathing activity prior experience.

H12. Stage of change stress management and stress score. There will be a positive correlation between stage of change response for stress management and stress score.

H13. Stroop task performance and other variables There will be no meaningful correlation between Stroop Task performance variables and other selected variables in this study.

H13.1. There will be no meaningful correlation between Stroop mean response time for matching (congruent) stimuli and other selected variables.

H13.2 There will be no meaningful correlation between Stroop mean response time for non-matching (incongruent) stimuli and other selected variables.

H13.3. There will be no meaningful correlation between Stroop items correctly completed and other selected variables.

Method of Inquiry

The author of this study collected quantitative and qualitative data using a quasi-experimental interrupted time-series (Shadish, Cook, & Campbell, 2002), within-subject, repeated measures design. The study employed convenience sampling to draw participants from the Spring 2018 semester student population of a state university on the island of O'ahu, Hawai'i.

The author collected participant physiological measurements by electronically recording skin conductance (SC), heart rate (HR), respiratory rate (RR), abdominal and thoracic breathing magnitude and breath ratio. The author collected stress and demographic data using a pre-activity questionnaire (Questionnaire 1) and collected participant perceptions of the study activities, stage of change responses and existing experience with the post-activity questionnaire (Questionnaire 2).

Assumptions

The author made the following assumptions pertaining to the study in good faith. It is possible that some or all of these assumptions are unwarranted or not applicable.

Representative sample. The author assumed the convenience sample was demographically representative of the UH Manōa student population and that demographic variables would not influence study results. Examination of the demographic data collected in this study would yield evidence that supports or refutes this assumption.

Breathing activities. The author assumed the breathing activities used in the study are inherently useful for stress management. This assumption was based on the prevalence of studies in the academic literature that have examined these activities. Examination of the participant perceptions regarding the breathing activities would yield evidence that supports or refutes this assumption.

Applicability. The author assumed that breath awareness in relation to stress is applicable to college and university students. This assumption was based on existing studies (specified in the literature review) that have examined breathing activities as stress management techniques with college and university students. One aspect of applicability might be participant interest in the study itself. The fact that there were more interested potential participants than there were appointments available during the semester may also support this assumption.

Examination of the participant perceptions regarding usefulness of the breathing activities would yield evidence that supports or refutes this assumption.

Generalizability. The author assumed that the results of this study are potentially generalizable to college and university students beyond the location where the study took place. Evidence that supports or refutes this assumption would only be available if this study is repeated in other locations with college and university students.

Limitations

Some of the questionnaire data collected in this study is limited because it relies on participant self-reported information. As a result, responses might reflect individual bias or some response results could be incomplete if participants chose not to share comments or otherwise elaborate. For example, one participant did not report on the questionnaire that the individual used a breath counting activity, but during the session debriefing disclosed that the individual sometimes counted breaths in order to fall asleep.

This study is limited by the relatively small sample size. While data from 96 participants was sufficient to achieve statistical power, it is possible that a larger sample size would reveal different results. Such results might remain only representative of one particular student population. To test this limitation, one could repeat this study with larger sample sizes, including conducting a longitudinal study. Drawing samples from other student populations and geographical locations would also address this issue.

Delimitations

Breathing activities. This study examines only two very specifically defined breathing activities: breath counting and abdominal breathing. The study does not study variations of these breathing activities or other breathing activities that are similar in technique or effect.

Mindfulness. The term mindfulness often appears in the academic and self-help literature related to breathing activities. Many extoll the benefits of breathing activities in establishing or maintaining mindfulness. Because the concept of mindfulness is so broad and diverse, the author does not attempt to define nor discuss it. It is notable that the term mindfulness can has been defined in many ways (Bishop et al., 2004) and can be considered a limited translation of a Buddhist technical term (Gethin, 2011).

Physiological measures. This study only uses selected physiological measures (and measures derived from): non-specific skin conductance response, heart beats and breathing cycles. One reason the author chose these measures was the relative ease of sensor emplacement. Other physiological and neurophysiological measurements could have been used, which would have increased time cost of the experimental sessions and impacted the convenience to the study participants. This study did not derive or analyze heart rate variability (HRV) and did not collect data using electromyography (EMG) skin temperature, blood pressure nor electroencephalogram (EEG).

Statistical analysis. The author used multilevel modeling to analyze the data from the physiological signals and the activities in the experimental sequence to gauge the effect of the breathing activities and bivariate correlational analysis to examine potential correlations related to the questionnaire data. This approach is only expected to reveal evidence supporting general conclusions about potential correlations among the variables and the possible effects of the breathing activities.

Chapter 2

Literature Review

Literature Review Purpose

A key objective of the literature review was to determine how abdominal breathing and breath counting are presently being used in educational settings. Ideal articles for this review are empirical studies of abdominal breathing or breath counting with college student populations for the purpose of self-regulation. Since these criteria are narrow, it is useful to include studies that examine other breathing exercises in educational settings, with other student populations and for objectives beyond stress management. There are two principal challenges that must be acknowledged when reviewing the literature related to breath use with students for stress management. First, there are the aforementioned variety of terms used to describe abdominal breathing. Second, studies that employ breathing techniques or exercises in educational settings often do so in conjunction with other techniques. This presents two challenges: (a) the breathing technique is not clearly described and (b) any positive outcomes cannot be uniquely attributed to the breathing exercise alone. Abdominal breathing can be defined as slow, deliberate breathing in which one purposefully and fully moves the diaphragm up and down, characterized by corresponding abdominal expansion and reduction (Brumback, 2017).

Information Sources

The author performed English-language searches in the following academic databases to select and retrieve articles for the literature review: (a) EBSCOhost: Academic Search Complete, Alt HealthWatch, CINAHL (with full text), Computer Source, ERIC, Fuente Académia, Health Source: Nursing/Academic Edition, MedicLatina, MEDLINE, Military & Government

Collection, Professional Development Collection, Psychology and Behavioral Sciences Collection, Social Work Abstracts, Teacher Reference Center, (b) APA PsychNET, (c) PubMed (including MEDLINE), (d) JSTOR, and (e) Google Scholar.

Search Strategies

The author initially used two Boolean search strings to find articles for potential inclusion in the literature review. The first is designed to find articles pertaining to abdominal breathing and college students. The second is designed to find information pertaining to breath counting and college students.

Abdominal breathing search string. The author used the following Boolean search string to retrieve articles related to abdominal breathing: ("abdominal breath*" OR "diaphragmatic breath*" OR "diaphragmal breath*" OR "belly breath*" OR ("deep and slow breath*") OR "slow deep breath*") AND (college OR university OR graduate) AND student*.

Breathing counting search string. The author used the following Boolean search string to retrieve articles related to breath counting: (“breath* counting” OR “counting breath*”) AND (college OR university OR graduate) AND student* AND (attention OR awareness).

To supplement the Boolean searches, the author also reviewed articles related to mindfulness and meditation used with college students because some of the techniques involve abdominal breathing or breath counting. A challenge with these particular types of studies is that breathing techniques are often described in general terms of mindfulness and do not include specific descriptions of the breathing activities. Bamber and Schneider’s (2016) literature review regarding mindfulness techniques used to help college students manage stress and anxiety provided a solid basis for identifying mindfulness-related studies related to breathing activities.

Additionally, the author reviewed the references section of articles retrieved through initial searches to identify relevant articles that did not appear in the initial searches.

Selection Criteria

Next, the author selected studies pertaining to breathing exercises from the search results based on the following criteria: (a) studies involving graduate or undergraduate university students, (b) studies involving aspects of learning environments or educational settings including student health and (c) studies involving the use of abdominal breathing and/or breath counting. The author excluded studies that employed the Mindfulness Based Stress Reduction (MBSR) Program and other studies that involved participants using multiple techniques in addition to abdominal breathing and/or breath counting since these studies did not uniquely measure breathing nor the effects of the breathing activities. The author also excluded studies that appeared to be designed as single-study 'validations' of biofeedback devices and studies that involved proprietary commercial programs.

Search Results

A total of nine articles, met these criteria (Appendix C). Many appear to have chosen college student populations for convenience sampling and seemed to study abdominal breathing or breath counting as a general self-regulation skill as opposed to applying breathing techniques to specific academic tasks.

Population and sample. Most study samples included undergraduate students (Jokerst, Gatto, Fazio, Stern, & Koch, 1999; Kniffin et al., 2014; Tloczynski & Tantriella, 1998; Zunhammer, Eichhammer, & Busch, 2013). Many of the studies drew samples from health-related fields such as nursing students (Forbes & Ronald J. Pekala, 1993; Pekala & Forbes, 1990), medical preparatory students (Paul et al., 2007), staff and postgraduate residents at a medical college (Turankar et al., 2013) or healthcare students (Sharma et al., 2014).

Purpose. The objective of most of the articles selected for the literature review was stress management (Forbes & Ronald J. Pekala, 1993; Pekala & Forbes, 1990; Sharma et al., 2014; Tloczynski & Tantriella, 1998; Turankar et al., 2013) including testing stresses (Paul et al., 2007). The goals of the other studies were to help individuals cope with motion sickness (Jokerst et al., 1999), to examine self-regulation in high risk scenarios (Kniffin et al., 2014) and to investigate pain perception (Zunhammer et al., 2013).

None of the studies reported information regarding (a) participants' perceptions of the breathing activities, (b) if participants had existing experience with abdominal breathing and breath counting nor (c) if the students found these practices useful. With this gap in the literature, the opportunity exists to collect information about participants' perceptions of abdominal breathing and breath counting; especially perceived effectiveness, perceived usefulness and perceived time cost.

Breathing technique. All studies involved some degree of abdominal breathing as an intervention, but the studies had a wide range of abdominal breathing activity durations. The longest study conducted over two academic years with the majority of participants completing a maximum of 209 five-minute, weekly sessions (Paul et al., 2007). Most studies involved a single session lasting less than one hour (e.g. Jokerst et al., 1999; Kniffin et al., 2014) or were of unspecified duration (e.g. Forbes & Pekala, 1993; Pekala & Forbes, 1990). Other studies had participants conduct daily practice for periods of one week (Turankar et al., 2013), six weeks (Tloczynski & Tantriella, 1998) or 12 weeks (Sharma et al., 2014). In addition to abdominal breathing, only one study involved breath counting as part of the intervention (Jokerst et al., 1999).

Study designs involving single measurement sessions have an advantage over longer studies involving multiple sessions because attrition is not a factor. The disadvantage of single session studies is that it's not possible to establish effects over time. Longitudinal studies require access to a population that is relatively stable over time such as a cohort group as well as consistent time allocation.

Measurement. Four of the studies exclusively used self-report measures determine effects (Paul et al., 2007; Pekala & Forbes, 1990; Sharma et al., 2014; Tloczynski & Tantriella, 1998). One study used both physiological measures of electrogastrogram (EGG) and respiratory rate combined with self-report measure of motion sickness symptoms (Jokerst et al., 1999). The remainder of the studies incorporated empirical measurements derived from heart rate (Forbes & Ronald J. Pekala, 1993; Kniffin et al., 2014; Turankar et al., 2013; Zunhammer et al., 2013), respiratory rate (Kniffin et al., 2014; Zunhammer et al., 2013); skin temperature (Forbes & Ronald J. Pekala, 1993), galvanic skin response (GSR—skin conductance) blood pressure and pulmonary function (Turankar et al., 2013), and end tidal respiratory CO_2 (Zunhammer et al., 2013).

None of the studies measured the ratio of thoracic and abdominal breathing, which is an effective measure of a participant's ability to successfully follow an abdominal breathing protocol (Terai et al., 2014).

Outcomes. The studies using self-report measures found evidence of perceived reduction of text anxiety, nervousness, self-doubt and increased concentration (Paul et al., 2007); decreased vigilance, cognitive rumination and attachment to negative affect (Pekala & Forbes, 1990);

reduced perceived stress (Sharma et al., 2014); decreased anxiety, depression and interpersonal problems (Tloczynski & Tantriella, 1998); and reduction in self-reported motion sickness (Jokerst et al., 1999).

Studies incorporating physiological measures noted reduction in skin temperature responsivity (Forbes & Ronald J. Pekala, 1993); prevention of tachygastria onset (Jokerst et al., 1999); lower respiratory rates and higher heart rate variability (Kniffin et al., 2014); and reduction of pulse rate and GSR (skin conductance) (Turankar et al., 2013).

Beyond abdominal breathing, Jokerst et al. (1999) did not find evidence that breath counting appeared to be effective in preventing tachygastria and symptoms of motion sickness. With regard to pain perception, Zunhammer et al. (2013) did not find significant evidence that abdominal breathing had an effect on pain perception. They acknowledged that their protocol may have been too demanding, which could have counteracted the effects of abdominal breathing.

Closely Related Studies. There are two studies that did not meet the literature review inclusion criteria but are worth mentioning because the studies involved college students and used breath attention.

Paholpak et al. (2012) studied 58 fifth-year medical students in Thailand and had the participants practice passive awareness of their breathing for twenty minutes a day with the aid of a guided meditation audio recording for 28 days. Based on the data collected from self-report measures, they concluded that “Among normal, intelligent, mentally healthy persons, short-term breathing meditation practice will not likely change psychiatric symptoms, memory function, intellectual performance, and academic achievement” (p. 461).

Dvořáková et al. (2017) studied 105 college freshmen in the United States and the study participants learned a variety of strategies to promote individual health and wellbeing including mindful breaths and breath awareness. The program consisted of eight, 80-minute sessions over six weeks (twice a week for the first two weeks and once a week thereafter). From the data collected via self-report measures, the top two most effective in-class practices were taking three mindful breaths and breath awareness (not further described).

Both studies examined use of breath attention with adult students but the apparently divergent outcomes highlight differences in design and cultural perspective. Paholpak et al. (2012) noted that the breath attention meditation practice in the study was “culturally appropriate for Thai medical students” (p. 462) and noted that even though there is sparse evidence that meditation is useful for treating depression and anxiety, such interventions are still popular in Western settings. In contrast, Dvořáková et al. (2017) describe their intervention as a universal mindfulness program that had “significant increase in students’ life satisfaction, and significant decrease in depression and anxiety” (p. 1). These two selected studies highlight the potential range of perspectives on the results of breathing-related studies with students and demonstrate the need for specificity in study design and interpretation of results.

Chapter 3

Method

Method Overview

This study uses the same lab, materials, equipment and exactly replicates the method used in the corresponding pilot study (Brumback, 2018) as well as aspects of the method described in the previously published work in progress (Brumback, 2017). The university Institutional Review Board (IRB) approved the project. Each participant session was scheduled to last 75 minutes and included one hour for the experimental procedure and 15 minutes for the questionnaires, sensor application/removal, debriefing and general administration.

Lab description. The author used the same lab as described in the pilot study (Brumback, 2018). The lab was air-conditioned and had an acoustic tile drop ceiling with recessed fluorescent lights. The participant and proctor workspaces were separated by a 64-inch by 72-inch fabric-covered office partition. The participant workspace was analogous to a standard 64-inch by 64-inch office cubicle. It was furnished with a static chair and a computer workstation with a 21-inch monitor, keyboard and mouse. The proctor workstation was located on the other side of the partition. In addition to a computer that controlled the physiological recording, the proctor workstation was equipped with a computer screen that mirrored the participant computer screen as well as a remote keyboard and mouse for the participant computer, which were used to display the experimental materials on participant computer screen. A diagram of the lab layout is shown in Appendix D.

Population

The population for this study consisted of students enrolled at a Hawai'i university during the spring semester of 2018. The author sought volunteers from undergraduate students enrolled in classes offered by the departments of Information and Computer Sciences, Information Technology Management and Educational Psychology; specifically (a) ICS 101—Tools for the Information Age, (b) ICS 425—Computer Security and Ethics, (c) ITM 353—Information Systems and Design, (c) ITM 431—Networking and Security and (d) EDEP 311—Psychological Evaluations. One PhD student (Educational Psychology) also participated.

Sample

The study only included healthy participants age 18 or older, with normal color vision, who were not expecting mothers. Exclusionary criteria were listed on the informed consent form (Appendix E) and students self-selected for the study. A total of 96 students successfully completed the experimental protocol. All undergraduate participants received extra credit as compensation for their participation. Two participants withdrew from the study before completing the protocol and two participants completed alternative individual information sessions instead of participating in the study—all four received extra credit compensation. Semester end limited data collection and the author was not able to accommodate all interested participants. Twelve potential participants attended an end of semester information session about the study as an alternative means of receiving extra credit.

Unit of Observation

The unit of observation was the individual student enrolled at the state university campus on the island of O'ahu. Participants were only eligible to complete the experimental protocol once. Participants in the pilot study (Brumback, 2018) were not eligible to participate but were eligible to receive extra credit by completing the alternative information session activity.

Variables

This project uses the same independent and dependent variables from the pilot study (Brumback, 2018).

Predictor. The independent variable for this study is breathing activity condition, which corresponds with the group to which the participant was randomly assigned: (a) Group 1—breath counting, (b) Group 2—abdominal breathing and (c) Group 3—breath counting and abdominal breathing combined. For within-subject comparison there are two conditions: (a) pre-breathing activity exposure periods (quiet sitting) and (b) post-breathing activity exposure periods (breath counting, abdominal breathing or combined breath counting and abdominal breathing).

Outcome. The dependent variables for this study are the physiological measures and the calculated values derived from them: (a) skin conductance mean value (SC), (b) heart rate mean value (HR), (c) respiratory rate mean value (RR), (d) abdominal breathing magnitude: standard deviation of abdominal breathing signal mean value (abdominal *SD*), (e) thoracic breathing magnitude: standard deviation of thoracic breathing signal mean value (thoracic *SD*) and (f) breath ratio mean value (BrRatio).

Instrumentation and Measurement

Physiological measures. This study used the BIOPAC MP 150 system and the accompanying Version 4.4 AcqKnowledge software (BIOPAC Systems Incorporated, 2014, n.d.) to record and analyze the physiological signals. The author used the system with electrodermal activity (EDA) sensors to measure skin conductance, electrocardiogram (ECG) sensors to measure heart rate and two belt sensors to measure abdominal and thoracic breathing. The author recorded signals at 1000 Hz across four channels: Channel 1—electrodermal activity (EDA), Channel 2—electrocardiogram (ECG), Channel 3—abdominal breathing, Channel 4—thoracic breathing. (Brumback, 2018). Physiological measures and evaluation criteria are displayed in Figure 3.1. Activity epochs were 2.5 minutes in duration.

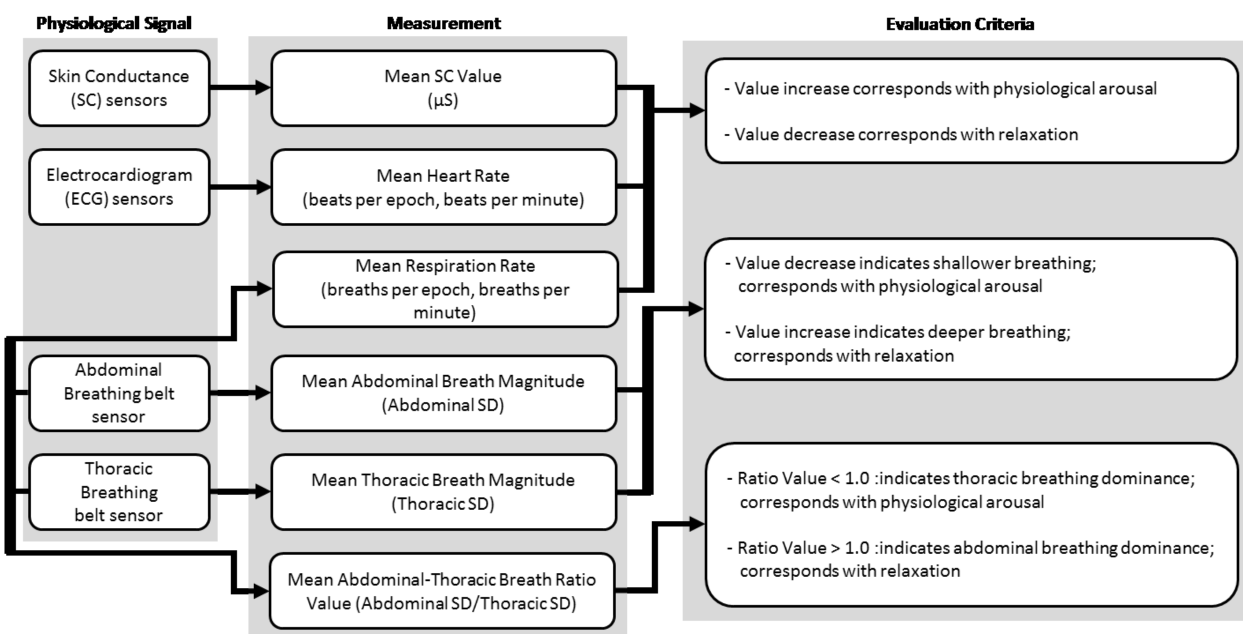


Figure 3.1. Physiological measures and evaluation criteria

Skin Conductance (SC). The author acquired SC signal using two disposable sensors pre-gelled with isotonic recording gel. The sensors were placed side by side on the medial side of the participant's left foot along the plantar surface of the longitudinal arch (Dawson et al., 2017; Potter & Bolls, 2012). The author emplaced sensors on each participant's left foot because it was closest to the physiological measurement equipment. The author calculated SC mean values (µs) for each epoch.

Heart rate (HR). The author acquired electrocardiogram (ECG) signals using two disposable pre-gelled sensors placed on each one of the participant's forearms inferior to the antecubital space (Potter & Bolls, 2012). HR is measured in beats per minute (BPM). The author used Acqknowledge Software (BIOPAC Systems Incorporated, 2014) to mark and count QRS peaks per epoch. Each QRS peak corresponds with one heartbeat. The author converted beats per epoch into BPM by dividing the heartbeat per epoch count by the number of minutes in the epoch (2.5 minutes).

Respiratory rate (RR). The author acquired RR using belt sensors placed around the participant's abdomen and upper thorax (Peper, Groshans, et al., 2016; Porges & Byrne, 1992). The author measured RR in breaths per minute (BrPM). After recording the abdominal and thoracic breathing signals, the author used AcqKnowledge Software (BIOPAC Systems Incorporated, 2014) to mark each inhale start and exhale start breath event. The author then visually inspected each abdominal and thoracic channel recording and corrected any marking discrepancies. Since the same breath events were measured from two different physical locations on the participant, the author compared the abdominal ant thoracic breathing channel recordings to one another for consistency. The author also sequentially compared breath events within channels to ensure every inhale event had a corresponding exhale event since a complete breath cycle consists of one inhale and one exhale (one breath). The author calculated breath events per epoch by adding the total inhale start marker count by the total exhale start marker count and then dividing the sum by two. The author then added abdominal and thoracic breathing cycles counts and divided by two to determine breaths per epoch. The author converted breaths per epoch to BrPM by dividing the breaths per epoch count by the number of minutes in the epoch (2.5 minutes).

Abdominal breathing magnitude (abdominal SD). Abdominal breathing magnitude is measured in microvolts (μv) and the author calculated it by taking the standard deviation of the voltage from the abdominal breathing sensor. The author then calculated mean values for each epoch.

Thoracic breathing magnitude (thoracic SD). Thoracic breathing magnitude is measured in microvolts (μv) and the author calculated it by taking the standard deviation of the voltage from the thoracic breathing sensor. The author then calculated mean values for each epoch.

Breath ratio (Br Ratio). Breath ratio is a calculated ratio value derived by dividing the thoracic *SD* by the abdominal *SD*. Values greater than one indicate abdominal breathing dominance and values less than one indicate thoracic breathing dominance. (There were no instances of BrRatio calculations equaling one, indicating abdominal and thoracic breathing magnitude were equivalent.) The author then calculated mean values for the Br Ratio for each epoch.

Stroop color word activity. This study adapted an existing (Yang, 2005) computer-based Stroop color-word activity in the same manner described in the pilot study:

> In the task, the program displays color words in a font color that matches or does not match the color word. Only four colors are used: red, green, yellow and blue.

> Items are randomly displayed to participant, half having matching color word and font color and half not. Participants are instructed to respond by pressing the key on the computer keyboard that corresponds with the first letter of the font color (not the color word). The message “Correct. Press SPACE to continue” appears after correct responses. The message “INCORRECT. Don’t rush” is displayed for incorrect responses. (Brumback, 2018)

Each Stroop activity lasted 2.5 minutes. After starting the activity, there was a one-second delay before each stimulus was presented. At the end of every Stroop activity the author saved the text output of the results into a Microsoft Notepad (Microsoft Corporation, 2016b) text file. The process of saving the results was visible to the participant after each activity and the author did this deliberately to help add to the perception of evaluation. Stroop activity results included response time in milliseconds (ms) for matching color word stimuli, response time in ms for unmatching color word stimuli and total items answered correctly (Stroop activity interface: Appendix F).

Physiological measurement analysis. The author used multilevel modeling (also known as hierarchical linear modeling (HLM)) to statistically evaluate the nested data structure where physiological measurement occasions (Level 1) were nested within participants (Level 2).

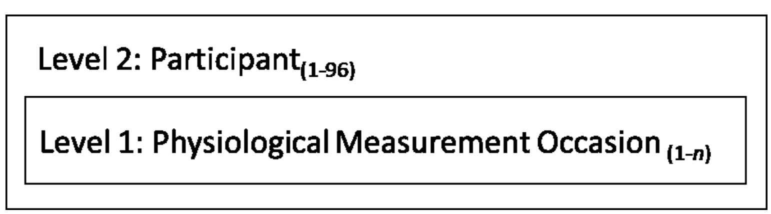


Figure 3.2. Two-level nested data structure

The author used the SPSS MIXED command (2017) to investigate changes in physiological measurements that potentially correlate with exposure to breathing activities. The author tested the models in three stages: (a) examination of an unconditional (null) model to determine estimated variance at each level, (b) addition of breathing activity exposure to the model as a fixed factor (c) addition of a group membership as a covariate.

Unconditional model. The author formed a two-level unconditional model (Equation 1) based on the data's nested structure: physiological measurements nested within participants (Level 1) between participants (Level 2). In Equation 1: *i* = physiological measure occasion, *j* = participant. The outcome variable is the physiological measure value.

$$Physiological\ Measure_{ij} = \gamma_{00} + U_{0j} + \varepsilon_{ij} \quad (1)$$

H1-H3 breathing activity exposure fixed factor. The author added breathing activity exposure to the model as a fixed factor (Equation 2; no breathing activity exposure = -1, breathing activity exposure = 1). In Equation 2: *i* = physiological measure occasion, *j* = participant. The outcome variable is the physiological measure value and the predictor variable is breath exposure.

$$(Physiological\ Measure)_{ij} = \gamma_{00} + \gamma_{10}\left((Breath\ Exposure)_{ij}\right) + U_{0j} + \varepsilon_{ij} \quad (2)$$

H1-H3 Group Covariate. The author investigated group membership as a covariate and compared the breath counting group (Group 1) to the other two groups and the abdominal breathing group (Group 2) to the other two groups by creating two new variables with contrast codes (counting group: 2, -1, -1; abdominal group: -1, 2, -1). shown in Equation 3. In Equation 3: *i* = physiological measure occasion, *j* = participant, the outcome variable is the physiological measure value. The predictor variable is breath exposure and the covariates are the contrast-coded counting and abdominal group variables.

$$(Physiological\ Measure)_{ij} = \gamma_{00} + \gamma_{10}(Breath\ Exposure)_{ij} + \gamma_{20}(Counting\ Group)_{ij} + \gamma_{30}(Abdominal\ Group)_{i} + U_{0j} + \varepsilon_{ij} \quad (3)$$

Questionnaires. The author created two questionnaires to gather information regarding participant stress levels, demographic information and perspectives regarding the breathing activities.

Questionnaire 1. The pre-activity survey (Appendix A) was computer-based and had a total of 17 questions. The author constructed it using Google Forms (Google LLC, 2018). The first question has 11 sub-items containing Feldt's 11-item College Student Stress Scale. Each item is measured on a continuous response scale coded 1 = never, 2 = rarely, 3 = somewhat, 4 = often and 5 = very often.

Question two identifies the participant's age. Individuals could select whole numbers between 18 and 100. It is a continuous numerical variable.

Question three identifies the participant's gender. This is categorical data coded 1 for male, 2 for female and 3 for other.

Question four identifies the participant's blood type. This is categorical data coded 1 for A, 2 for B, 3 for O, 4 for AB and 5 for unknown.

Question five identifies the participant's handedness. It is categorical data coded 1 for right, 2 for left, and 3 for ambidextrous.

Questions six through 15 are branching questions that identify the participant's ethnic background. It is categorical data. The response categories were:

- Asian: Chinese, Filipino, Indian (Asian Indian), Japanese, Korean, Lao, Thai, Vietnamese, Mixed, Other.

- Hawaiian or Pacific Islander: Guamanian or Chamorro, Native Hawaiian/Part Hawaiian, Micronesian, Samoan, Tongan, Hawaiian or Pacific Islander Mixed, Hawaiian or Pacific Islander Other.
- African-American/Black
- American-Indian/Alaska Native
- Caucasian/White
- Hispanic
- Mixed
- Other

Question 16 identifies the participant's academic status. It is categorical data. The response categories were: (a) Freshman, (b) Sophomore (c) Junior (d) Senior, (e) Masters, (f) PhD, (g) Unclassified Post Baccalaureate (h) Other.

Question 17 identifies the participant's major or course of study. It is categorical data and a free text response.

Questionnaire 2. The post-activity survey was computer-based and had a total of 76 items. It consisted of 31 central questions, some with branching response confidence or description questions. The author constructed it using Google Forms (Google LLC, 2018) The first 18 questions were followed by branching yes/no confidence questions. The question and confidence responses from the first 18 items were combined and scored as shown in Table 3.1.

Table 3.1

Questionnaire 2—Two Stage Response Scoring

Stage One:	No			Undecided	Yes		
Stage Two:	Extremely strongly	Very strongly	Somewhat strongly		Somewhat strongly	Very strongly	Extremely strongly
Score:	1	2	3	4	5	6	7

Behavioral control. Four questions indicate perceived behavioral control of (a) breath awareness and (b) the breathing activity the participant was exposed to. For each item the participant was asked if they perceived the item to be (c) easy and (d) if they believed they were able to do it.

Usefulness. Four questions indicate perceived usefulness of (a) breath awareness (b) breathing activities and if it was useful to be aware of (c) one's own breathing (d) the breathing of others.

Time cost. Two questions indicate perceived time cost and asked if the participant had time in their personal life to focus on (a) breath awareness and (b) breathing activities.

Importance. Eight questions indicate perceived subjective norms related to (a) breath awareness and (b) breathing activities. Each question asked if the participant perceived the item to be important to (a) one's self, (b) one's friends, (c) one's family and (d) one's culture.

Prior experience. Six questions indicate prior experience and asked if the participant had experience with (a) awareness of one's own breath, (b) awareness of the breathing of others and (c) breathing activities. Experience questions had yes/no response choices followed by branching free-text questions. If the participant selected yes, they were asked to describe the experience they had with (d) awareness of one's own breath, (e) awareness of the breathing of others and (f) breathing activities. The author used the ToCloud website (2014) to determine the most frequent phrases and the Concordia website (2008) to determine individual word frequencies in the aggregated participant comments.

Stage of change. Three questions indicate participant stage of change for (a) stress management, (b) breath awareness and (c) abdominal breathing. Each item consisted of a definition followed by a stage of change response choice, which was followed by a response confidence question. The author combined the stage of change response and confidence response from each of the stage of change items as shown in Table 3.2.

Table 3.2

Questionnaire 2—Stage of Change and Confidence Level Response Scoring

Stage of Change Response Choice	Confidence Level Response Choice						
	Very confident	Confident	Somewhat confident	Undecided	Somewhat not confident	Not confident	Not at all confident
1. Yes, I have been for MORE than 6 months.	7	6	5	4	3	2	1
2. Yes, I have been for LESS than 6 months.	7	6	5	4	3	2	1
3. No, but I intend to in the next 30 days.	7	6	5	4	3	2	1
4. No, but I intend to in the next 31 days to 6 months.	7	6	5	4	3	2	1
5. No, and I do NOT intend to in the next 6 months.	7	6	5	4	3	2	1

Note. Questionnaire 2 (Appendix B) had three stage of change questions regarding stress management, breath awareness and abdominal breathing (questions 61 to 64). Each of the three stage of change questions was followed by a confidence question. Responses from the stage of change and corresponding confidence questions were combined using this scoring matrix.

Participation. Four questions indicated participant perceptions of their participation in the study. Each was followed by a confidence question that was scored in the same manner as the first 18 questions (Table 3.1). The participation questions asked if a participant (a) would recommend the study to their friends, (b) if they believed participation was a good use of one's time and (c) if they believed participation in the study would help them in the long term. The final question (d) was a free text response, inviting participants to add any comments or recommendations that they would like to share. The author used the ToCloud website (2014) to determine the most frequent phrases and the Concordia website (2008) to determine individual word frequencies in the aggregated participant comments.

Group Assignment

Between the eighth and ninth activities in the experimental sequence (Table 3.4) The author randomly assigned the participants to one of the three treatment groups via restricted random assignment in order to form equal group sizes. To accomplish the restricted random assignment and minimize the possibility of researcher effects, the author marked three 1.57-inch diameter ping-pong balls with Roman numerals corresponding with treatment group (I, II, III) in ultraviolet (UV)-reactive ink in order to further obscure the markings from the participant and author. The author then placed the marked ping-pong balls into a six-inch tall plastic container with a 4.5-inch opening, tapering to a four-inch base (48-ounce FAGE yoghurt container). After completing first half of the experimental protocol, the author presented the container with the ping-pong balls to the participant, above eye level so neither the participant nor the author could view the ping-pong balls. The author then instructed the participant to select a ping-pong ball and assigned the participant to the group corresponding with the marking on the ball (revealed by a UV light). The author then removed the selected ball so that the next participant was only able to select from the two remaining two balls. The third participant in the series was not presented the opportunity to select a ping-pong ball and author automatically assigned the participant in to the remaining group. Table 3.3 shows participants by group.

Table 3.3

Participants by Group

	Group		
	1—Breath Counting (*n* =32)	2—Abdominal Breathing (*n* =32)	3—Combined (*n* = 32)
Participants (*N* = 96)	03, 06, 09, 11, 13, 18, 20, 24, 25, 30, 33, 35, 38, 40, 45, 46, 49, 54, 56, 60, 61, 65, 69, 71, 75, 76, 79, 83, 86, 88, 91, 94	02, 05, 08, 10, 14, 17, 21, 22, 27, 29, 32, 34, 37, 41, 43, 48, 50, 52, 57, 59, 62, 64, 68, 72, 74, 77, 81, 84, 85, 89, 93, 96	01, 04, 07, 12, 15, 16, 19, 23, 26, 28, 31, 36, 39, 42, 44, 47, 51, 53, 55, 58, 63, 66, 67, 70, 73, 78, 80, 82, 87, 90, 92, 95

Activity Sequence

This study follows exactly the same experimental activity sequence specified by Brumback (2017, 2018). The author provided each prospective participant the informed consent form (Appendix E). If individuals agreed to participate and provided informed consent, the author seated the participant at the participant computer workstation and applied the physiological sensors while explaining the purpose of each.

The participant first completed the pre-activity survey and then completed the sequence of 2.5-minute activities shown in Table 3.4. The first half of the sequence occurred before the participant was exposed to a breathing activity. The first activity (1) was a baseline physiological measurement. The second (2) activity was a practice Stroop color-word activity. The third activity (3) was a Stroop color-word activity that was followed by a five-minute quiet sitting activity (which was a composite of two, 2.5- minute periods of quiet sitting: 4a and 4b). Participants completed a total of three Stroop activities followed by quiet sitting (Activities 3 to 8).

In the second half of the activity sequence the participant was exposed to the breathing activity. Participants randomly selected (or were randomly assigned) to a breathing activity group as previously described. Next the participants practiced the breathing activity (9). Participants then completed three iterations of a Stroop activity followed by five minutes of conducting the breathing activity (Activities 10 to 15). After the last breathing activity period, participants completed the post-activity questionnaire (Questionnaire 2).

Table 3.4

Experimental Activity Sequence

	Numbered activities, 2.5-minute periods										
Quiet sitting	1.[I]			4a.	4b.		6a.	6b.		8a.	8b.
Stroop task (before)		2.[II]	3.			5.			7.		
Breathing activity		9.[II]		11a.	11b.		13a.	13b.		15a.	15b.
Stroop task (after)			10.			12.			14.		

Note. I. baseline, II. Practice, a. activity first half, b. activity second half

Quiet sitting. This study used the same quiet sitting sequence as the pilot study (Brumback, 2018): three periods of quiet sitting (Table 3.4, Activities 11a, 11b, 13a, 13b, 15a and 15b). “For quiet sitting, participants were instructed to maintain a comfortable sitting position with their backs straight and refrain from talking” (Brumback, 2018, p. 20).

Computer-based Stroop color word task. This study used the same Stroop color-word activity as the pilot study (Brumback, 2018). Each Stroop activity lasted 2.5-minutes. The interface presented stimuli to the participant in a random order with half of the items matching color word and font color and half with the color word and font color not matching. Only four colors were used: red, green, yellow and blue. The author instructed participants to complete the task as quickly and accurately as they were able. The primary purpose of the Stroop task was to elicit physiological responses from the participants, but the author still recorded and analyzed individual task performance measures.

Treatments. The author randomly assigned participants to one of three conditions: (a) breath counting, (b) abdominal breathing and (c) combined breath counting and abdominal breathing.

Group 1—Breath counting. This study used the same breath counting activity, instructions and materials as the pilot study (Brumback, 2018). The author provided participants a breath counting activity worksheet (Appendix G) and verbally reviewed the instructions on the worksheet with the participant. The instructions were identical to the instructions used in the pilot study (Brumback, 2018):

1. Sit up comfortably with your back straight and both feet on the floor.
2. Breathe comfortably and focus your attention on your breathing.
3. When the time starts, mark the worksheet with the next breath event that occurs: inhale start, inhale end, exhale start, exhale end.
4. Continue to mark the worksheet with each subsequent breath event as it occurs: inhale start, inhale end, exhale start, exhale end.
5. Continue to breathe comfortably.

(p. 20)

Figure 3.3 shows an excerpt from the breath counting activity worksheet that participants marked the box corresponding with each breath event.

Figure 3.3. Breath counting activity worksheet excerpt: I_S—inhale start, I_E—inhale end, E_S—exhale start, E_E—exhale end. Participants were instructed to mark the box that corresponded with each breath event as the event occurred. Participants marked the worksheet from left to right, with each line delineating a new breath cycle.

Group 2—Abdominal breathing. This study used the same abdominal breathing activity, instructions and materials as the pilot study (Brumback, 2018). The author provided participants abdominal breathing activity instruction sheet (Appendix H) and verbally reviewed the instructions with the participant:

1. Sit up comfortably with your back straight and both feet on the floor.
2. Place your dominant hand on the center of your chest and your other hand on the center of your abdomen.
3. Inhale slowly through your nose and permit your abdomen to expand as your diaphragm descends and your lungs fill; while at the same time keeping your chest and upper body as still as you can.
4. Exhale slowly through your nose and permit your abdomen to reduce and move toward your spine as your diaphragm rises and your lungs empty; while at the same time keeping your chest and upper body as still as you can.
5. Keep your eyes open and observe your abdomen as it moves.
6. Focus your attention on the sensations of breathing and when you notice that your mind has wandered, bring your attention back to your breathing sensations.
7. Continue to breathe slowly, deeply and comfortably.

(pp. 20-21)

Group 3—Combined. This study used the same combined breathing activity, instructions and materials as the pilot study (Brumback, 2018). In the combined group, the author provided participants both the (a) breath counting worksheet and (b) abdominal breathing activity instructions sheet and then verbally reviewed the breath counting and abdominal breathing instructions with the participants. Next, the author instructed the participants to conduct the breath counting and abdominal breathing activities simultaneously. As in the pilot study, instructions for abdominal breathing were slightly modified so that participants placed their non-dominant hands on their abdomens and used their dominant hands to mark the breath counting activity worksheet (Brumback, 2018).

Data Preparation

Physiological data.

Cleaning. The author first used AcqKnowledge (BIOPAC Systems Incorporated, 2014) software to automatically mark both the abdominal and thoracic breathing channel recordings. The author then visually inspected both. If the event markers (inhale start, exhale start) were erroneous, the author adjusted the markers to correspond the actual breath events on the waveform.

Preparation. Next, the author used the same software to convert the physiological signal waveforms into mean value measures for 2.5-minute (150 second) epochs, that correspond to each activity in the experimental sequence (Table 3.4). Outputs of the conversion process were individual Microsoft Excel (Microsoft Corporation, 2016a) files for each participant. Measures included skin conductance (SC), heart beats, the standard deviation of the abdominal and thoracic breathing signals, inhale and exhale count for abdominal and thoracic breath. The author established respiratory rate (RR) by calculating breath cycles for the abdominal and thoracic breathing signals and averaging the abdominal and thoracic breathing cycle counts. The author calculated breath ratio by dividing the standard deviation of the abdominal breathing signal by the standard deviation of the thoracic breathing signal as described by Peper, Groshans, Johnston, Harvey, and Shaffer (2016). The author then aggregated the Microsoft Excel files from each individual participant into a single, composite Microsoft Excel file.

After converting the physiological data, the author created boxplots for each of the dependent variables to identify outliers. The author then examined each outlier to determine if the variation was due to individual differences or if there was any discrepancy in physiological signal measurement or data conversion. One participant had a number of outlying heart rate measures and reexamination of the physiological data file revealed that the AcqKnowledge Software had erroneously marked the channel because the recording was noisy. The heart beats were still visible in the signal and the author manually counted the beats and entered the correct count into the dataset. Individual physiological differences accounted for all other outliers since there was no noise nor discrepancy in the accompanying physiological recordings.

Missing values. There were two instances of missing data in the physiological measures data set. The missing values were likely due to data recording errors and the author used imputation to synthesize inputs for the missing values.

Participant 15 of Group 3 was missing all physiological signal measures from the second half (150 seconds) of activity 15b (second half of the third breathing activity). The author calculated the mean values for Activities 15a and 15b for the other 31 participants in Group 3 and derived a mean difference for each physiological measure. The author then applied the mean difference of the measures to activity 15a of participant 15 to impute mean values for Activity 15b physiological measures.

Participant 30 was missing a single 10-second section at the very end of the quiet sitting activity (8b). The author calculated the difference between the two preceding 10-second sections for all physiological measures and applied this difference to the last recorded 10-second section to impute mean values for the missing 10-second section.

Questionnaire data.

Cleaning. The questionnaire data were not missing any values and only required cleaning for the free-text response items. The author only corrected minor grammatical, capitalization and spelling errors for these items. Additionally, the author standardized the course of study descriptions to correspond with the college majors offered by the university and spelled out all acronyms.

Preparation. The author saved the Google Forms data files from both surveys as Microsoft Excel files and combined the spreadsheets. The author added the 11 stress score responses from each participant to calculate individual stress scores. The author also combined the ethnic category descriptions for each participant and combined each survey response with the corresponding confidence response.

Scale reliability. For Feldt's 11-item college student stress scale (first section of Questionnaire 1), the Cronbach's coefficient alpha was 0.861. Only removal of Item 6 (Table 3.5) would cause a small improvement the alpha for the scale. This suggests an acceptable level of reliability for the College Student Stress Scale.

Table 3.5

Questionnaire 1—Feldt's 11-Item College Student Stress Scale Reliability

College Student Stress Scale Item	Corrected item-total correlation	Alpha if item deleted
1. I felt anxious or distressed about personal relationships	0.536	0.850
2. I felt anxious or distressed about family matters	0.555	0.849
3. I felt anxious or distressed about financial matters	0.522	0.851
4. I felt anxious or distressed about academic matters	0.414	0.858
5. I felt anxious or distressed about housing matters	0.516	0.852
6. I felt anxious or distressed about being away from home [a]	0.301	0.865
7. I questioned my ability to handle difficulties in my life	0.654	0.841
8. I questioned my ability to attain my goals	0.649	0.841
9. I felt anxious or distressed about events not going as planned	0.549	0.849
10. I felt as though I was no longer in control of my life	0.705	0.837
11. I felt overwhelmed by difficulties in my life	0.672	0.840

[a] Item with low reliability.

For Questionnaire 2, the author first combined the item responses with the confidence scores of the corresponding items. Next the author calculated Cronbach's coefficient alpha for each of the four composite variables of attitude, subjective norms, behavioral control and participation (Table 3.6).

The composite attitude variable had an alpha of 0.758. Only removing Item 22 would improve the composite variable scale. The composite subjective norms variable had an alpha of 0.874 and no single item had a score suggesting substantive improvement of this score if the item were removed. The composite control variable had an alpha of 0.343, suggesting that the composite variable is not reliable. Removing Items 1, 4 and 17 would improve the composite variable scale, but this improvement would not be sufficient for an acceptable alpha value. The composite participation variable had an alpha of 0.727. Only removing Item 73 would improve the composite variable scale.

Table 3.6

Questionnaire 2—Composite Variable Scale Reliability

Composite variable and questionnaire items	Composite *N*-items	Composite alpha	Corrected item-total correlation	Alpha if item deleted
Attitude	6	0.758		
13. Awareness Useful			0.576	0.702
16. Activity Useful			0.645	0.685
19. Aware Own Useful			0.598	0.707
22. Aware Others Useful [a]			0.277	0.780
25. Awareness Time			0.473	0.731
28. Activity Time			0.498	0.724
Subjective Norms	8	0.874		
31. Aware Personal Important			0.605	0.861
34. Aware Friends Important			0.611	0.861
37. Aware Family Important			0.766	0.843
40. Aware Culture Important			0.570	0.865
43. Activity Personal Important			0.576	0.865
46. Activity Friends Important			0.681	0.854
49. Activity Family Important			0.728	0.848
52. Activity Culture Important			0.547	0.868
Control	7	0.343 [b]		
1. Aware Able [a]			0.034	0.351
4. Aware Easy [a]			0.026	0.358
7. Activity Able			0.209	0.306
10. Activity Easy			0.212	0.282
55. Experience Own Aware			0.274	0.200
57. Experience Others Aware [a]			0.046	0.374
59. Experience Activities			0.258	0.217
Participation	3	0.727		
67. Participation Recommend			0.576	0.613
70. Participation Time Use			0.629	0.546
73. Participation Help Long Term [a]			0.461	0.762

Note. $N = 96$
[a] Item with low reliability. [b] Composite item with low reliability.

Stroop activity data. The author extracted data from each individual Stroop color-word activity from each Microsoft Notepad text file and placed it into a Microsoft Excel file for each participant. The author then combined individual Excel files into a single Excel file.

Data aggregation. The author combined the physiological, survey and Stroop data spreadsheets into one single Excel spreadsheet file and then imported the file into IBM SPSS (2017) for statistical data analysis.

Analytical methods. To test H1-H4, the author used multilevel modeling to analyze the physiological data and determined improvement in model fit by any reduction in deviance, Akaike information criterion (AIC) and Schwarz's Bayesian information criterion (BIC). The author added the parameters of breath activity exposure (Equation 2) and group (Equation 2) to the null model (Equation 1) to see if breath activity exposure and treatment group had any effect on participant physiological measurements.

The author used bivariate correlation to test H5-H13. For post-hoc analysis of bivariate correlations involving multiple comparisons, the author applied the Benjamini-Hochberg (1995) procedure to control false discovery rate (FDR).

Specifically, the author used the SPSS MIXED command (2014b) for multilevel modeling analysis. The author compared models by calculating deviance (-2*log likelihood), Akaike's Information Criterion,(AIC) and Schwarz's Bayesian Information Criterion, (BIC) as recommended by Hox (2010). Lower values for the three criteria indicate better fit than a model with a higher value on the corresponding index.

The author used SPSS CORRELATIONS command (2014a) for Pearson product-moment correlation analysis. For the Benjamini-Hochberg procedure the author used a spreadsheet tool (McDonald, 2015) which calculated adjusted *p*-values for each potential relationship using a false discovery rate (FDR) of 0.05.

Chapter 4

Results

Descriptive Statistics

Sample. Of the 100 individuals that showed up for data collection appointments, 96 participants completed the protocol and are included in the study results (*N* = 96). Two participants voluntarily withdrew from the study part way through the protocol and did not complete it. One participant completed the alternative appointment activity because data collection was not possible due to a campus-wide power failure. Another participant completed the alternative appointment activity because the individual had previously participated in the pilot study (Brumback, 2018).

Questionnaire 1.

Demographics. Participants included 50 females (52.1 %) and 46 males (47.9 %). Participant age ranged from 18-49 with an average age of 22 years (*SD* = 5.00). Participant ethnic category, academic status and course of study are listed in Table 4.2,

Table 4.3 and Table 4.4. Some participants had experience with breath awareness and breathing activities before participating in the study: (a) 56 (58.33 %) of the participants had experience with awareness of their own breath, (b) 15 (15.63 %) had experience with awareness of others' breath and (c) 55 (57.29 %) had experience with breathing activities. Participant comments regarding experience with breath awareness and breathing activities are listed in Appendix I.

Stress score. Total scores for Feldt's College Student Stress Scale (1 = never, 2 = rarely, 3 = somewhat, 4 = often and 5 = very often) ranged from 14 to 49 with a mean of 31.14 (*SD* =

7.50). Table 4.1 displays the means and standard deviations for the 11 stress score item responses.

Table 4.1

Descriptive Statistics—College Student Stress Scale Responses

Item	*M*	*SD*
1. Personal relationships	2.84	1.01
2. Family matters	2.92	1.10
3. Financial matters	3.20	1.12
4. Academic matters	3.86	0.98
5. Housing matters	2.40	1.11
6. Away from home	1.96	0.94
7. Handling difficulties	2.84	1.11
8. Attain your personal goals	2.94	1.06
9. Events not going as planned	3.00	1.08
10. No longer in control	2.28	1.07
11. Overwhelmed by difficulties	2.90	1.01

Note. $N = 96$

Table 4.2 displays participant-selected ethnic category. Approximately 64 % of the participants identified as Asian, including 12 % of the Asian respondents identifying as mixed. Approximately 20 % of the respondents identified as Caucasian/White. Approximately 7% of the respondents identified as Hawaiian or Pacific Islander, which included 3% Native Hawaiian/Part Hawaiian and 1% mixed. Around 5% of the participants selected other mixed for their ethnic category.

Table 4.2

Frequencies and Percentages of Participant-Selected Ethnic Category

Item	*n*	%
Caucasian/White	19	19.79
Asian - Chinese	13	13.54
Asian - Japanese	13	13.54
Asian - Filipino	10	10.41
Asian - Korean	6	6.25
Hispanic	3	3.13
Native Hawaiian/Part Hawaiian	3	3.13
Asian - Cambodian	2	2.08
Asian - Taiwanese	2	2.08
Asian - Vietnamese	2	2.08
Guamanian or Chamorro	2	2.08
Asian - Nepali	1	1.04
African-American/Black	1	1.04
Samoan	1	1.04
Asian - Mixed - African American, German, Chinese	1	1.04
Asian - Mixed - Chinese, Indonesian	1	1.04
Asian - Mixed-Filipino, Vietnamese	1	1.04
Asian - Mixed - Filipino, Caucasian/White	1	1.04
Asian - Mixed - Filipino, Japanese	1	1.04
Asian - Mixed - Hawaiian, German	1	1.04
Asian - Mixed - Japanese, Caucasian	1	1.04
Asian - Mixed - Japanese, Caucasian/White	1	1.04
Asian - Mixed - Korean, Caucasian/White	1	1.04
Asian - Mixed - Korean, Japanese	1	1.04
Asian - Mixed - Vietnamese, Chinese, Filipino	1	1.04
Asian - Mixed - Caucasian/White, Japanese	1	1.04
Hawaiian or Pacific Islander - Mixed - 1/4 Mexican, 1/4 Okinawan, 1/6 Hawaiian, mixed Caucasian/White	1	1.04
Other Mixed - European, Filipino	1	1.04
Other Mixed - Hispanic, Caucasian/White	1	1.04
Other Mixed - Mexican, Caucasian/White	1	1.04
Other Mixed - Caucasian/White, Filipino	1	1.04
Other Mixed - Caucasian/White, Hispanic	1	1.04

Note. N = 96

Table 4.3 shows participant academic status. Most of the participants were sophomores or juniors with the remainder being freshmen, seniors and one PhD student.

Table 4.3

Frequencies and Percentages of Participant Academic Status

Academic Status	*n*	%
Freshman	19	19.79
Sophomore	31	32.32
Junior	30	31.31
Senior	15	15.63
PhD	1	1.00

Note. N = 96

Table 4.4 shows participant responses for course of study. There were 38 unique response categories (free text response). The top three response categories counted responses from participants where the category was listed uniquely or listed first if multiple responses were described: business (23%), management information systems (16%) and travel industry management (11%).

Table 4.4

Frequencies and Percentages of Participant Courses of Study

Item	*n*	%
Business	10	10.42
Business Administration	3	3.13
Business, Marketing	3	3.13
Business, Management Information Systems	2	2.08
Business & Economics (Pre-Law)	1	1.04
Business Entrepreneurship	1	1.04
Business Management	1	1.04
Business with Marine Bio Minor	1	1.04
Management Information Systems	10	10.42
Management Information System & Human Resources	1	1.04
Management Information Systems & International Business	1	1.04
Management Information Systems & Japanese	1	1.04
Management Information Systems Business	1	1.04
Management Information Systems, Marketing, Finance, Management Business	1	1.04
Travel Industry Management	9	9.38
Travel Industry Management / Communicology	1	1.04
Travel Industry Management: Hospitality	1	1.04
Marketing	7	7.29
Accounting	4	4.16
Accounting & Management Information Systems	6	6.25
Finance	4	4.16
Finance, Management Information Systems	3	3.13
Exploratory Business	3	3.13
Communications	2	2.08
International Business & Marketing	3	3.13
Kinesiology & Rehabilitation Science	2	2.08
Pre-Business	2	2.08
Accounting & Entrepreneurship	1	1.04
Economics	1	1.04
Educational Psychology	1	1.04
Entrepreneurship	1	1.04
Fashion & Business	1	1.04
Information & Computer Sciences	1	1.04
Information & Computer Sciences Cyber Security focus	1	1.04
Kinesiology & Rehabilitation Science, Health	1	1.04
Korean	1	1.04
Mechanical Engineering	1	1.04
Psychology	1	1.04
Secondary Education	1	1.04

Note. $N = 96$

Physiological measures.

Table 4.5 shows the descriptive statistics for the baseline physiological measures for the 96 participants (Activity 1).

Table 4.5

Descriptive Statistics—Baseline Physiological Measures

Physiological Measure/Calculation	*M*	*SD*
Skin conductance (SC—µs)	3.69	2.06
Heart rate (HR—BPM)	75.40	11.16
Respiratory rate (RR—BrPM)	13.57	4.00
Abdominal breathing magnitude (Abdominal *SD*—µv)	0.49	0.63
Thoracic breathing magnitude (Thoracic *SD*—µv)	1.51	1.57
Breath ratio (BrRatio—ratio value)	1.15	2.81

Note. $N = 96$

Graphs of physiological data by group. For each group the author graphed the mean values by activity for each physiological measure and derived calculation as part of the data visualization and inspection process. Figure 4.1 through Figure 4.6 show the mean SC, HR, RR, abdominal *SD*, thoracic *SD*, and BrRatio for each group by activity. All three groups appeared to have similar patterns, across the sequence of activities. The Stroop activities (2—practice, 3, 5, 7, 10, 12, 14) were mostly evident as spikes in the graphs for SC, HR, and RR indicating an increase of these signal values that corresponds with the Stroop activity. Similarly, the periods of quiet sitting (4a, 4b, 6a, 6b, 8a, 8b) and breathing activities (9—practice, 11a, 11b, 13a, 13b, 15a, 15b) appeared to correspond with reduced values for SC, HR, and RR. The graph of RR values by activity (Figure 4.3) appeared to have the closest correspondence between the three groups, which could be evidence of similar effect on RR for all three breathing activities.

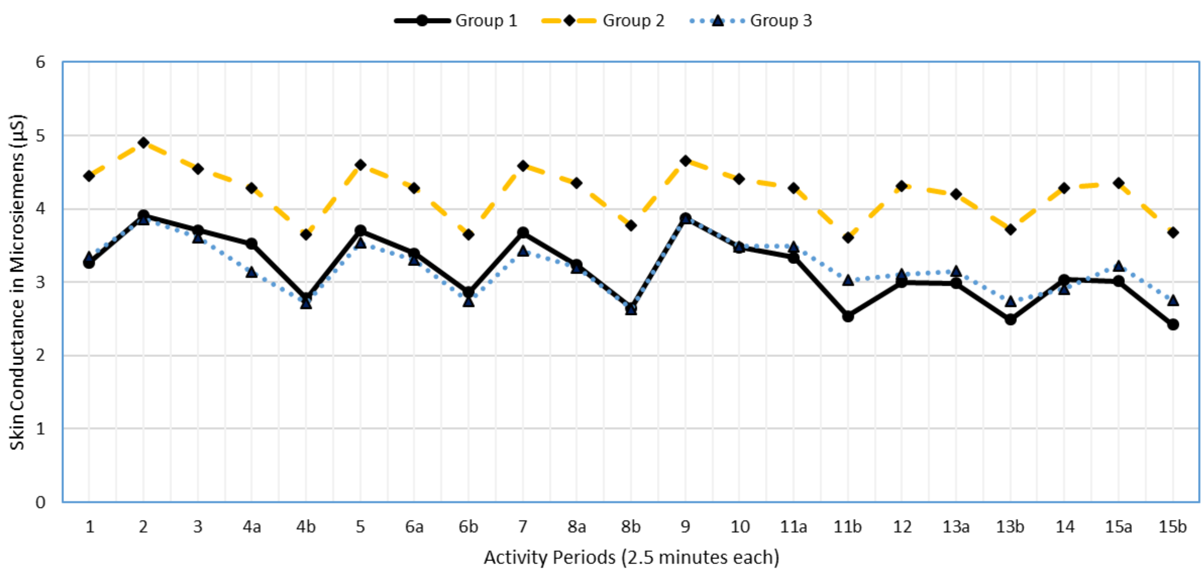


Figure 4.1. Graph—within group mean skin conductance (SC) by activity. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

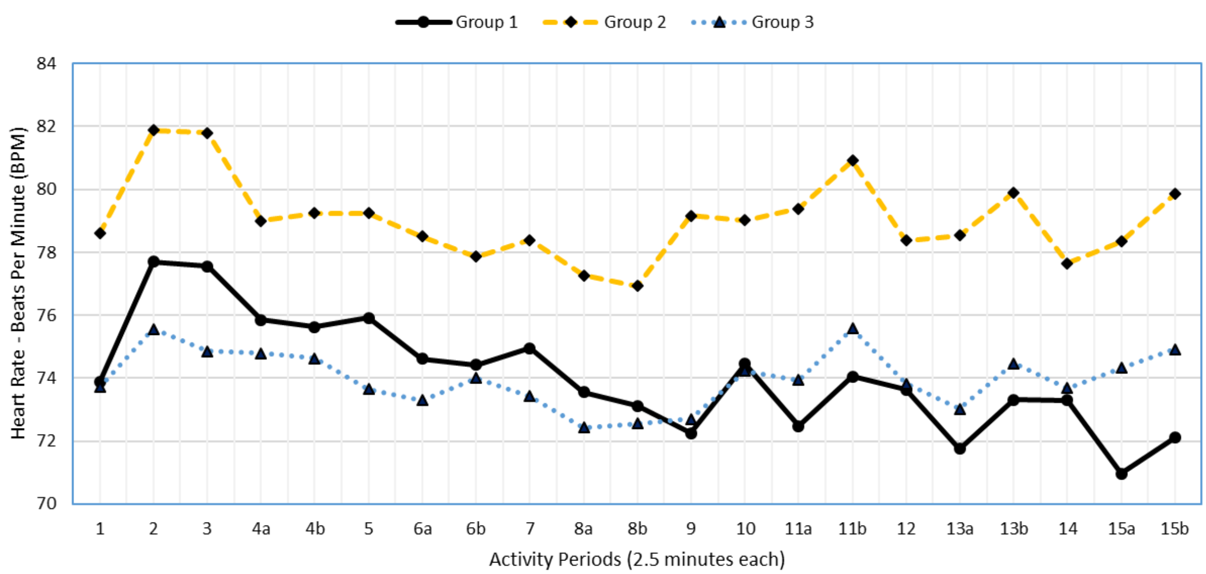


Figure 4.2. Graph—within group mean heart rate (HR) by activity. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

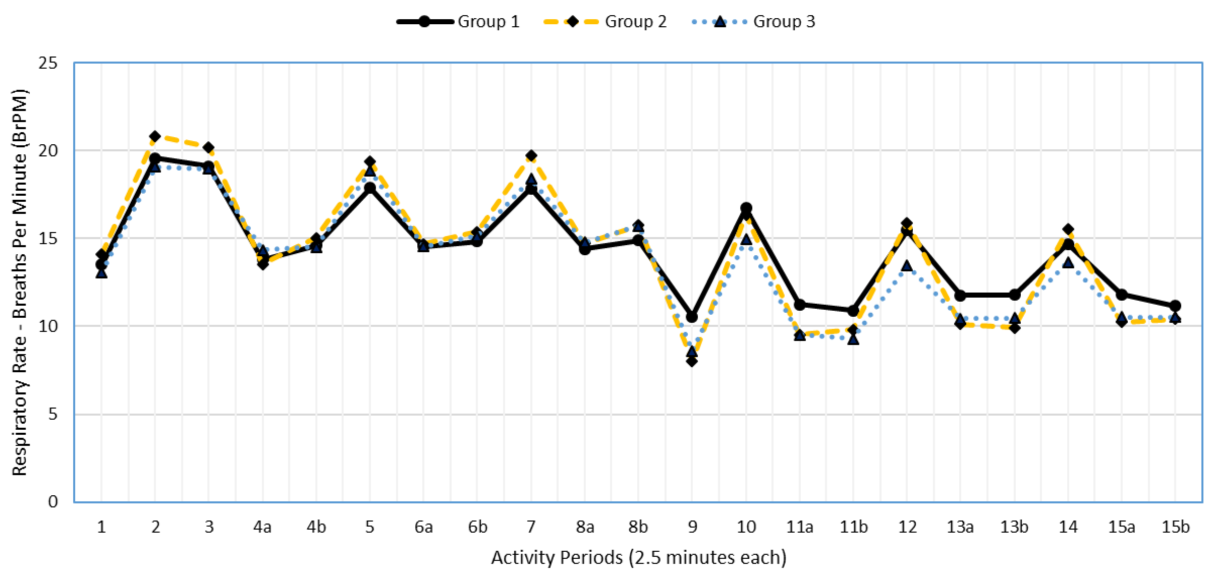


Figure 4.3. Graph—within group mean respiratory rate (RR) by activity. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

The breathing activities (9—practice, 11a, 11b, 13a, 13b, 15a, 15b) were evident in the graphs of the abdominal *SD*, thoracic *SD* and BrRatio, (Figure 4.4 through Figure 4.6) which corresponds with exposure to the breathing activities (post breathing activity exposure: Activities 9 to 15). Especially evident is an increase in abdominal *SD* and BrRatio and a decrease in thoracic *SD* for Group 2 (abdominal breathing), which is also consistent with the breathing activity.

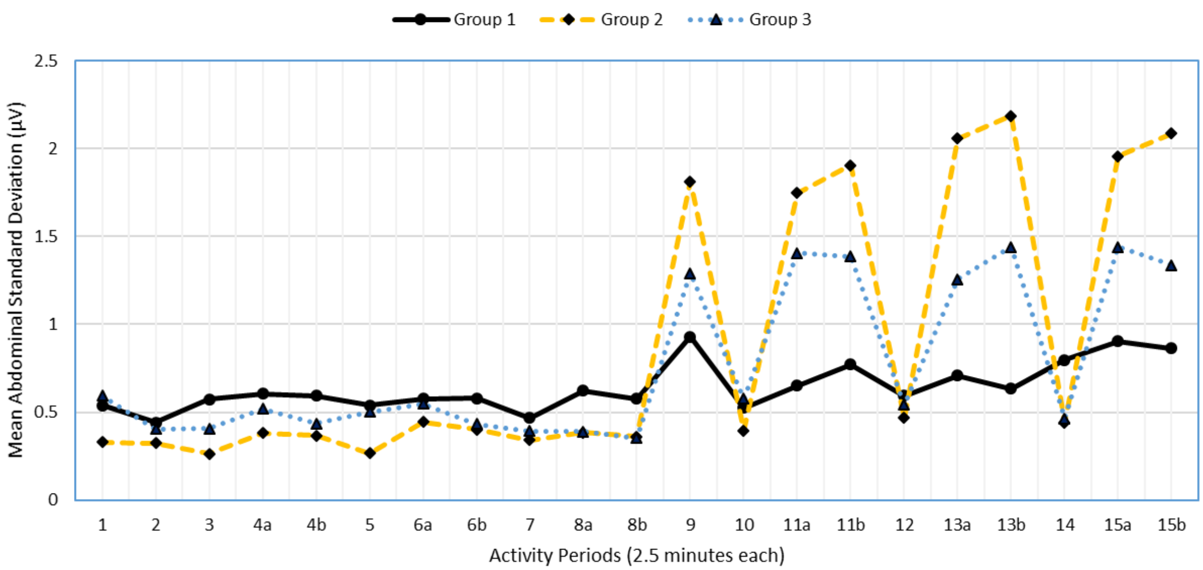


Figure 4.4. Graph—within group mean abdominal breathing magnitude (abdominal *SD*) by activity. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

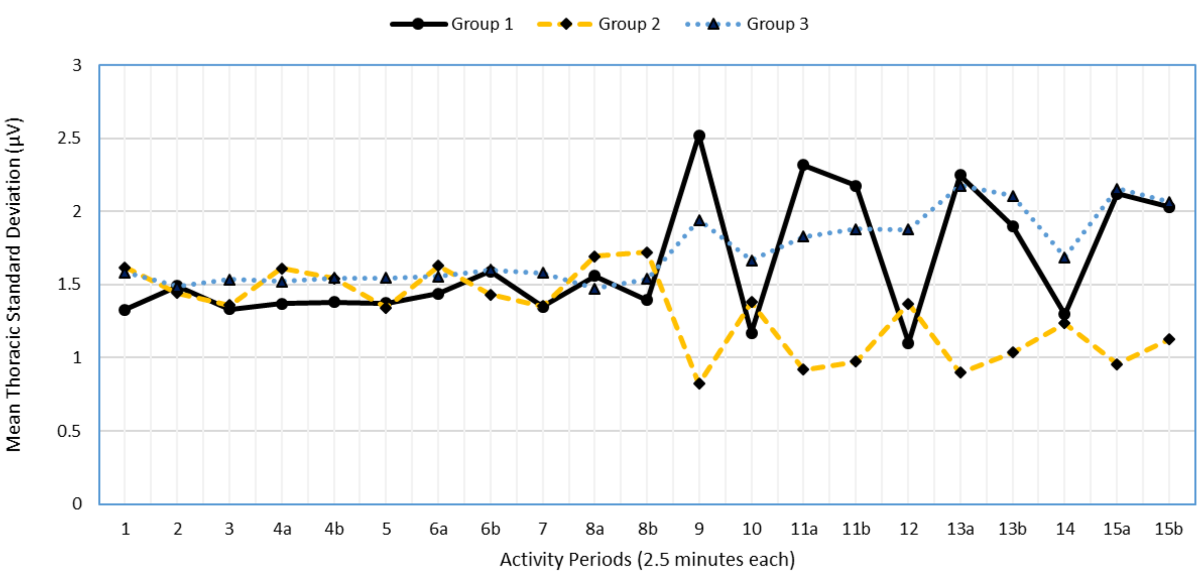


Figure 4.5. Graph—within group thoracic breathing magnitude (thoracic *SD*) by activity. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

The graph of breath ratio by activity (Figure 4.6) enabled the author to identify a participant from Group 1 (breath counting activity) who appeared to naturally have an abdominal breathing style, characterized by breathing with a very small amount of thoracic movement and a relatively large amount of abdominal movement. Due to the nature of the calculation of the breath ratio, this individual's high breath ratio values distorted the overall values for Group 1. (Figure 4.6) The author rechecked the data recording and session notes for the participant. The recording was noise-free and correct. In the session notes, the author had documented the abdominal breathing style at the very beginning of the session. Removing this participant's values from the graph (Figure 4.7) provided a plot that was more consistent with the expected values for the pre-breathing activity exposure. This participant was not removed from the data set, and is only removed from Figure 4.7 to show how these outlier values influenced the values for Group 1 on the breath ratio graph.

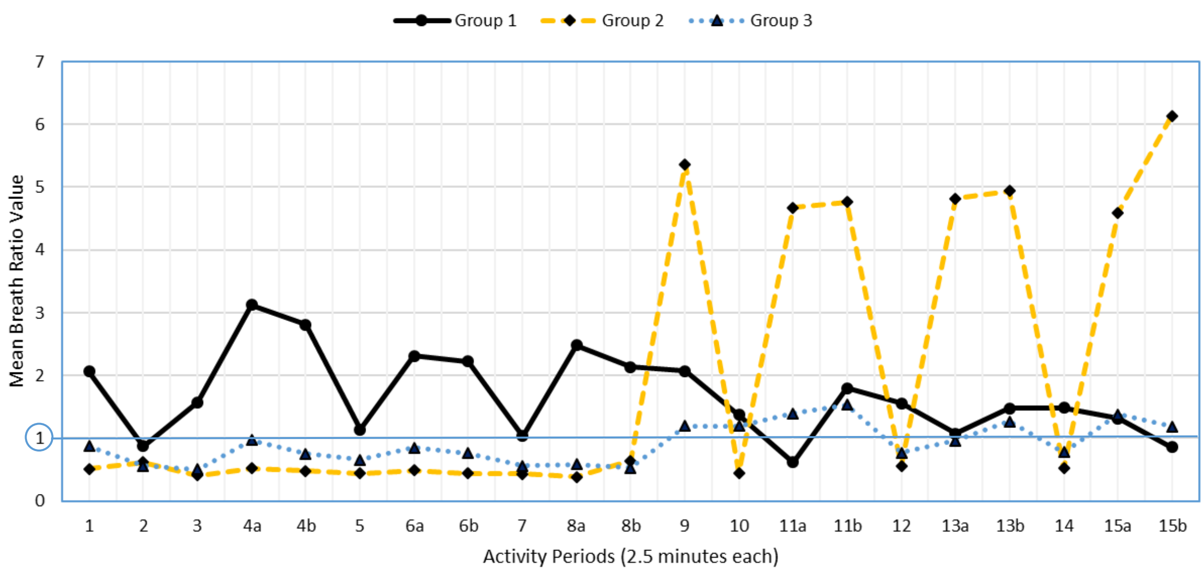


Figure 4.6. Graph—within group mean breath ratio (BrRatio) by activity. Values greater than one are categorized as abdominal breathing. Values less than one are categorized as thoracic breathing.

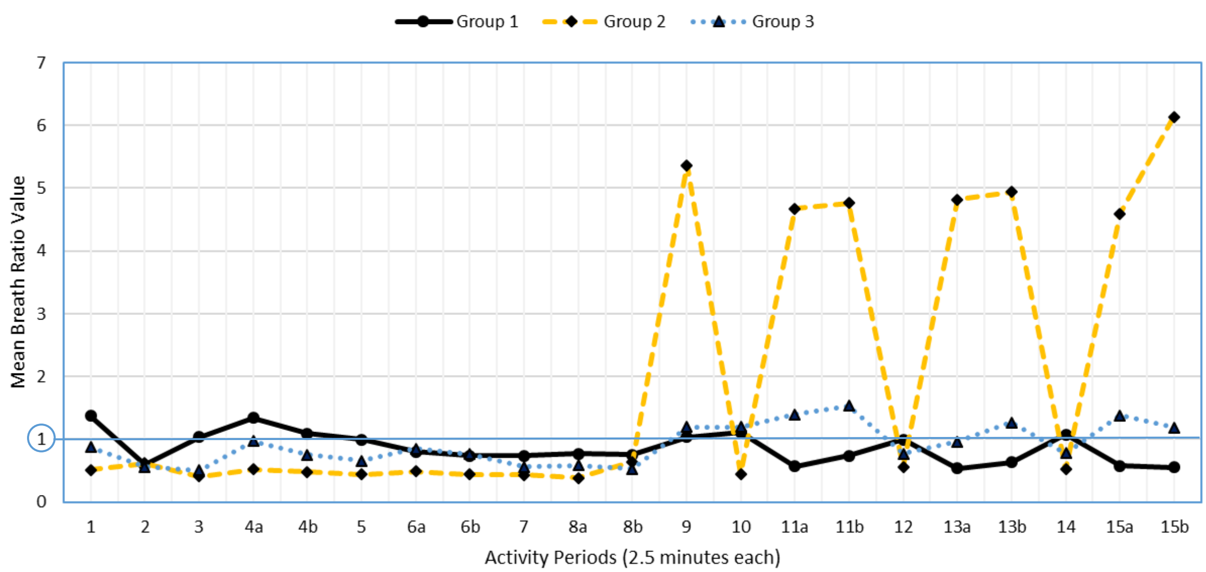


Figure 4.7. Graph—within group mean breath ratio (BrRatio) by activity—participant 20 removed from graph results only. Values greater than one are categorized as abdominal breathing. Values less than one are categorized as thoracic breathing. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

Questionnaire 2. Descriptive statistics for Questionnaire 2 responses are shown in Table 4.6 through Table 4.29. The author used data gathered via Questionnaire 2 to examine potential relationships listed in (a) H6—future use of breath awareness and attitude, (b) H7:future use of abdominal breathing and attitude, (c) H8—future use of breath awareness and subjective norms, (d) H9—future use of abdominal breathing and subjective norms, (e) H10—future use of breath awareness and control (f) H11—future use of abdominal breathing and control and (g) H12—future use of stress management and stress score.

Perceived control. Table 4.6 through Table 4.9 display the frequencies, percentages, number of participants and standard deviations of perceived behavioral control responses for breath awareness and the breathing activity. The author used these responses to examine potential relationships listed in (a) H6: future use of breath awareness and attitude and (b) H7: future use of abdominal breathing and attitude.

Table 4.6

Frequencies and Percentages of Breathing Awareness—Able: Were you able to become aware of your breathing during this study?

Response	*n*	%
7. Yes—Extremely Strongly	13	13.54
6. Yes—Very Strongly	42	43.75
5. Yes—Somewhat Strongly	35	36.46
4. Undecided	6	6.25
3. No—Somewhat Strongly	0	0.00
2. No—Very Strongly	0	0.00
1. No—Extremely Strongly	0	0.00

Note. $N = 96$, $M = 5.65$, $SD = 0.79$

Table 4.7

Frequencies and Percentages of Breathing Awareness—Easy: Was it easy for you to become aware of your breathing during this study?

Response	*n*	%
7. Yes—Extremely Strongly	14	14.58
6. Yes—Very Strongly	37	38.54
5. Yes—Somewhat Strongly	26	27.08
4. Undecided	9	9.38
3. No—Somewhat Strongly	8	8.33
2. No—Very Strongly	2	2.08
1. No—Extremely Strongly	0	0.00

Note. $N = 96$, $M = 5.35$, $SD = 1.21$

Table 4.8

Frequencies and Percentages of Breathing Activity—Able: Were you able to conduct the breathing activity during this study?

Response	*n*	%
7. Yes—Extremely Strongly	27	28.13
6. Yes—Very Strongly	38	39.58
5. Yes—Somewhat Strongly	22	22.92
4. Undecided	9	9.38
3. No—Somewhat Strongly	0	0.00
2. No—Very Strongly	0	0.00
1. No—Extremely Strongly	0	0.00

Note. $N = 96$, $M = 5.86$, $SD = 0.92$

Table 4.9

Frequencies and Percentages of Breathing Activity—Easy: Was it easy for you to conduct the breathing activity during this study?

Response	*n*	%
7. Yes—Extremely Strongly	17	17.71
6. Yes—Very Strongly	29	30.21
5. Yes—Somewhat Strongly	19	19.79
4. Undecided	18	18.75
3. No—Somewhat Strongly	7	7.29
2. No—Very Strongly	2	2.08
1. No—Extremely Strongly	4	4.17

Note. $N = 96$, $M = 5.09$, $SD = 1.54$

Perceived usefulness. Table 4.10 through Table 4.13 display the frequencies, percentages, number of participants and standard deviations of perceived usefulness responses for breath awareness and the breathing activity.

Table 4.10

Frequencies and Percentages of Personal Use—Awareness Useful: Do you believe breath awareness is useful to you personally?

Response	*n*	%
7. Yes—Extremely Strongly	24	25.00
6. Yes—Very Strongly	25	26.04
5. Yes—Somewhat Strongly	13	13.54
5. Undecided	23	23.96
3. No—Somewhat Strongly	7	7.29
2. No—Very Strongly	2	2.08
1. No—Extremely Strongly	2	2.08

Note. $N = 96$, $M = 5.3$, $SD = 1.51$

Table 4.11

Frequencies and Percentages of Personal Use—Activities Useful: Do you believe breathing activities are useful to you personally?

Response	*n*	%
7. Yes—Extremely Strongly	23	23.96
6. Yes—Very Strongly	22	22.92
5. Yes—Somewhat Strongly	13	13.54
5. Undecided	30	31.25
3. No—Somewhat Strongly	5	5.21
2. No—Very Strongly	2	2.08
1. No—Extremely Strongly	1	1.04

Note. $N = 96$, $M = 5.19$, $SD = 1.43$

Table 4.12

Frequencies and Percentages of Personal Use—Aware Own Breathing: Do you believe it is useful to be aware of your own breathing in your daily life?

Response	*n*	%
7. Yes—Extremely Strongly	28	29.17
6. Yes—Very Strongly	33	34.38
5. Yes—Somewhat Strongly	22	22.92
5. Undecided	9	9.38
3. No—Somewhat Strongly	2	2.08
2. No—Very Strongly	2	2.08
1. No—Extremely Strongly	0	0.00

Note. $N = 96$, $M = 5.73$, $SD = 1.17$

Table 4.13

Frequencies and Percentages of Personal Use—Aware Others' Breathing: Do you believe it is useful to be aware of the breathing of others in your daily life?

Response	*n*	%
7. Yes—Extremely Strongly	9	9.38
6. Yes—Very Strongly	19	19.79
5. Yes—Somewhat Strongly	12	12.50
5. Undecided	27	28.13
3. No—Somewhat Strongly	18	18.75
2. No—Very Strongly	9	9.38
1. No—Extremely Strongly	2	2.08

Note. $N = 96$, $M = 4.36$, $SD = 1.55$

Time cost. Table 4.14 through Table 4.15 display the frequencies, percentages, number of participants and standard deviations of perceived time cost for breath awareness and the breathing activity.

Table 4.14

Frequencies and Percentages of Personal Use—Time Awareness: Do you have time in your daily life to focus on breath awareness?

Response	*n*	%
7. Yes—Extremely Strongly	8	8.33
6. Yes—Very Strongly	22	22.92
5. Yes—Somewhat Strongly	20	20.83
5. Undecided	20	20.83
3. No—Somewhat Strongly	12	12.50
2. No—Very Strongly	7	7.29
1. No—Extremely Strongly	7	7.29

Note. $N = 96$, $M = 4.43$, $SD = 1.67$

Table 4.15

Frequencies and Percentages of Personal Use—Time Activities: Do you have time in your daily life to focus on breathing activities?

Response	*n*	%
7. Yes—Extremely Strongly	11	11.46
6. Yes—Very Strongly	18	18.75
5. Yes—Somewhat Strongly	16	16.67
5. Undecided	22	22.92
3. No—Somewhat Strongly	12	12.50
2. No—Very Strongly	13	13.54
1. No—Extremely Strongly	4	4.17

Note. $N = 96$, $M = 4.36$, $SD = 1.70$

Subjective norms—breath awareness. Table 4.16 through Table 4.19 display the frequencies, percentages, number of participants and standard deviations of the responses for breath awareness importance to one's self, friends, family and culture. The author used these responses to examine potential relationships listed in H8—future use of breath awareness and subjective norms.

Table 4.16

Frequencies and Percentages of Importance—Awareness—Personal: Is breath awareness important to you personally?

Response	*n*	%
7. Yes—Extremely Strongly	15	15.63
6. Yes—Very Strongly	16	16.67
5. Yes—Somewhat Strongly	17	17.71
5. Undecided	28	29.17
3. No—Somewhat Strongly	13	13.54
2. No—Very Strongly	6	6.25
1. No—Extremely Strongly	1	1.04

Note. $N = 96$, $M = 4.69$, $SD = 1.51$

Table 4.17

Frequencies and Percentages of Importance—Awareness—Friends: Is breath awareness important to your friends?

Response	*n*	%
7. Yes—Extremely Strongly	1	1.04
6. Yes—Very Strongly	2	2.08
5. Yes—Somewhat Strongly	3	3.13
5. Undecided	55	57.29
3. No—Somewhat Strongly	12	12.50
2. No—Very Strongly	13	13.54
1. No—Extremely Strongly	10	10.42

Note. $N = 96$, $M = 3.40$, $SD = 1.21$

Table 4.18

Frequencies and Percentages of Importance—Awareness—Family: Is breath awareness important to your family?

Response	*n*	%
7. Yes—Extremely Strongly	10	10.42
6. Yes—Very Strongly	8	8.33
5. Yes—Somewhat Strongly	5	5.21
5. Undecided	50	52.08
3. No—Somewhat Strongly	3	3.13
2. No—Very Strongly	14	14.58
1. No—Extremely Strongly	6	6.25

Note. $N = 96$, $M = 4.02$, $SD = 1.59$

Table 4.19

Frequencies and Percentages of Importance—Awareness—Culture: Is breath awareness important in your culture?

Response	*n*	%
7. Yes—Extremely Strongly	5	5.21
6. Yes—Very Strongly	3	3.13
5. Yes—Somewhat Strongly	7	7.29
5. Undecided	38	39.58
3. No—Somewhat Strongly	18	18.75
2. No—Very Strongly	15	15.63
1. No—Extremely Strongly	10	10.42

Note. $N = 96$, $M = 3.48$, $SD = 1.47$

Subjective norms—breathing activities. Table 4.20 through Table 4.23 display the frequencies, percentages, number of participants and standard deviations of the responses for breathing activities importance to one's self, friends, family and culture. The author used these responses to examine potential relationships listed in H9—future use of abdominal breathing and subjective norms.

Table 4.20

Frequencies and Percentages of Importance—Activities—Personal: Are breathing activities important to you personally?

Response	*n*	%
7. Yes—Extremely Strongly	20	20.83
6. Yes—Very Strongly	14	14.58
5. Yes—Somewhat Strongly	17	17.71
5. Undecided	22	22.92
3. No—Somewhat Strongly	17	17.71
2. No—Very Strongly	6	6.25
1. No—Extremely Strongly	0	0.00

Note. $N = 96$, $M = 4.79$, $SD = 1.57$

Table 4.21

Frequencies and Percentages of Importance—Activities—Friends: Are breathing activities important to your friends?

Response	*n*	%
7. Yes—Extremely Strongly	2	2.08
6. Yes—Very Strongly	3	3.13
5. Yes—Somewhat Strongly	3	3.13
5. Undecided	48	50.00
3. No—Somewhat Strongly	15	15.63
2. No—Very Strongly	15	15.63
1. No—Extremely Strongly	10	10.42

Note. $N = 96$, $M = 3.38$, $SD = 1.30$

Table 4.22

Frequencies and Percentages of Importance—Activities—Family: Are breathing activities important to your family?

Response	*n*	%
7. Yes—Extremely Strongly	9	9.38
6. Yes—Very Strongly	6	6.25
5. Yes—Somewhat Strongly	6	6.25
5. Undecided	46	47.92
3. No—Somewhat Strongly	11	11.46
2. No—Very Strongly	13	13.54
1. No—Extremely Strongly	5	5.21

Note. $N = 96$, $M = 3.93$, $SD = 1.52$

Table 4.23

Frequencies and Percentages of Importance—Activities—Culture: Are breathing activities important in your culture?

Response	*n*	%
7. Yes—Extremely Strongly	7	7.29
6. Yes—Very Strongly	5	5.21
5. Yes—Somewhat Strongly	7	7.29
5. Undecided	37	38.54
3. No—Somewhat Strongly	14	14.58
2. No—Very Strongly	17	17.71
1. No—Extremely Strongly	9	9.38

Note. $N = 96$, $M = 3.61$, $SD = 1.59$

Stage of change. Table 4.24 through Table 4.26 display the composite response and response confidence scores for stage of change (planned future use) for stress management, breath awareness, and abdominal breathing. The author used these responses to examine potential relationships listed in (a) H6—future use of breath awareness and attitude, (b) H7—future use of abdominal breathing and attitude, (c) H8—future use of breath awareness and subjective norms, (d) H9—future use of abdominal breathing and subjective norms, (e) H10—future use of breath awareness and control (f) H11—future use of abdominal breathing and control and (g) H12—future use of stress management and stress score.

Stress management stage of change responses. The stress management definition that preceded the stress management stage of change response options was: “Stress management includes regular relaxation and physical activity, talking with others, and/or making time for social activities” (Evers et al., 2006, p. 523). Over half of the participants were very confident (23%) or confident (26 %) or somewhat confident (14%) that they had been managing stress according to this definition for more than six months. This indicates most participants were in the maintenance stage of change for stress management.

Table 4.24

Stage of Change Stress Management: Do you regularly manage stress according to this definition?

Stage of change	Very confident	Confident	Somewhat confident	Undecided	Somewhat not confident	Not confident	Not at all confident
	Confidence Level Response						
1. Maintenance	22	25	13	0	1	0	0
2. Action	0	4	7	0	0	0	0
3. Preparation	1	1	6	1	2	0	0
4. Contemplation	0	1	5	1	2	0	0
5. Precontemplation	1	0	2	1	0	0	0

Note. N = 96

Breath awareness stage of change responses. The breath awareness definition that preceded the breath awareness stage of change response options was: Breath awareness is the regular act of being aware of or attending to one's breath including (but not limited to) noticing one's breathing, counting breaths and focusing on breath-related sensations. It is also known as attending to breath, awareness of breathing, breath attention, breath-focused attention, breath-focused awareness, breath-focused concentration, breath-focused meditation, focused breathing, meditation breath attention, mindful breathing, mindfulness of breathing. Over half the participants were very confident (23%) or confident (26%) or somewhat confident (14%) that they had been conducting breath awareness according to this definition for more than six months, indicating that they were in the maintenance stage of change for breath awareness.

Table 4.25

Stage of Change Breath Awareness: Are you regularly aware of your breath according to this definition?

	Confidence Level Response						
Stage of change	Very confident	Confident	Somewhat confident	Undecided	Somewhat not confident	Not confident	Not at all confident
1. Maintenance	9	18	4	1	0	0	0
2. Action	0	4	6	0	0	0	0
3. Preparation	2	11	16	2	0	0	0
4. Contemplation	0	3	8	0	0	0	0
5. Precontemplation	0	3	6	3	0	0	0

Note. N = 96

Abdominal breathing stage of change responses. The abdominal breathing definition that preceded the abdominal breathing stage of change response options was: Abdominal breathing is the regular act of slow and deliberate respiration in which one purposefully and fully moving the diaphragm down during inhalation and up during exhalation which results in moderate abdominal expansion and reduction of the during breathing. It is also known as diaphragmatic breathing, slow-deep breathing and belly breathing. Almost one-third of participants were very confident (9%), confident (19%) or somewhat confident (4%) that they had been conducting abdominal breathing according to this definition for more than six months, indicating that they were in the maintenance stage of change for abdominal breathing. Just over one quarter of the participants were confident (11%) or somewhat confident (16%) that they did not conduct abdominal breathing according to the definition but intended to do so in the next 30 days, indicating that they were in the preparation stage of change for abdominal breathing.

Table 4.26

Stage of Change Abdominal Breathing: Do you regularly conduct abdominal breathing according to this definition?

	Confidence Level Response						
Stage of change	Very confident	Confident	Somewhat confident	Undecided	Somewhat not confident	Not confident	Not at all confident
1. Maintenance	9	11	1	1	0	0	0
2. Action	0	3	3	0	1	0	0
3. Preparation	2	5	11	6	1	0	0
4. Contemplation	1	7	11	2	0	0	0
5. Precontemplation	2	7	8	4	0	0	0

Note. N = 96

Perceptions of study participation. Table 4.27 through Table 4.29 display the frequencies, percentages, number of participants and standard deviations of participant perceptions of participating in the study.

Table 4.27

Frequencies and Percentages of Participation—Recommend: Would you recommend that your friends participate in this study?

Response	*n*	%
7. Yes—Extremely Strongly	23	23.96
6. Yes—Very Strongly	24	25.00
5. Yes—Somewhat Strongly	23	23.96
5. Undecided	25	26.04
3. No—Somewhat Strongly	0	0.00
2. No—Very Strongly	1	1.04
1. No—Extremely Strongly	0	0.00

Note. N = 96, *M* = 5.44, *SD* = 1.18

Table 4.28

Frequencies and Percentages of Participation—Time Use: Do you believe this study was a good use of your time?

Response	*n*	%
7. Yes—Extremely Strongly	30	31.25
6. Yes—Very Strongly	22	22.92
5. Yes—Somewhat Strongly	7	28.13
5. Undecided	14	14.58
3. No—Somewhat Strongly	1	1.04
2. No—Very Strongly	2	2.08
1. No—Extremely Strongly	0	0.00

Note. N = 96, *M* = 5.63, *SD* = 1.22

Table 4.29

Frequencies and Percentages of Participation—Help Long Term: Do you feel that participating in this study may help you personally for the long term?

Response	*n*	%
7. Yes—Extremely Strongly	17	17.71
6. Yes—Very Strongly	18	18.75
5. Yes—Somewhat Strongly	16	16.67
5. Undecided	34	35.42
3. No—Somewhat Strongly	8	8.33
2. No—Very Strongly	2	2.08
1. No—Extremely Strongly	1	1.04

Note. N = 96, *M* = 4.92, *SD* = 1.40

Existing experience. The author used responses regarding participant existing experience to examine potential relationships listed in (a) H10.3: intended future use of breath awareness and prior experience with breath awareness and (b) H.11.3: intended future use of abdominal breathing and prior experience with abdominal breathing.

Existing experience comments—awareness of own breathing. Free text responses to the question ‘Please describe your previous experience with awareness of your own breathing’ are listed in Appendix I. Only 56 of the 96 participants (58%) disclosed experience with awareness of one’s own breath. The most frequent phrases in this response: Apple Watch (6), breathing exercises (3), lifting weights (2), deep breaths (2), high blood pressure (2), and breathing app (2).

The most frequent single words appearing three or more times were: before (3), down (3), during (3), especially (3), exercise (3), mindfulness (3), minute (3), myself (3), playing (3), practice (3), through (3), training (3), very (3), anxiety (4), app (4), calm (4), can (4), day (4), deep (4), doing (4), every (4), focus (4), sports (4), take (4), try (4), while (4), you (4), your (4), would (5), Apple (6), aware (6), breaths (6), control (6), exercises (6), how (6), watch (6), with (6), breathe (7), that (7), yoga (8), breath (9), for (11), meditation (14), when (14), breathing (23). Single word frequencies from participant own breath experience comments are shown in Appendix I, Figure I-1. Based on the phrase and word frequencies from the responses, it appears that participants had experience with awareness of their own breath from meditation, yoga, and Apple Watch use as well as sports, music and theater. These word and phrase frequencies are important indications of participant existing experience with awareness of one's own breath.

Existing experience comments—awareness of others' breathing. Free text responses to the question 'Please describe your previous experience with awareness of others' breathing' are listed in Appendix I. Only 15 of the 96 participants (16%) disclosed experience with awareness of others' breath. There were no common phrases that appeared in this group of responses.

The most frequent single words appearing three or more times were: for (3), notice (3), sometimes (3), would (3), breath (4), breathing (4), with (4), people (5), when (9). Single word frequencies from participant experience with awareness of others' breathing comments are shown in Appendix I, Figure I-2. Based on word frequencies from the responses, it appears that the most common participant experience with awareness of others' breathing was noticing when someone is anxious or nervous. These word frequencies are important indications of participant existing experience with awareness of others' breath.

Existing experience comments—breathing activities. Free text responses to the question 'Please describe your previous experience with breathing activities' are listed in Appendix I. Only 55 of the 96 participants (57%) disclosed their experience with breathing activities. The most frequent phrases in this response: breathing exercises (6), breathing activities (4), high school (4), Apple Watch (3), abdominal breathing (2), breathing activity (2), and deep breathing (2).

The most frequent single words appearing three or more times were: about (3), anxiety (3), Apple (3), exercise (3), focus (3), our (3), playing (3), practice (3), practicing (3), specific (3), that (3), was (3), before (4), class (4), deep (4), high (4), learned (4), watch (4), when (4), help (5), school (5), swimming (5), activities (6), breath (6), during (6), had (6), you (6), breathe (7), exercises (8), with (8), for (10), yoga (11), meditation (12), breathing (25). Single word frequencies from participant own breath experience comments are shown in Appendix I, Figure I-3. Based on the phrase and word frequencies, it appears that the most common participant experience with breathing activities were from meditation, yoga, sports, music and theater. These word and phrase frequencies are important indications of participant existing experience with breathing activities.

Participant comments and recommendations. Free text responses to the question 'Please add any comments or recommendations that you would like to share' are listed in Appendix J. Only 25 of the 96 participants (26%) chose to make final comments and recommendations. The most frequent phrases in this response: abdominal breathing (3), test subject (2), breathing exercise (2), breathing habits (2).

The most frequent single words appearing three or more times were: abdominal (3), about (3), but (3), different (3), done (3), great (3), learned (3), relaxing (3), test (3), time (3), very (3), activity (4), exercise (4), mind (4), that (4), with (4), focus (5), for (5), well (5), this (8), study (9), was (9), breathing (14). Single word frequencies from participant own breath experience comments are shown in Appendix J, Figure J-1. The most frequent participant responses for the final comments and recommendations can be described as general expressions of gratitude and commendation.

Physiological Analysis: H1-H5

H1-H3 analysis—physiological measurements. The first three hypothesis pertained to the potential effects of three breathing activities on the physiological signals when compared with periods of quiet sitting (Table 4.30). Analysis of the physiological signals by activity and group follow.

Table 4.30

Experimental Activity Sequence showing the 2.5-Minute Periods of Quiet Sitting and Breathing Activity Analyzed to Examine H1-H3

	Numbered activities, 2.5-minute periods					
Quiet sitting	4a.	4b.	6a.	6b.	8a.	8b.
Breathing activity	11a.	11b.	13a.	13b.	15a.	15b.

Note. a = activity first half and b = activity second half.

The author compared the five-minute periods of quiet sitting (Activities 4, 6 and 8) with the five-minute periods of breathing activity (Activities 11, 13 and 15) with each physiological measure as the outcome (dependent) variable. The author divided each five-minute activity period into two 2.5 minute first and second halves for a total of 12, 2.5-minute sections.

Unconditional model. The author applied the null model (Equation 1) to each physiological measure and calculated the intraclass correlation coefficient (ICC) for each level by dividing the variance estimate of each level by the total variance estimate (Table 4.31 to Table 4.36).

Table 4.31

H1-H3 Estimated Variance of Mean Skin Conductance Within and Between Individuals

Level		Variance estimate	ICC
1		0.607***	
2		4.498***	0.881
	Total Estimated Variance:	5.104	

Note. ICC = Intraclass correlation coefficient
***p < 0.001

Table 4.31 shows the two-level null model comparison for skin conductance for the selected periods of quiet sitting and periods of breathing activity. The ICC suggests that the proportion of variance for the two-level model is approximately 12% within individuals and 88% between individuals. Since the variance is statistically significant within and between individuals, a two-level model is warranted for examining mean skin conductance.

Table 4.32

H1-H3 Estimated Variance of Mean Heart Rate Within and Between Individuals

Level		Variance estimate	ICC
1		13.212***	
2		94.179***	0.877
	Total Estimated Variance:	107.391	

Note. ICC = Intraclass correlation coefficient
***p < 0.001

Table 4.32 shows the two-level null model comparison for heart rate for the selected periods of quiet sitting and periods of breathing activity. The ICC suggests that the proportion of variance for the two-level model is approximately 12% within individuals and 88% between individuals. Since the variance is statistically significant within and between individuals, a two-level model is warranted for examining mean heart rate.

Table 4.33

H1-H3 Estimated Variance of Mean Respiratory Rate Within and Between Individuals

Level		Variance estimate	ICC
1		9.937***	
2		7.731***	0.438
	Total Estimated Variance:	17.668	

Note. ICC = Intraclass correlation coefficient
***p < 0.001

Table 4.33 shows the two-level null model comparison for respiratory rate for the selected periods of quiet sitting and periods of breathing activity. The ICC suggests that the proportion of variance for the two-level model is approximately 56% within individuals and 44% between individuals. Since the variance is statistically significant within and between individuals, a two-level model is warranted for examining mean respiratory rate.

Table 4.34

H1-H3 Estimated Variance of Mean Abdominal Breathing Magnitude Within and Between Individuals

Level		Variance estimate	ICC
1		0.807***	
2		0.738***	0.478
	Total Estimated Variance:	1.545	

Note.: ICC = Intraclass correlation coefficient
***p < 0.001

Table 4.34 shows the two-level null model comparison for the standard deviation of the mean abdominal breathing signal for the selected periods of quiet sitting and periods of breathing activity. The ICC suggests that the proportion of variance for the two-level model is approximately 52% within individuals and 48% between individuals. Since the variance is statistically significant within and between individuals, a two-level model is warranted for examining mean abdominal breathing magnitude (abdominal *SD)*.

Table 4.35

H1-H3 Estimated Variance of Mean Thoracic Breathing Magnitude Within and Between Individuals

Level		Variance estimate	ICC
1		0.782***	
2		1.615***	0.674
	Total Estimated Variance:	2.398	

Note. ICC = Intraclass correlation coefficient
***p < 0.001

Table 4.35 shows the two-level null model comparison for the standard deviation of the thoracic breathing signal for the selected periods of quiet sitting and periods of breathing activity. The ICC suggests that the proportion of variance for the two-level model is approximately 33% within individuals and 67% between individuals. The variance is statistically significant within individuals and between individuals, so a two-level model is warranted for examining mean thoracic breathing magnitude (thoracic *SD)*.

Table 4.36

H1-H3 Estimated Variance of Mean Breath Ratio Within and Between Individuals

Level		Variance estimate	ICC
1		14.225***	
2		16.347***	0.535
	Total Estimated Variance:	30.571	

Note. ICC = Intraclass correlation coefficient
***p < 0.001

Table 4.36 shows the two-level null model comparison for the standard deviation of the breath ratio for the selected periods of quiet sitting and periods of breathing activity. The ICC suggests that the proportion of variance for the two-level model is approximately 47% within individuals and 54% between individuals. Since the variance is statistically significant within and between individuals, a two-level model is warranted for examining mean breath ratio.

H1-H3 breathing activity exposure fixed factor. To determine if any of the three breathing activities had a statistically significant effect on participant physiological measures when compared to quiet sitting, the author added breathing activity exposure to the model as a fixed factor (Equation 2; no breathing activity exposure was coded as -1, breathing activity exposure was coded as 1). Statistically significant effects of the breathing activities only appeared for the breathing measures (Table 4.39 to Table 4.42).

There does not appear to be a statistically significant effect for breathing activity exposure (intervention variable) and skin conductance and when adding breathing activity exposure as a factor (Table 4.37, Figure 4.8), which does not support the hypotheses that the breathing activities have an effect on skin conductance (H1.1, H2.1, and H3.1). There does not appear to be a statistically significant effect for breathing activity exposure (intervention variable) and heart rate when adding breathing activity exposure as a factor (Table 4.38, Figure 4.9) which does not support that the breathing activities have an effect on heart rate (H1.2, H2.2, and H3.2). Increases in deviance, AIC and BIC indicate a diminished model fit when adding breathing activity exposure to the model for both skin conductance and heart rate.

Table 4.37

H1-H3 Mean Skin Conductance Fixed and Random Effects Estimates—Unconditional Model Compared to Breathing Activity Exposure Model

Parameter	Unconditional (null) model	Breathing activity exposure model
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.001 (0.218)	0.001 (0.218)
Breathing activity exposure		-0.029 (0.023)
Random		
Between participant estimated variance	0.607 (0.026)	0.605 (0.026)
Within participant estimated variance	4.498 (0.657)	4.498 (0.656)
Model fit		
-2*log likelihood (deviance)	3120.381	3121.791
AIC	3126.381	3129.791
BIC	3141.524	3149.988

Note. *N* = 96, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.

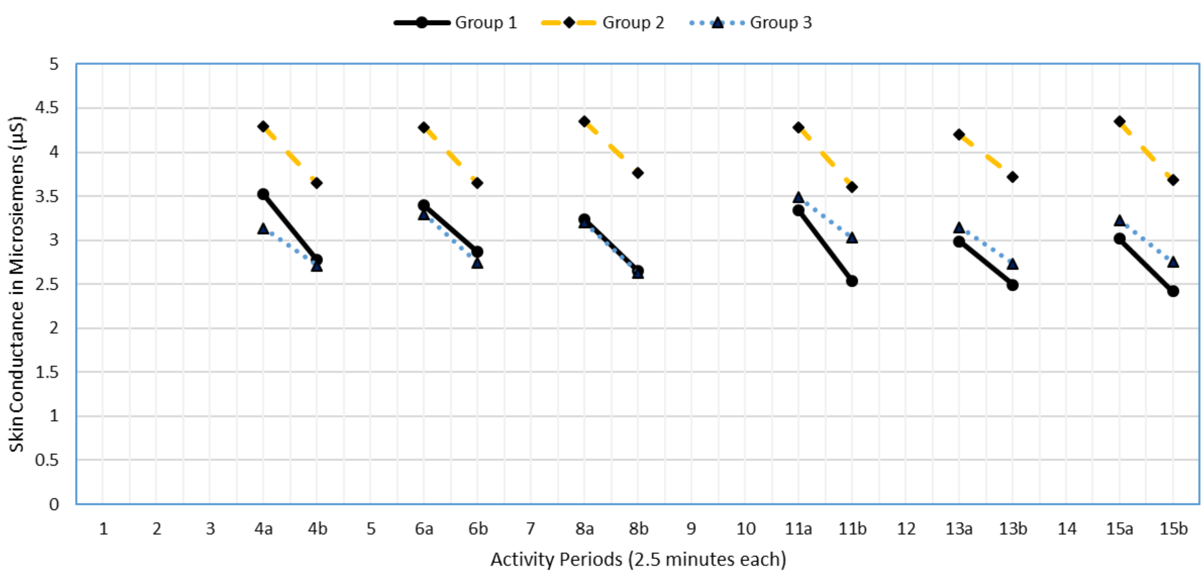


Figure 4.8. Mean skin conductance—periods of quiet sitting (Activities 4, 6, and 8) compared to periods of breathing activity (Activities 11, 13 and 15). Letters a and b designate the 2.5 minute first and second halves of the five-minute activity. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

Table 4.38

H1-H3 Mean Heart Rate Fixed and Random Effects Estimates—Unconditional Model Compared to Breathing Activity Exposure Model

Parameter	Unconditional (null) model	Breathing activity exposure model
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.017 (0.996)	0.015 (0.996)
Breathing activity exposure		0.025 (0.107)
Random		
between participant estimated variance	13.212 (0.576)	13.204 (0.574)
Within participant estimated variance	94.179 (13.753)	94.206 (13.756)
Model fit		
-2*log likelihood (deviance)	6659.880	6670.282
AIC	6665.880	6678.282
BIC	6681.022	6698.479

Note. *N* = 96, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.

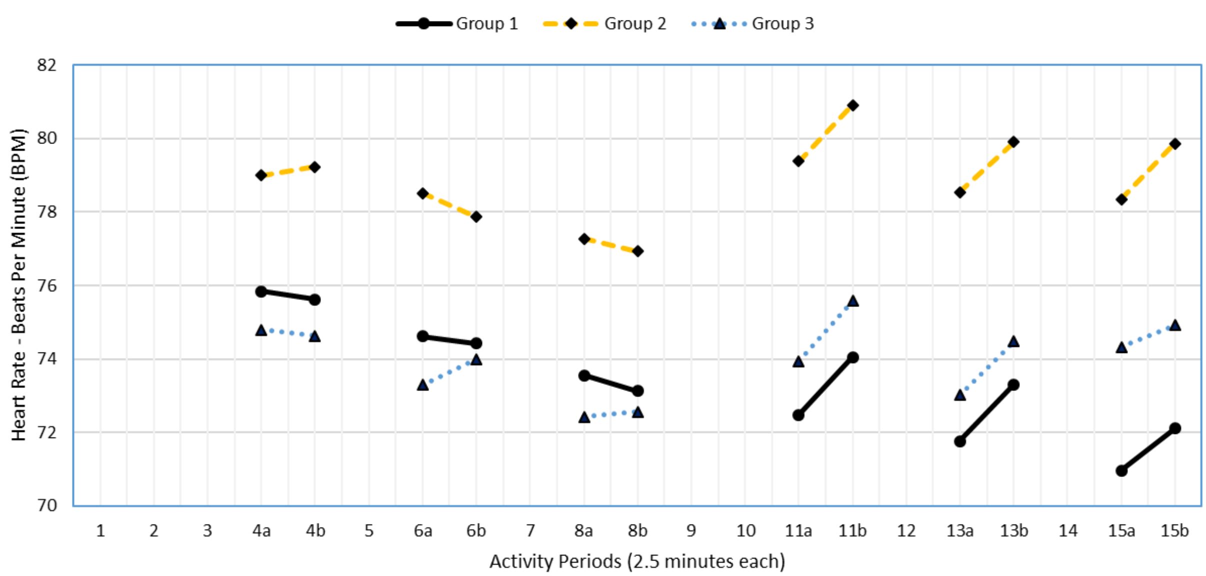


Figure 4.9. Mean heart rate (HR)—periods of quiet sitting (Activities 4, 6, and 8) compared to periods of breathing activity (Activities 11, 13 and 15). Letters a and b designate the 2.5 minute first and second halves of the five-minute activity. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

When adding breathing activity exposure as a factor, there appears to be a statistically significant relationship ($p < 0.001$) between breathing activity exposure (intervention variable) and respiratory rate (RR) with a magnitude of -2.101 (95% confidence interval: -2.232 to -1.971) when allowing for variability across individual respiratory rate measures. This negative estimate value indicates that respiratory rate decreases after breathing activity exposure when comparing quiet sitting periods and subsequent breathing activity periods. Reduction in variance estimate between this model and the null model for RR: (9.937 - 5.124) / 9.937 = 0.484 indicates the addition of breathing activity exposure accounts for approximately 48% of the modeled variance for respiratory rate. Comparison of unconditional and breathing activity exposure model for RR is displayed in Table 4.39 and graphed RR values are displayed in Figure 4.10. Adding breathing activity exposure to the model improved model fit based on reduced deviance, AIC and BIC.

Table 4.39

H1-H3 Mean Respiratory rate Fixed and Random Effects Estimates—Unconditional Model Compared to Breathing Activity Exposure Model

Parameter	Unconditional (null) model	Breathing activity exposure model
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.001 (0.299)	-0.002 (0.299)
Breathing activity exposure		-2.101*** (0.067)
Random		
Between participant estimated variance	9.937 (0.433)	5.124 (0.223)
Within participant estimated variance	7.731 (1.236)	8.175 (1.242)
Model fit		
-2*log likelihood (deviance)	6128.380	5439.721
AIC	6134.380	5447.721
BIC	6149.522	5467.918

Note. N = 96, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.
***$p < 0.001$

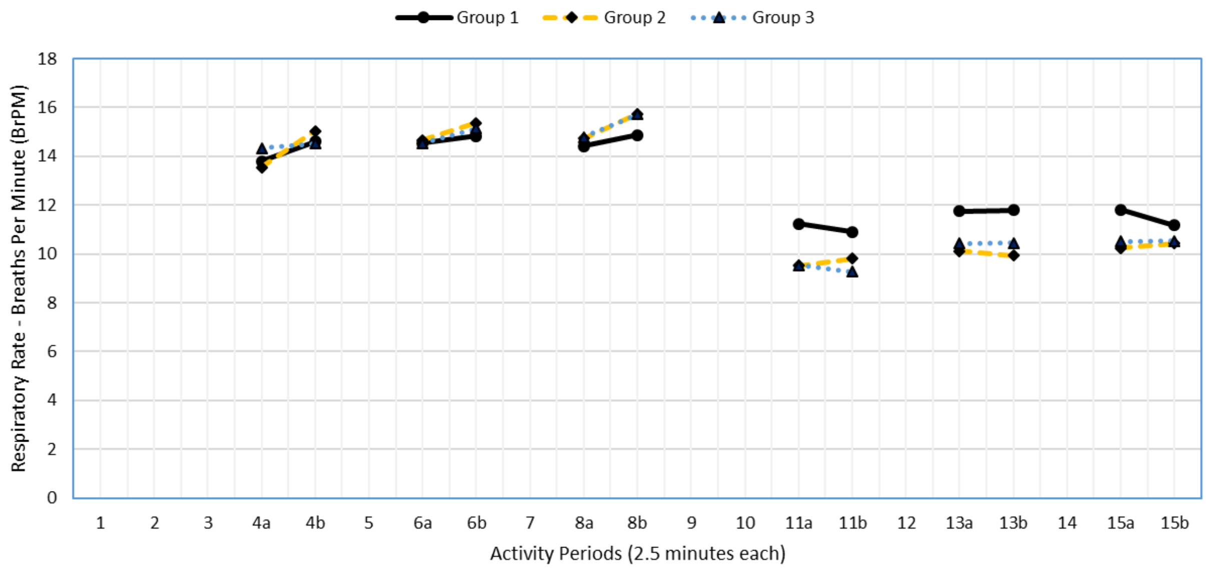


Figure 4.10. Mean respiratory rate (RR)—periods of quiet sitting (Activities 4, 6, and 8) compared to periods of breathing activity (Activities 11, 13 and 15). Letters a and b designate the 2.5 minute first and second halves of the five-minute activity. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

When adding breathing activity exposure as a factor, there appears to be a statistically significant relationship (p = 0.001) between breathing activity exposure (intervention variable) and abdominal breathing magnitude (abdominal *SD*) with a statistical magnitude of 0.449 (95% confidence interval: 0.404 to 0.493) when allowing for variability across individual abdominal *SD* measures. This positive effect indicates that when comparing periods of quiet sitting and periods of breathing activity, abdominal breathing magnitude increases, which supports H1.3, H2.3, and H3.3. This increase in abdominal breathing is consistent with exposure to breathing activities, especially for Group 2, which employed the abdominal breathing activity. Calculating the reduction in variance estimate between this model and the null model for abdominal *SD* (0.807 -0.588) / 0.807 = 0.272 indicates the addition of breathing activity exposure accounts for approximately 27% of the modeled variance for abdominal breathing magnitude. Comparison of unconditional and breathing activity exposure model for abdominal breathing magnitude is displayed in Table 4.40. Graphed abdominal breathing magnitude values are displayed in Figure

4.11. Adding breathing activity exposure to the model improved model fit based on reduced deviance, AIC and BIC.

Table 4.40

H1-H3 Mean Abdominal Breathing Magnitude: Fixed and Random Effects Estimates—Unconditional Model Compared to Breathing Activity Exposure Model

Parameter	Unconditional (null) model	Breathing activity exposure model
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	-0.001 (0.092)	0.000 (0.092)
Breathing activity exposure		0.449*** (0.023)
Random		
Between participant estimated variance	0.807 (0.352)	0.588 (0.026)
Within participant estimated variance	0.738 (0.116)	0.755 (0.116)
Model fit		
-2*log likelihood (deviance)	3255.583	2925.605
AIC	3261.583	2933.605
BIC	3276.725	2953.802

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.
***$p < 0.001$

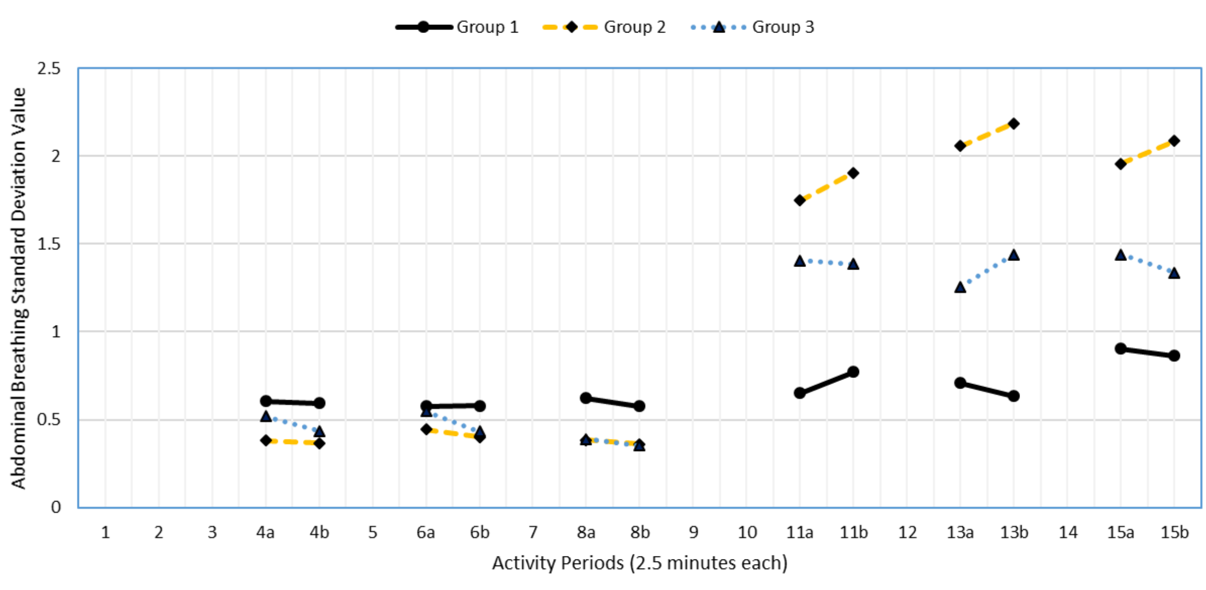


Figure 4.11. Mean abdominal breathing magnitude (abdominal *SD*)—periods of quiet sitting (Activities 4, 6, and 8) compared to periods of breathing activity (Activities 11, 13 and 15). Letters a and b designate the 2.5 minute first and second halves of the five-minute activity. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

When adding breathing activity exposure as a factor, there appears to be a statistically significant relationship ($p < 0.001$) between breathing activity exposure (intervention variable) and thoracic breathing magnitude (thoracic *SD*) with a statistical magnitude of 0.090 (95% confidence interval: 0.039 to 0.141) when allowing for variability across individual thoracic *SD* measures. This positive effect indicates that when comparing periods of quiet sitting and periods of breathing activity, thoracic breathing magnitude increases, which does not support H1.4, H2.4, and H3.4. However, the graph of thoracic breathing magnitude mean values (Figure 4.12) reveals that while the thoracic breathing magnitude values appear to increase for groups one and three, the mean thoracic breathing magnitude values appear to decrease for Group 2 (abdominal breathing). Calculating the reduction in variance estimate between this model and the null model for thoracic *SD* (0.782 -0.772) / 0.782 = 0.013 indicates the addition of breathing activity exposure accounts for approximately 1.3% of the modeled variance for thoracic *SD*. Comparison of unconditional and breathing activity exposure model for thoracic *SD* is displayed in Table 4.41. Minor reductions in deviance, AIC and BIC indicate a slightly improved model fit when adding breathing activity exposure to the model.

Table 4.41

H1-H3 Mean Thoracic Breathing Magnitude: Fixed and Random Effects Estimates—Unconditional Model Compared to Breathing Activity Exposure Model

Parameter	Unconditional (null) model	Breathing activity exposure model
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	-0.002 (0.132)	-0.001 (0.132)
Breathing activity exposure		0.090*** (0.026)
Random		
Between participant estimated variance	0.782 (0.034)	0.772 (0.034)
Within participant estimated variance	1.615 (0.243)	1.616 (0.243)
Model fit		
-2*log likelihood (deviance)	3292.906	3284.374
AIC	3298.906	3292.374
BIC	3314.048	3312.571

Note. *N* = 96, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.
***$p < 0.001$

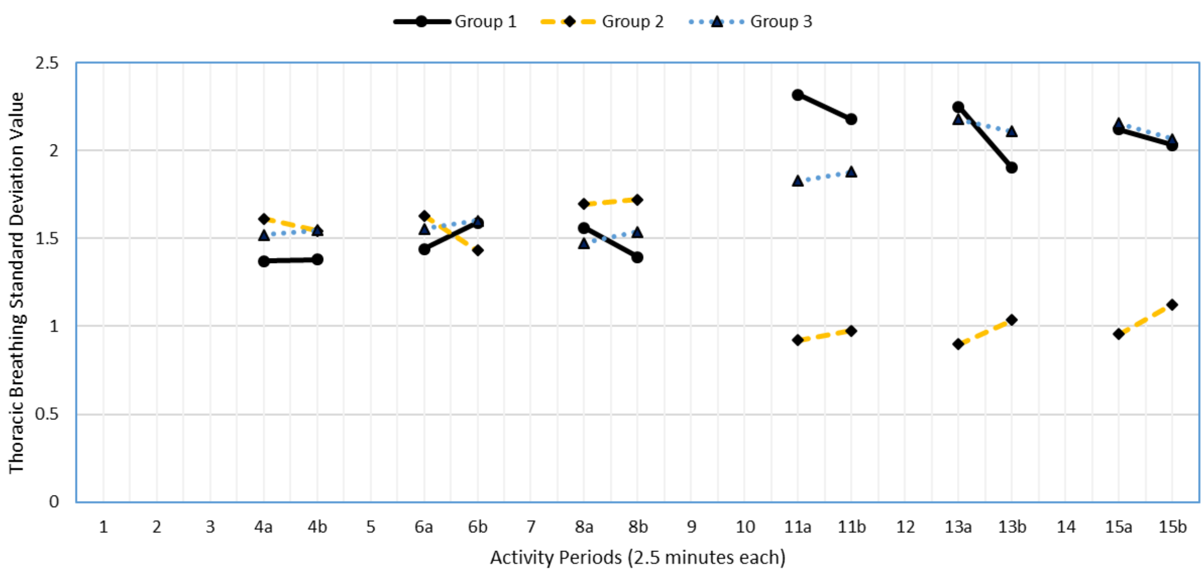


Figure 4.12. Mean thoracic breathing magnitude (thoracic *SD*)—periods of quiet sitting (Activities 4, 6, and 8) compared to periods of breathing activity (Activities 11, 13 and 15). Letters a and b designate the 2.5 minute first and second halves of the five-minute activity. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

When adding breathing activity exposure as a factor, there appears to be a statistically significant relationship ($p < 0.001$) between breathing activity exposure (intervention variable) and breath ratio (Br Ratio) with a magnitude of 0.620 (95% confidence interval: 0.406 to 0.835) when allowing for variability across individual breath ratio measures. This positive effect indicates that when comparing periods of quiet sitting and periods of breathing activity, breath ratio increases, which supports H1.3, H2.3, and H3.3. Calculating the reduction in variance estimate between this model and the null model for Br Ratio (14.225 - 13.779) / 14.225 = 0.031 indicates the addition of breathing activity exposure accounts for approximately 3% of the modeled variance for BrRatio. Comparison of unconditional and breathing activity exposure model for BrRatio is displayed in Table 4.42 and graphed BrRatio values are displayed in Figure 4.13. Reductions in deviance, AIC and BIC indicate a slightly improved model fit when adding breathing activity exposure to the model.

Table 4.42

H1-H3 Mean Breath Ratio Fixed and Random Effects Estimates—Unconditional Model Compared to Breathing Activity Exposure Model

Parameter	Unconditional (null) model	Breathing activity exposure model
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	-0.001 (0.427)	0.002 (0.427)
Breathing activity exposure		0.620*** (0.109)
Random		
Between participant estimated variance	14.225 (0.620)	13.779 (0.600)
Within participant estimated variance	16.347 (2.531)	16.380 (2.531)
Model fit		
-2*log likelihood (deviance)	6575.235	6552.729
AIC	6581.235	6560.729
BIC	6596.377	6580.926

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.
***$p < 0.001$

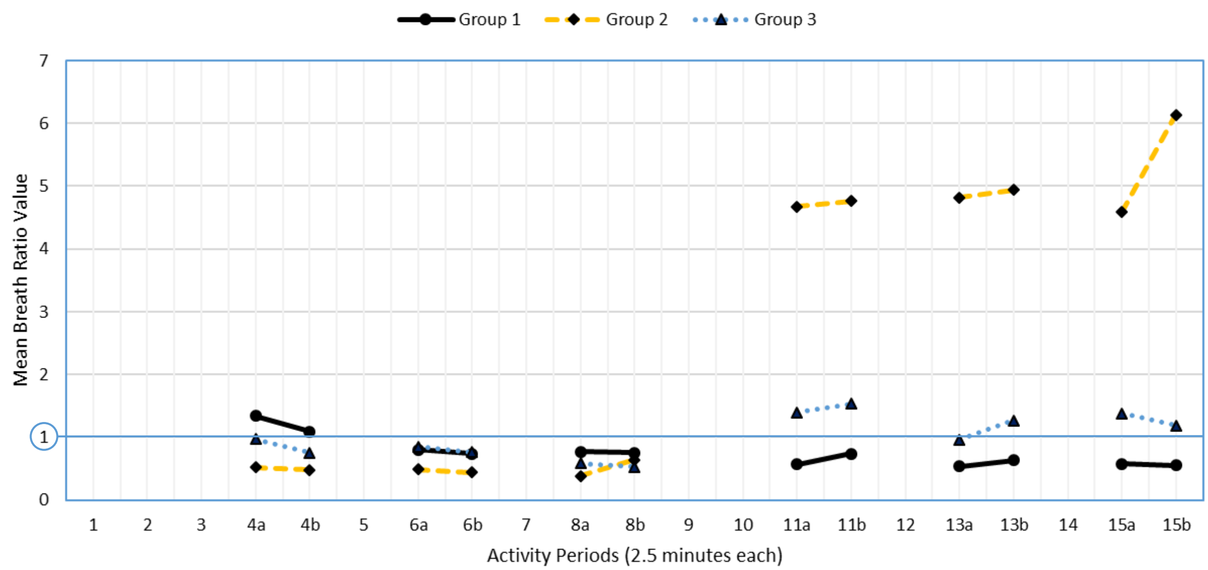


Figure 4.13. Mean breath ratio (BrRatio)—periods of quiet sitting (Activities 4, 6, and 8) compared to periods of breathing activity (Activities 11, 13 and 15)—participant 20 removed from graph results only. Letters a and b designate the 2.5 minute first and second halves of the five-minute activity. Values greater than one indicate abdominal breathing dominance. Group 1 = breath counting, Group 2 = abdominal breathing, Group 3 = breath counting abdominal breathing combined.

H1-H3 Group Covariate. The author investigated group membership as a covariate (Equation 3). Table 4.43 to Table 4.48 show the results of the group covariate investigation for the physiological signals. No covariation appeared when comparing the breath counting group (Group 1) with the other two groups. Comparing the abdominal breathing group (Group 2) with the other two groups only revealed statistically significant coavariation ($p < 0.05$) for heart rate (Table 4.44).

Table 4.43

H1-H3 Mean Value Skin Conductance Fixed and Random Effects Estimates—Breathing Activity Exposure Model Compared to Breathing Activity Exposure Model with Group Covariate

Parameter	Breathing activity exposure model	Breathing activity exposure model with group covariate
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.001 (0.218)	-0.001 (0.212)
Breathing activity exposure	-0.029 (0.023)	-0.029 (0.023)
Counting group		-0.028 (0.173)
Abdominal group		0.322 (0.173)
Random		
Between participant estimated variance	0.605 (0.026)	0.605 (0.026)
Within participant estimated variance	4.498 (0.656)	4.270 (0.624)
Model fit		
-2*log likelihood (deviance)	3121.791	3116.861
AIC	3129.791	3128.861
BIC	3149.988	3159.157

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.

Table 4.44

H1-H3 Mean Value Heart Rate Fixed and Random Effects Estimates—Breathing Activity Exposure Model Compared to Breathing Activity Exposure Model with Group Covariate

Parameter	Breathing activity exposure model	Breathing activity exposure model with group covariate
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.015 (0.996)	0.015 (0.966)
Breathing activity exposure	0.025 (0.107)	0.025 (0.107)
Counting group		-0.180 (0.788)
Abdominal group		1.590* (1.788)
Random		
Between participant estimated variance	13.204 (0.574)	13.203 (0.575)
Within participant estimated variance	94.206 (13.756)	88.512 (12.934)
Model fit		
-2*log likelihood (deviance)	6670.282	6664.368
AIC	6678.282	6676.368
BIC	6698.479	6706.663

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.
*$p < 0.05$

Table 4.45

H1-H3 Mean Value Respiratory Rate Fixed and Random Effects Estimates—Breathing Activity Exposure Model Compared to Breathing Activity Exposure Model with Group Covariate

Parameter	Breathing activity exposure model	Breathing activity exposure model with group covariate
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	-0.002 (0.299)	-0.002 (0.298)
Breathing activity exposure	-2.101 (0.067)	-2.101 (0.067)
Counting group		0.176 (0.243)
Abdominal group		-0.013 (0.243)
Random		
Between participant estimated variance	5.124 (0.223)	5.124 (0.223)
Within participant estimated variance	8.175 (1.242)	8.108 (1.232)
Model fit		
-2*log likelihood (deviance)	5439.721	5438.969
AIC	5447.721	5450.969
BIC	5467.918	5481.264

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.

Table 4.46

H1-H3 Mean Value Abdominal Breathing Magnitude: Fixed and Random Effects Estimates—Breathing Activity Exposure Model Compared to Breathing Activity Exposure Model with Group Covariate

Parameter	Breathing activity exposure model	Breathing activity exposure model with group covariate
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.000 (0.092)	0.000 (0.089)
Breathing activity exposure	0.449 (0.023)	-0.449 (0.023)
Counting group		-0.081 (0.073)
Abdominal group		0.092 (0.073)
Random		
Between participant estimated variance	0.588 (0.026)	0.588 (0.026)
Within participant estimated variance	0.755 (0.116)	0.711 (0.110)
Model fit		
-2*log likelihood (deviance)	2925.605	2920.108
AIC	2933.605	2932.108
BIC	2953.802	2962.403

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.

Table 4.47

H1-H3 Mean Value Thoracic Breathing Magnitude: Fixed and Random Effects Estimates—Breathing Activity Exposure Model Compared to Breathing Activity Exposure Model with Group Covariate

Parameter	Breathing activity exposure model	Breathing activity exposure model with group covariate
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	-0.001 (0.132)	-0.001 (0.130)
Breathing activity exposure	0.090 (0.026)	0.090 (0.026)
Counting group		0.001 (0.106)
Abdominal group		-0.163 (0.106)
Random		
Between participant estimated variance	0.772 (0.034)	0.772 (0.034)
Within participant estimated variance	1.616 (0.243)	1.562 (0.235)
Model fit		
-2*log likelihood (deviance)	3284.374	3281.243
AIC	3292.374	3293.243
BIC	3312.571	3323.539

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.

Table 4.48

H1-H3 Mean Value Breath Ratio Fixed and Random Effects Estimates—Breathing Activity Exposure Model Compared to Breathing Activity Exposure Model with Group Covariate

Parameter	Breathing activity exposure model	Breathing activity exposure model with group covariate
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.002 (0.427)	0.002 (0.421)
Breathing activity exposure	0.620 (0.109)	0.620 (0.109)
Counting group		0.283 (0.344)
Abdominal group		0.575 (0.344)
Random		
Between participant estimated variance	13.779 (0.600)	13.779 (0.510)
Within participant estimated variance	16.380 (2.531)	15.885 (2.459)
Model fit		
-2*log likelihood (deviance)	6552.729	6549.973
AIC	6560.729	6561.973
BIC	6580.926	6592.269

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.

H1-H3 Analytical Summary. There were statistically significant effects for the breathing physiological measures and breathing activity exposure for the selected activity periods. A statically significant effect only appeared for heart rate when comparing the abdominal breathing group to the other two groups. This evidence suggests that all three breathing activities (counting, abdominal breathing and combined breath counting and abdominal breathing) may have similar effects on breathing. It also suggests that the breathing activities have a positive effect, respiratory rate (decrease), abdominal breathing depth (increase) and breath ratio (increase). The breathing activities did not appear to have a positive effect on thoracic breathing magnitude (thoracic *SD*) based on a statistically significant increase in the depth of thoracic breathing. Group was not a significant factor in model variance, but a statistically significant covariation for heart rate emerged when comparing the Group 2 (abdominal breathing) to the other two groups.

H4 analysis—breathing activity exposure and Stroop activities. To examine if breathing activity exposure had an effect on participant breathing during subsequent Stroop activities, the author compared the 2.5-minute periods of Stroop activities before breathing activity exposure (3, 5, 7) with 2.5-minute periods of Stroop activities after breathing activity exposure (10, 12, 14) with each breathing physiological measure as an outcome (dependent) variable (Table 4.49).

Table 4.49

Experimental Activity Sequence Showing the 2.5-Minute Stroop Activities Analyzed to Examine H4

	Activity sequence number, 2.5-minute periods		
Stroop task (before)	3.	5.	7.
Stroop task (after)	10.	12.	14.

Unconditional model. Using the same approach for testing H1-H3, the author formed a two-level unconditional (null) model based on the data's nested structure: breathing measurements (Level 1) nested within participants (Level 2). The author applied the null model to each breathing measure and calculated the ICC for each level by dividing the variance estimate of each level by the total variance estimate.

Table 4.50

H4 Null Model Comparison Mean Respiratory rate

Level		Variance estimate	ICC
1		11.319***	
2		10.459***	0.480
	Total Estimated Variance:	21.778	

Note. ICC = Intraclass correlation coefficient
***$p < 0.001$

Table 4.50 shows the estimated variance between levels for mean respiratory rate. The ICC suggests that the proportion of variance for the two-level model is approximately 52% within individuals and 48% between individuals. Since the variance is statistically significant within individuals and between individuals, a two-level model is warranted for examining mean respiratory rate.

Table 4.51

H4 Null Model Comparison Mean Abdominal Breathing Magnitude

Level		Variance estimate	ICC
1		0.155***	
2		0.376***	0.709
	Total Estimated Variance:	0.531	

Note. ICC = Intraclass correlation coefficient
***p < 0.001

Table 4.51 shows the estimated variance between levels for mean abdominal breathing magnitude values (abdominal *SD*). The ICC suggests that the proportion of variance for the two-level model is approximately 29% within individuals and 71% between individuals. Since the variance is statistically significant within individuals and between individuals, a two-level model is warranted for examining mean abdominal breathing magnitude.

Table 4.52

H4 Null Model Comparison Mean Thoracic Breathing Magnitude

Level		Variance estimate	ICC
1		0.428***	
2		1.553***	0.784
	Total Estimated Variance:	1.981	

Note. ICC = Intraclass correlation coefficient
***$p < 0.001$

Table 4.52 shows the estimated variance between levels for mean thoracic breathing magnitude values. The ICC suggests that the proportion of variance for the two-level model is approximately 22% within individuals and 78% between individuals. Since the difference is statistically significant within individuals and between individuals, a two-level model is warranted for examining mean thoracic breathing magnitude.

Table 4.53

H4 Null Model Comparison Mean Breath Ratio

Level		Variance estimate	ICC
1		1.177***	
2		2.646***	0.692
	Total Estimated Variance:	3.824	

Note. ICC = Intraclass correlation coefficient
***$p < 0.001$

Table 4.53 shows the estimated variance between levels for mean breath ratio values. The ICC suggests that the proportion of variance for the two-level model is approximately 31% within individuals and 69% between individuals. Since the difference is statistically significant within individuals and between individuals, a two-level model is warranted for examining mean breath ratio.

H4 covariates. For the Stroop activity periods, the author examined breathing activity exposure as a fixed factor (Equation 2). The activity sequence number corresponded with the aforementioned 2.5-minute Stroop activities; three before and three after exposure to breathing activity. Results appear in Table 4.54 to Table 4.57. Reductions in deviance, AIC and BIC indicate an improved model fit when adding breathing activity exposure to the model for all measures except for thoracic breathing magnitude (thoracic *SD*).

Calculating the reduction in variance estimate between this model and the null model for respiratory rate (11.319 - 7.145) / 11.319 = 0.368 indicates adding breathing activity exposure to the model accounts for approximately 37% of the estimated variance. Calculating the reduction in variance estimate between this model and the null model for abdominal breathing magnitude (0.155 – 0.150) / 0.155 = 0.032 indicates adding breathing activity exposure to the model accounts for approximately 3% of the estimated variance. Calculating the reduction in variance estimate between this model and the null model for breath ratio (1.177 – 1.164) / 1.177 = 0.011

indicates adding breathing activity exposure to the model accounts for approximately 1% of the estimated variance.

Table 4.54

H4 Mean Respiratory Rate During Stroop Activity Periods Fixed and Random Effects Estimates—Unconditional Model Compared to Breathing Activity Exposure Model

Parameter	Unconditional (null) model	Breathing activity exposure model
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.000 (0.359)	0.000 (0.359)
Breathing activity exposure		-1.865*** (0.111)
Random		
Between participant estimated variance	11.319 (0.731)	7.145 (0.461)
Within participant estimated variance	10.459 (1.786)	11.154 (1.784)
Model fit		
-2*log likelihood (deviance)	3212.609	2991.804
AIC	3218.609	2999.804
BIC	3231.678	3017.228

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.
***$p < 0.001$

Table 4.55

H4 Stroop Activity Periods Mean Abdominal Breathing Magnitude: Fixed and Random Effects Estimates—Unconditional Model Compared to Breathing Activity Exposure Model

Parameter	Unconditional (null) model	Breathing activity exposure model
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.000 (0.63)	0.000 (0.065)
Breathing activity exposure		0.058*** (0.016)
Random		
Between participant estimated variance	0.155 (0.010)	0.150 (0.010)
Within participant estimated variance	0.376 (0.058)	0.377 (0.058)
Model fit		
-2*log likelihood (deviance)	822.967	810.105
AIC	828.967	818.105
BIC	842.036	835.529

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.
***$p < 0.001$

Table 4.56

H4 Stroop Activity Periods Mean Thoracic Breathing Magnitude: Fixed and Random Effects Estimates—Unconditional Model Compared to Breathing Activity Exposure Model

Parameter	Unconditional (null) model	Breathing activity exposure model
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.000 (0.130)	0.000 (0.130)
Breathing activity exposure		0.001 (0.027)
Random		
Between participant estimated variance	0.428 (0.028)	0.428 (0.028)
Within participant estimated variance	1.553 (0.235)	1.554 (0.235)
Model fit		
-2*log likelihood (deviance)	1445.455	1445.455
AIC	1451.455	1453.455
BIC	1464.524	1470.879

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.

Table 4.57

H4 Stroop Activity Periods Mean Breath Ratio Fixed and Random Effects Estimates—Unconditional Model Compared to Breathing Activity Exposure Model

Parameter	Unconditional (null) model	Breathing activity exposure model
Fixed	Coefficient (SE)	Coefficient (SE)
Intercept	0.00 (0.172)	0.000 (0.172)
Breathing activity exposure		0.107* (0.043)
Random		
Between participant estimated variance	1.177 (0.076)	1.164 (0.075)
Within participant estimated variance	2.646 (0.410)	2.649 (0.410)
Model fit		
-2*log likelihood (deviance)	1985.282	1979.614
AIC	1991.282	1987.614
BIC	2004.350	2005.038

Note. $N = 96$, *SE* = standard error, AIC = Akaike information criterion, and BIC = Bayesian information criterion. Lower deviance, AIC or BIC value indicates better fit than a model with a higher value on the respective index.
*$p < 0.05$

There appears to be a statistically significant ($p < 0.001$) relationship between respiratory rate and breathing activity exposure with a magnitude of -1.865 (95% confidence interval: -2.084 to -1.656) when allowing for variability across individual respiratory rate measures. This negative effect indicates when comparing Stroop activities before and after exposure to breathing activity, respiratory rate decreases. This result by itself could be viewed as a negative change in breathing, since concentrating on computer-based activities can cause reductions in breathing. Viewed in this manner, this would not support H4, however considering this result with positive changes in abdominal breathing magnitude (abdominal *SD*) and breath ratio, could indicate a positive change in breathing, which would support H4—exposure to breathing activities will cause a reduction in participant's breathing during subsequent computer-based activities.

There appears to be a statistically significant (p = 0.001) relationship between abdominal breathing magnitude (abdominal *SD*) and breathing activity exposure with a magnitude of 0.0058 (95% confidence interval: 0.027 to 0.090) when allowing for variability across individual abdominal *SD* measures. This positive effect indicates that abdominal breathing magnitude during Stroop activities increases after exposure to the breathing activity, which supports H4—exposure to breathing activities will cause a reduction in participant's breathing during subsequent computer-based activities.

There does not appear to be a statistically significant relationship between thoracic breathing magnitude (thoracic *SD*) and breathing activity exposure when allowing for variability across individual thoracic *SD* measures, which does not support H4—exposure to breathing activities will cause a reduction in participant's breathing during subsequent computer-based activities.

There appears to be a statistically significant ($p < 0.05$) relationship between breath ratio (BrRatio) and breathing activity exposure with a magnitude of 0.107 (95% confidence interval: 0.019 to 0.196) when allowing for variability across individual BrRatio measures. This positive effect indicates that when comparing Stroop activities before breathing activity exposure and Stroop activities after breathing activity exposure, BrRatio increases, indicating a positive change in breathing, which supports H4—exposure to breathing activities will cause a reduction in participant's breathing during subsequent computer-based activities.

The author investigated group membership as a covariate (Equation 3) and compared the breath counting group (Group 1) to the other two groups and the abdominal breathing group (Group 2) to the other two groups by creating two new variables with contrast codes (counting group: 2, -1, -1; abdominal group: -1, 2, -1). Subsequent analysis revealed no statistically significant effect between any of the breathing measures and group. This provisionally indicates that all three treatment groups (a) have no effect on or (b) have similar effects on participant breathing.

H4 analytical summary. When comparing the Stroop activity periods before and after breathing activity exposure, there were statistically significant effects for breathing activity exposure and the breathing measures of respiratory rate, abdominal breathing magnitude and breath ratio, which supports the hypothesis. There did not appear to be any statistically significant effect for breathing activity exposure and thoracic breathing magnitude, which does not support the hypothesis.

H5 analysis—stress score and breathing. The author examined potential correlation between participant stress score and each breathing physiological measure as outcome (dependent) variables for the pre-breathing activity exposure for the Stroop activities (Table 4.58, Activities 3, 5 and 7) and the periods of quiet sitting (Table 4.58, Activities 4, 6 and 8).

Table 4.58

Experimental activity sequence showing the 2.5-minute Stroop activities and the quiet sitting activities (before breathing activity exposure) analyzed to examine H5.

	Numbered activities, 2.5-minute periods								
Quiet sitting		4a.	4b.		6a.	6b.		8a.	8b.
Stroop task (before)	3.			5.			7.		

Note. a. activity first half, b. activity second half

Stroop activities before breathing activity exposure. Results of stress score compared to the breathing physiological measures for the Stroop activities before breathing activity exposure appear in Table 4.59 to Table 4.62.

There does not appear to be a correlation between stress score and respiratory rate (Table 4.59) based on the *r* value of 0.045 and a *p* value of 0.452. This does not support H5.1—there is a correlation between participant stress score and respiratory rate for activities before breathing activity exposure.

Table 4.59

Pre-Breathing Activity Stroop Tasks—No Correlation Between Stress Score and Respiratory rate

Variable	Mean	*SD*	1.	2.
1. Stress Score	31.140	7.470	1.000	
2. Respiratory rate	18.915	3.992	0.045	1.000

Note. *N* = 288
p = 0.452

There appears to be a negative correlation between stress score and abdominal breathing magnitude (Table 4.60) based on the *r* value of -0.151 and a *p* value of less than 0.05. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports H5.2—there is a correlation between participant stress score and abdominal breathing magnitude for activities before breathing activity exposure.

Table 4.60

Pre-Breathing Activity Stroop Tasks—Negative Correlation Between Stress Score and Abdominal Breathing Magnitude Value

Variable	Mean	*SD*	1.	2.
1. Stress Score	31.140	7.470	1.000	
2. Abdominal *SD*	0.417	0.682	-0.151*	1.000

Note. *N* = 288
*p < 0.05

There does not appear to be a correlation between stress score and thoracic breathing magnitude (Table 4.61) based on the *r* value of -0.100 and a *p* value of 0.091. This does not support H5.3—there is a correlation between participant stress score and thoracic breathing magnitude for activities before breathing activity exposure.

Table 4.61

Pre-Breathing Activity Stroop Tasks—No Correlation Between Stress Score and Thoracic Breathing Magnitude Value

Variable	Mean	*SD*	1.	2.
1. Stress Score	31.140	7.470	1.000	
2. Thoracic *SD*	1.417	1.425	-0.100	1.000

Note. $N = 288$
$p = 0.091$

There does not appear to be a correlation between stress score and BrRatio (Table 4.62) based on the *r* value of -0.093 and a *p* value of 0.115. This does not support H5.4—there is a correlation between participant stress score and breath ratio (BrRatio) for activities before breathing activity exposure.

Table 4.62

Pre-Breathing Activity Stroop Tasks—No Correlation Between Stress Score and Breath Ratio Value

Variable	Mean	*SD*	1.	2.
1. Stress Score	31.140	7.470	1.000	
2. Breath Ratio (BrRatio)	0.750	1.785	-0.093	1.000

Note. $N = 288$
$p = 0.115$

Quiet sitting activities before breathing activity exposure. The results of the correlation tests for stress score and the dependent physiological variables in the pre-breathing-activity conditions are displayed in Table 4.63 to Table 4.66. These correlation tests addressed whether participants' breathing measures during activities before being exposed to the breathing activity correlated with their existing stress levels.

There does not appear to be a correlation between stress score and respiratory rate (Table 4.63) based on the *r* value of 0.032 and a *p* value of 0.437. This does not support H5.1—there is a correlation between participant stress score and respiratory rate for activities before breathing activity exposure.

Table 4.63

Pre-Breathing Activity Quiet Sitting—No Correlation Between Stress Score and Respiratory rate

Variable	Mean	*SD*	1.	2.
1. Stress Score	31.140	7.470	1.000	
2. Respiratory rate	14.731	3.434	0.032	1.000

Note. $N = 576$
$p = 0.437$

There appears to be a negative correlation between stress score and abdominal breathing *SD* (Table 4.64) based on the *r* value of -0.151 and a *p* value of less than 0.01. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports H5.2—there is a correlation between participant stress score and abdominal breathing magnitude for activities before breathing activity exposure.

Table 4.64

Pre-Breathing Activity Quiet Sitting—Negative Correlation Between Stress Score and Abdominal Breathing Magnitude Value

Variable	Mean	*SD*	1.	2.
1. Stress Score	31.140	7.470	1.000	
2. Abdominal *SD*	0.476	0.609	-0.151**	1.000

Note. $N = 576$
$^{**}p < 0.01$

There does not appear to be a correlation between stress score and thoracic *SD* (Table 4.65) based on the *r* value of 0.003 and a *p* value of 0.941. This does not support H5.3—there is a correlation between participant stress score and thoracic breathing magnitude for activities before breathing activity exposure.

Table 4.65

Pre-Breathing Activity Quiet Sitting—No Correlation Between Stress Score and Thoracic Breathing Magnitude Value

Variable	Mean	*SD*	1.	2.
1. Stress Score	31.140	7.470	1.000	
2. Thoracic *SD*	1.533	1.465	0.003	1.000

Note. $N = 576$
$p = 0.941$

There does not appear to be a correlation between stress score and breath ratio (Table 4.66) based on the *r* value of -0.032 and a *p* value of 0.438. This does not support H5.4—there is a correlation between participant stress score and breath ratio for activities before breathing activity exposure.

Table 4.66

Pre-Breathing Activity Quiet Sitting—No Correlation Between Stress Score and Breath Ratio Value

Variable	Mean	*SD*	1.	2.
1. Stress Score	31.140	7.470	1.000	
2. Breath Ratio (BrRatio)	1.250	5.399	-0.032	1.000

Note. $N = 576$
$p = 0.438$

H5 analytical summary. When comparing Stroop and quiet sitting periods before breathing activity exposure, there only appears to be a statistically significant negative correlation between stress score and abdominal breathing magnitude: as stress scores decrease, abdominal breathing magnitude (abdominal *SD*) values increase. This evidence appears to support H5.2. There were no statistically significant correlations between stress score and respiratory rate, thoracic breathing magnitude (thoracic *SD*) nor breath ratio. This evidence does not appear to support H5.1, H5.3 and H5.4.

Questionnaire Analysis: H6-H12

Questionnaire response scoring. The questions in the first section of the post-activity questionnaire (Questionnaire 2) incorporated two stages. Yes, undecided, no response options followed by questions measuring participant perception of response strength: somewhat strongly, very strongly, and extremely strongly. The author then scored responses for these questions by combining both response parts (Table 4.67).

Table 4.67

Two Part Question Scoring

Part 1:	Yes			Undecided	No		
Part 2:	Extremely strongly	Very strongly	Somewhat strongly		Somewhat strongly	Very strongly	Extremely strongly
Score:	1	2	3	4	5	6	7

The author scored stage of change questions by combining the stage of change response with the seven-item confidence response (Table 3.2).

Table 4.68

Combined Stage of Change and Confidence Level Response Scoring

	Confidence level response choice						
Stage of Change Response Choice	Very confident	Confident	Somewhat confident	Undecided	Somewhat not confident	Not confident	Not at all confident
1. Yes, I have been for MORE than 6 months.	1	1.1	1.2	1.3	1.4	1.5	1.6
2. Yes, I have been for LESS than 6 months.	2	2.1	2.2	2.3	2.4	2.5	2.6
3. No, but I intend to in the next 30 days.	3	3.1	3.2	3.3	3.4	3.5	3.6
4. No, but I intend to in the next 31 days to 6 months.	4	4.1	4.2	3.4	4.4	4.5	4.6
5. No, and I do NOT intend to in the next 6 months.	5	5.1	5.2	3.5	5.4	5.5	5.6

Note. $N = 96$

H6 analysis—breath awareness future use and attitude

H6 correlation tests addressed whether participants' reported future use of breath awareness correlated with their attitude regarding breath awareness.

H6.1 results. Test results appear in Table 4.69. There appears to be a positive correlation between intended future use of breath awareness and perceived usefulness based on the r value of 0.489 and a p value of less than 0.01. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports the hypothesis.

Table 4.69

Correlation Between Intended Future Use of Breath Awareness and Perceived Usefulness

Variable	Mean	*SD*	1.	2.
1. Stage of Change Breath Awareness	2.74	1.42	1.000	
2. Perceived Usefulness	2.77	1.51	0.489**	1.000

Note. $N = 96$
**p < 0.01

H6.2 results. Test results appear in Table 4.70. There appears to be a positive correlation between intended future use of breath awareness and perceived time cost based on the *r* value of 0.346 and a *p* value of less than 0.01. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports the hypothesis.

Table 4.70

Correlation Between Intended Future Use of Breath Awareness and Perceived Time Cost

Variable	Mean	*SD*	1.	2.
1. Stage of Change Breath Awareness	2.74	1.42	1.000	
2. Perceived Time Cost	3.57	1.67	0.346**	1.000

Note. $N = 96$
**p < 0.01

H7 analysis—abdominal breathing future use and attitude

H7 correlation tests addressed whether participants reported future use of abdominal breathing correlated with their attitude regarding breathing activities.

H7.1 results. Test results appear in Table 4.71. There appears to be a positive correlation between intended future use of abdominal breathing and perceived usefulness based on the *r* value of 0.292 and a *p* value of less than 0.01. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports the hypothesis.

Table 4.71

Correlation Between Intended Future Use of Abdominal Breathing and Perceived Usefulness

Variable	Mean	*SD*	1.	2.
1. Stage of Change Abdominal Breathing	3.28	1.48	1.000	
2. Perceived Usefulness	2.81	1.43	0.292**	1.000

Note. N = 96
**p < 0.01

H7.2 results. Test results appear in Table 4.72. There does not appear to be a correlation between intended future use of abdominal breathing and perceived time cost based on the *r* value of 0.194 and a *p* value of 0.058. This does not support the hypothesis.

Table 4.72

No Correlation Between Intended Future Use of Abdominal Breathing and Perceived Time Cost

Variable	Mean	*SD*	1.	2.
1. Stage of Change Abdominal Breathing	3.28	1.48	1.000	
2. Perceived Time Cost	3.64	1.70	0.194	1.000

Note. N = 96
p = 0.058

H8 analysis—breath awareness future use and subjective norms

H8 correlation tests addressed whether participants' reported future use of breath awareness correlated with their perceived subjective norms regarding breath awareness.

H8.1 results. Test results appear in Table 4.73. There appears to be a positive correlation between intended future use of breath awareness and personal beliefs based on the *r* value of 0.501 and a *p* value of less than 0.01. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports the hypothesis.

Table 4.73

No Correlation Between Intended Future Use of Breath Awareness and Personal Beliefs

Variable	Mean	*SD*	1.	2.
1. Stage of Change Breath Awareness	2.74	1.42	1.000	
2. Personal Beliefs	3.31	1.51	0.501**	1.000

Note. $N = 96$
**$p < 0.01$

H8.2 results. Test results appear in Table 4.74. There does not appear to be a correlation between intended future use of breath awareness and perceived peer beliefs based on the *r* value of 0.156 and a *p* value of 0.130. This does not support the hypothesis.

Table 4.74

No Correlation Between Intended Future Use of Breath Awareness and Perceived Peer Beliefs

Variable	Mean	*SD*	1.	2.
1. Stage of Change Breath Awareness	2.74	1.42	1.000	
2. Perceived Peer Beliefs	4.60	1.21	0.156	1.000

Note. $N = 96$
$p = 0.130$

H8.3 results. Test results appear in Table 4.75. There initially appeared to be a positive correlation between intended future use of breath awareness and perceived family beliefs based on the *r* value of 0.208 and a *p* value of less than 0.05, however the significance of the correlation did not remain after the post-hoc Benjamini-Hochberg procedure. This does not support the hypothesis.

Table 4.75

Initial Correlation Between Intended Future Use of Breath Awareness and Perceived Family Beliefs

Variable	Mean	*SD*	1.	2.
1. Stage of Change Breath Awareness	2.74	1.42	1.000	
2. Perceived Family Beliefs	3.98	1.59	0.208*	1.000

Note. $N = 96$
*$p < 0.05$—This significance did not remain after the post-hoc Benjamini-Hochberg procedure.

H8.4 results. Test results appear in Table 4.76. There does not appear to be a correlation between intended future use of breath awareness and perceived cultural beliefs based on the *r* value of 0.197 and a *p* value of 0055. This does not support the hypothesis.

Table 4.76

No Correlation Between Intended Future Use of Breath Awareness and Perceived Cultural Beliefs

Variable	Mean	*SD*	1.	2.
1. Stage of Change Breath Awareness	2.74	1.42	1.000	
2. Perceived Cultural Beliefs	4.52	1.47	0.197	1.000

Note. $N = 96$
$p = 0.055$

H9 analysis—abdominal breathing future use and subjective norms

H9 correlation tests addressed whether participants' reported future use of abdominal breathing correlated with their perceived subjective norms regarding breathing activities.

H9.1 results. Test results appear in Table 4.77. There does not appear to be a correlation between intended future use of abdominal breathing and personal beliefs based on the *r* value of 0.168 and a *p* value of 0.102 This does not support the hypothesis.

Table 4.77

No Correlation Between Intended Future Use of Abdominal Breathing and Personal Beliefs

Variable	Mean	*SD*	1.	2.
1. Stage of Change Abdominal Breathing	3.28	1.48	1.000	
2. Personal Beliefs	3.21	1.57	0.168	1.000

Note. $N = 96$
$p = 0.102$

H9.2 results. Test results appear in Table 4.78. There does not appear to be a correlation between intended future use of abdominal breathing and perceived peer beliefs based on the *r* value of 0.128 and a *p* value of 0.214 This does not support the hypothesis.

Table 4.78

No Correlation Between Intended Future Use of Abdominal Breathing and Perceived Peer Beliefs

Variable	Mean	*SD*	1.	2.
1. Stage of Change Abdominal Breathing	3.28	1.48	1.000	
2. Perceived Peer Beliefs	4.63	1.30	0.128	1.000

Note. $N = 96$
$p = 0.214$

H9.3 results. Test results appear in Table 4.79. There does not appear to be a correlation between intended future use of abdominal breathing and perceived family beliefs based on the r value of 0.169 and a p value of 0.099 This does not support the hypothesis.

Table 4.79

No Correlation Between Intended Future Use of Abdominal Breathing and Perceived Family Beliefs

Variable	Mean	*SD*	1.	2.
1. Stage of Change Abdominal Breathing	3.28	1.48	1.000	
2. Perceived Family Beliefs	4.07	1.52	0.169	1.000

Note. $N = 96$
$p = 0.099$

H9.5 results. Test results appear in Table 4.80. There does not appear to be a correlation between intended future use of abdominal breathing and perceived cultural beliefs based on the r value of 0.166 and a p value of 0.107 This does not support the hypothesis.

Table 4.80

No Correlation Between Intended Future Use of Abdominal Breathing and Perceived Cultural Beliefs

Variable	Mean	*SD*	1.	2.
1. Stage of Change Abdominal Breathing	3.28	1.48	1.000	
2. Perceived Cultural Beliefs	4.39	1.59	0.166	1.000

Note. $N = 96$
$p = 0.107$

H10 analysis—breath awareness future use and control

H10 correlation tests addressed whether participants' reported future use of breath awareness correlated with their perceived behavioral control of breath awareness.

H10.1 results. Test results appear in Table 4.81. There does not appear to be a correlation between intended future use of breath awareness and breath awareness ability based on the *r* value of 0.060 and a *p* value of 0.560. This does not support the hypothesis.

Table 4.81

No Correlation Between Intended Future Use of Breath Awareness and Breath Awareness Ability

Variable	Mean	*SD*	1.	2.
1. Stage of Change Breath Awareness	2.74	1.42	1.000	
2. Breath Awareness Ability	2.35	0.79	0.060	1.000

Note. $N = 96$
$p = 0.560$

H10.2 results. Test results appear in Table 4.82. There appears to be a positive correlation between intended future use of breath awareness and perceived ease of use based on the *r* value of 0.390 and a *p* value of less than 0.01. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports the hypothesis.

Table 4.82

Correlation Between Intended Future Use of Breath Awareness and Perceived Ease of Use

Variable	Mean	*SD*	1.	2.
1. Stage of Change Breath Awareness	2.74	1.42	1.000	
2. Breath Awareness Ease of Use	2.65	1.21	0.390**	1.000

Note. $N = 96$
**$p < 0.01$

H 10.3 results. Test results appear in Table 4.83. There appears to be a positive correlation between intended future use of breath awareness and prior experience based on the *r* value of -0.499 and a *p* value of less than 0.01. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports the hypothesis.

Table 4.83

Correlation Between Intended Future Use of Breath Awareness and Prior Experience

Variable	Mean	*SD*	1.	2.
1. Stage of Change Breath Awareness	2.74	1.42	1.000	
2. Breath Awareness Prior Experience	0.58	0.50	-0.499**	1.000

Note. N = 96
**p < 0.01

H11 analysis—abdominal breathing future use and control

H11 correlation tests addressed whether participants' reported future use of abdominal breathing correlated with their perceived behavioral control of the breathing activity.

H 11.1 results. Test results appear in Table 4.84. There appears to be a positive correlation between intended future use of abdominal breathing and breathing activity ability based on the *r* value of 0.279 and a *p* value of less than 0.01. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports the hypothesis.

Table 4.84

Correlation Between Intended Future Use of Abdominal Breathing and Breathing Activity Ability

Variable	Mean	*SD*	1.	2.
1. Stage of Change Abdominal Breathing	3.28	1.48	1.000	
2. Breathing Activity Ability	2.14	0.94	0.279**	1.000

Note. N = 96
**p < 0.01

H11.2 results. Test results appear in Table 4.85. There appears to be a positive correlation between intended future use of abdominal breathing and perceived ease of use based on the *r* value of 0.282 and a *p* value of less than 0.01. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports the hypothesis.

Table 4.85

Correlation Between Intended Future Use of Abdominal Breathing and Perceived Ease of Use

Variable	Mean	*SD*	1.	2.
1. Stage of Change Abdominal Breathing	3.28	1.48	1.000	
2. Breathing Activity Ease of Use	2.91	1.54	0.282**	1.000

Note. $N = 96$
**p < 0.01

H11.3 results. Test results appear in Table 4.86. There appears to be a positive correlation between intended future use of abdominal breathing and prior experience based on the *r* value of -0.287 and a *p* value of less than 0.01. The significance of the correlation remained after the post-hoc Benjamini-Hochberg procedure. This supports the hypothesis.

Table 4.86

Correlation Between Intended Future Use of Abdominal Breathing and Prior Experience

Variable	Mean	*SD*	1.	2.
1. Stage of Change Abdominal Breathing	3.28	1.48	1.000	
2. Breathing Activity Prior Experience	0.57	0.50	-0.287**	1.000

Note. $N = 96$
**p < 0.01

H12 analysis—stress management future use and stress score

H12 correlation tests addressed whether participants' reported future use of stress management correlated with their stress score.

H12 results. Test results appear in Table 4.87. There appears to be a positive correlation between intended future use of stress management and stress score based on the *r* value of 0.259 and a *p* value of less than 0.05. This supports the hypothesis.

Table 4.87

Correlation Between Intended Future Use of Stress Management and Stress Score

Variable	Mean	*SD*	1.	2.
1. Stage of Change Stress Management	1.92	1.27	1.000	
2. Stress Score	31.14	7.50	0.259*	1.000

Note. $N = 96$
*p < 0.05

H13 analysis—Stroop activity

H13 correlation tests addressed whether aspects of participants' Stroop activity performance correlated with other selected variables in the study.

H13.1 results. Initially there appeared to be a negative correlation between Stroop mean response time for matching (same) stimuli and (a) breathing activity ease of use, ($r(94) = -0.243$, $p < 0.05$), (b) stage of change stress management without confidence score, ($r(94) = -0.211$, $p < 0.05$) and (c) stage of change stress management with confidence score, ($r(94) = -0.210$, $p < 0.05$). These correlations were eliminated via the post-hoc Benjamini-Hochberg procedure. Absence of statistically significant meaningful correlations supports the hypothesis.

H13.2 results. Initially there appeared to be a negative correlation between Stroop mean response time not matching and (a) breathing activity ease of use, ($r(94) = -0.207$, $p < 0.05$) and (b) breathing activity perceived time cost, ($r(94) = -0.234$, $p < 0.05$). These correlations were eliminated via the post-hoc Benjamini-Hochberg procedure. Absence of statistically significant meaningful correlations supports the hypothesis.

H13.3 results. Initially there appeared to be a negative correlation between Stroop mean correct total and (a) breathing activity ease of use, ($r(94) = -0.247$, $p < 0.05$), (b) breath awareness perceived time cost, ($r(94) = -0.208$, $p < 0.05$), (c) breathing activity perceived time cost, ($r(94) = -0.206$, $p < 0.05$) and (d) stage of change stress management without confidence score, ($r(94) = -0.205$, $p < 0.05$). These correlations were eliminated via the post-hoc Benjamini-Hochberg procedure. Absence of statistically significant meaningful correlations supports the hypothesis.

Chapter 5

Discussion and Conclusions

Findings Summary

This project had two objectives. First, to investigate if college students could use a five-minute breathing activity to regulate physiological responses caused by a computer mediated task. Second, to determine if there are any differences between the breathing activities on individual physiological responses for (a) breath counting, (a) abdominal breathing and (c) breath counting and abdominal breathing combined.

Study results suggest that college student use of a five-minute breathing activities can cause a change in some physiological responses induced by a computer use, but because the breathing activities seemed to have similar effects, additional information is required to determine the nuanced efficacy of each. The abdominal breathing activity seemed to have the greatest effect on heart rate, which is consistent with cardiopulmonary anatomy and physiology. Positive effects of all three breathing activities on the breathing measures of respiratory rate, abdominal breathing magnitude (abdominal *SD*) and breath ratio (BrRatio) are consistent with the breathing activities and indicate that the participants were able to successfully follow the instructions for the breathing activity protocol. There also appears to be a negative correlation between stress score and abdominal breathing magnitude when examining the periods before breathing activity exposure, meaning that higher stress scores generally accompany lower abdominal breathing magnitude. This evidence is consistent with existing studies that advocate abdominal breathing for stress management.

Study post-activity survey responses suggest that certain aspects of (a) attitude, (b) subjective norms and (c) behavioral control are related to an individual's planned future use of breath awareness and abdominal breathing activities. Survey responses also revealed that some participants already had experience with breath awareness and breathing activities and that many participants believed that their participation in the study was worthwhile.

This study contributes to the academic discourse related to stress management and university students by combining evidence from physiological measurements and survey responses to show the effectiveness of breath counting, abdominal breathing and combined breathing activity for stress management. A single, 2.5-minute breathing activity practice session is sufficient to enable an individual to successfully use subsequent five-minute periods of the same activity to mitigate physiological stress caused by a computer mediated task. The breathing activities in this study represent stress management strategies for students in contemporary college and university settings, yet abdominal breathing and breath counting remain fundamentally connected to the legacy the traditions in which these breathing activities originated.

Interpretation

H1-H3 discussion. Hypotheses 1 to 3 examined whether the three breathing activities had an effect on participant SC, HR, RR, Abdominal SD, Thoracic SD and BrRatio. Figure 5.1 shows a summary of results for each physiological measurement.

When considering exposure to breathing activity as a factor in the multilevel model for physiological signals when comparing periods of quiet sitting with periods of breathing activity the author found no evidence regarding reduction of skin conductance nor heart rate, so no evidence appeared to support of H1.1, H1.2, H2.1, H2.2, H3.1, and H3.2.

The only statistically significant differences in physiological measures emerged for breathing measures, supporting H1.3, H1.4, H2.3, H2.4, H3.3, and H3.4. However, when examining the modeled variance for each of the breathing measures, breathing activity exposure explained approximately (a) 48% of the modeled difference for respiratory rate, (b) 27% of the modeled difference for abdominal breathing magnitude (abdominal *SD*), (c) only 1.3% of the modeled difference for thoracic breathing magnitude (thoracic *SD*) and approximately 3% of modeled difference for breath ratio (BrRatio).

After adding group to the model as a covariate, the only statistically significant difference appeared for the abdominal breathing activity group and heart rate (HR). This difference suggests that the abdominal breathing activity has the greatest effect on heart rate when compared to the other two breathing activities. The absence of statistically significant differences for skin conductance, abdominal breathing magnitude, thoracic breathing magnitude and breath ratio indicates that the design of the study did not enable the author to detect statistically significant effect for these measures or that differences for these measures do not exist. It is also worthwhile to note the similar results for the three breathing activities could be due to the use of a combined breathing activity group (Group 3), in which participants performed both the breath counting and abdominal breathing activities, which were used separately by Group1 and Group 2—potentially reducing contrast between groups.

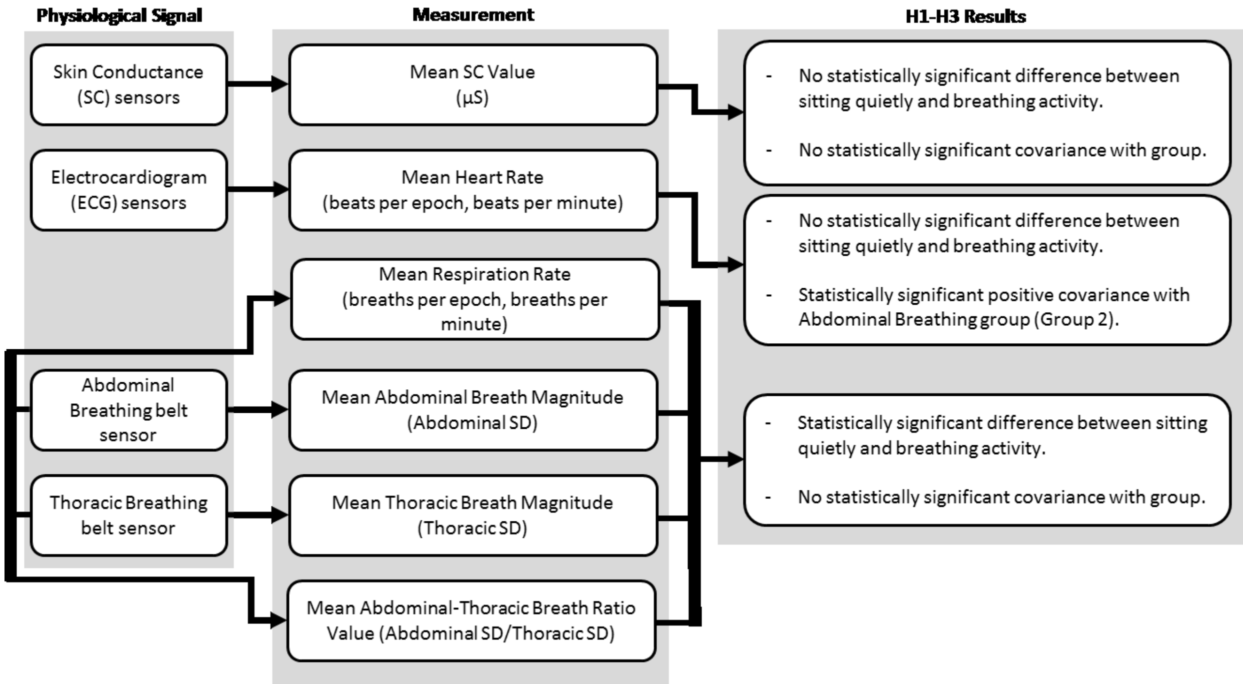


Figure 5.1. H1-H3 physiological measurement results summary.

H4 discussion. Hypothesis 4 pertained to whether exposure to breathing activities had an effect on participant RR, Abdominal SD, Thoracic SD and BrRatio for Stroop activities that occurred after the breathing activities. A summary of H4 findings are displayed in Figure 5.2.

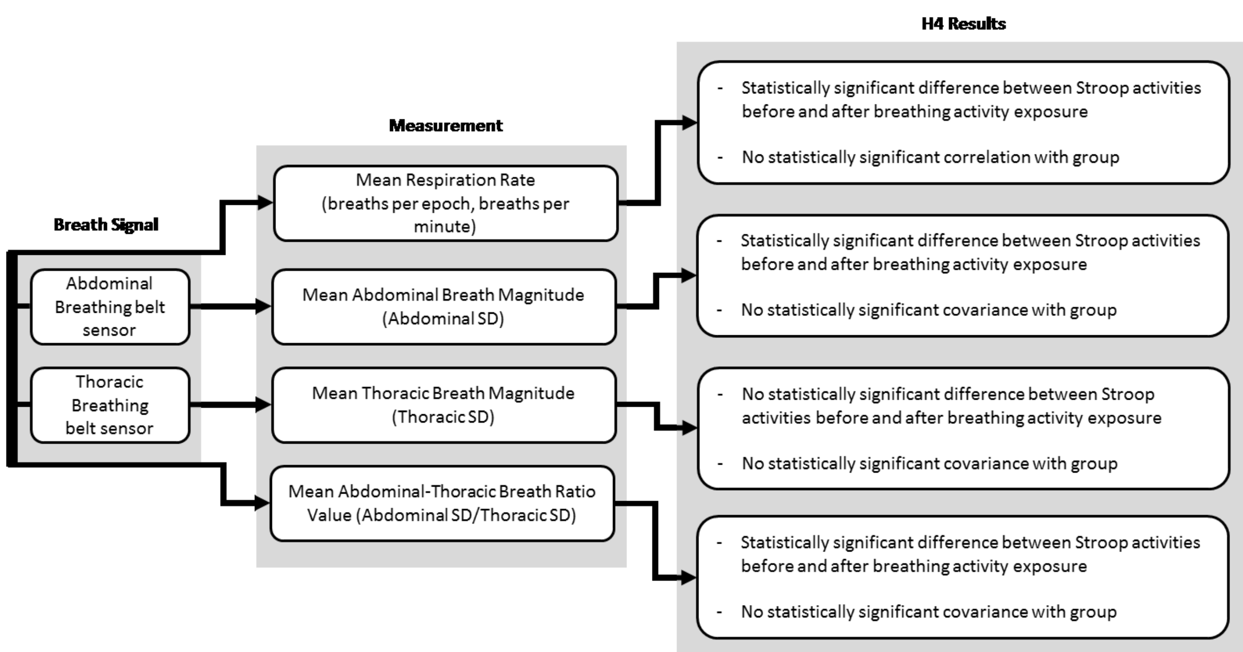


Figure 5.2. H4 measurement results summary.

When comparing the Stroop activity periods before and after breathing activity exposure, there were statistically significant effects for breathing activity exposure and the breathing measures of respiratory rate, abdominal breathing magnitude (abdominal *SD*) and breath ratio (BrRatio), which supports the hypothesis. There did not appear to be any statistically significant effects between breathing activity exposure and thoracic breathing magnitude (thoracic *SD*), which does not support the hypothesis.

When considered together, reductions in respiratory rate, increases in abdominal breathing magnitude and increases in breath ratio indicate an overall positive change in breathing. Absence of statistically significant change of thoracic breathing magnitude indicates that participant thoracic breathing magnitude was relatively consistent for all Stroop activities. If thoracic breathing magnitude remains consistent and abdominal breathing magnitude increases after breathing activity exposure, the calculated breath ratio will show subsequent movement towards abdominal breathing dominance, which could be viewed as supporting evidence for a positive change in breath ratio. Additionally, exposure to the abdominal breathing activity covaried with breath ratio, which indicates that exposure to the abdominal breathing activity has an effect on breath ratio for Stroop Activities after breathing activity exposure.

H5 discussion. For activities before the breathing activities, there only appeared to be a statistically significant negative correlation between stress score and abdominal breathing values, indicating that participants that had lower stress scores had higher abdominal breathing magnitude values (and vice versa). This evidence is consistent with existing studies that advocate abdominal breathing for stress management as well.

There were no other statistically significant correlations between stress score and respiratory rate measures. This indicates measurement and comparison of some respiration measures in this study were not sufficient to detect correlations between stress scores and respiratory rate, thoracic breathing magnitude, and breath ratio or that no correlations exist between these variables. It is also possible that participant stress levels were not high enough to invoke detectable physiological responses for these measures. It also may highlight a substantial difference between the constructs of stress scores calculated from participant survey responses and physiological stress. The 11-item stress questionnaire only asked if participants had experienced each of the 11 stressors within the last week, at the very beginning of the study. The study did not include post-activity stress measurement to detect any change in overall stress levels, but changes in overall stress may appear in a single, one-hour experimental session. Two participants disclosed recent, unprecedented stressors in their lives, but their physiological measurement recordings were not unique when compared to the recordings of the other participants.

H6 discussion. There appeared to be a positive correlation in participant responses when comparing breath awareness and perceived behavioral control. Specifically intended future use of breath awareness correlated with both perceived usefulness and perceived time cost. This indicates that if participants believed breath awareness to be useful, they were more likely to engage in or plan to engage in the activity of breath awareness. Likewise, it also indicates that if participants believed they had time to engage in breath awareness, they were more likely to engage in or plan to engage in the activity of breath awareness.

H7 discussion. There appeared to be a correlation between abdominal breathing and some aspects of perceived behavioral control. Specifically intended future use of abdominal breathing correlated with both perceived usefulness but not perceived time cost. This indicates that if participants believed abdominal breathing to be useful, they were more likely to engage in or plan to engage in the activity of abdominal breathing. It also indicates that time cost was not a factor in individual decisions to engage in or plan to engage in the activity of abdominal breathing

H8 discussion. There appeared to be a correlation between breath awareness and some aspects of perceived subjective norms. Specifically, intended future use of breath awareness correlated with both perceived personal beliefs, but not perceived family, peer and cultural beliefs. This indicates that if participants personally believed breath awareness was important, they were more likely to engage in or plan to engage in the activity of breath awareness. It also means that family, peer and cultural beliefs were not factors in individual decisions to engage in or plan to engage in the activity of breath awareness.

H9 discussion. There appeared to be no correlation between abdominal breathing and perceived subjective norms. Specifically, intended future use of abdominal breathing did not appear to be related to personal, peer, family nor cultural beliefs. It is possible that abdominal breathing is an activity that was not consistent with their personal, peer, family or cultural beliefs.

H10 discussion. There appeared to be a correlation between breath awareness and some aspects of perceived behavioral control. Specifically, intended future use of breath awareness correlated with both perceived ease of use and prior experience, but not individual ability. This indicates that if participants found the activity easy to do and/or had prior experience with the activity, they were more likely to engage in or plan to engage in the activity of breath awareness.

It could also mean that individual ability had no bearing on one's future plans to engage in breath awareness.

H11 discussion. There appeared to be a positive correlation in participant responses when comparing abdominal breathing and perceived behavioral control. Specifically, intended future use of abdominal breathing correlated with ability, ease of use and prior experience. This indicates participants are more likely to engage in (or plan to engage in) abdominal breathing if believed they were able to conduct abdominal breathing, believed it was easy to use and/or had experience with abdominal breathing.

H12 discussion. There appeared to be a positive correlation between participant stress score and stage of change for stress management. This indicates that participants with higher stress scores were more likely report engagement in or planned engagement in stress management activities. This could indicate a relatively high degree of participant stress awareness as well as a certain degree of participant stress management efficacy.

H13 discussion. There did not appear to be any statistically significant correlations between Stroop activity performance items and other selected variables in the study, which is consistent with the hypotheses. Some correlations initially appeared, but were eliminated via the post-hoc Benjamini-Hochberg procedure. Since analysis of the Stroop activity performance measures was not central to this project, future, more comprehensive analysis of these measures could be conducted in future studies.

Context

This study begins to address an apparent gap in the academic literature regarding college and university student use of breath counting and abdominal breathing by providing evidence regarding the efficacy of these activities for stress management. It augments existing work by applying more than one breathing activity, using additional physiological measures and applying the breathing activities for the goal of stress management. Additionally, it gathered participant views regarding intended future use of the breath awareness and abdominal breathin as well as perceived behavioral beliefs, subjective norms and behavioral control regarding these activities.

Breath counting. This study adds to the work of a number of studies that used abdominal breathing with college students (Forbes & Ronald J. Pekala, 1993; Jokerst et al., 1999; Kniffin et al., 2014; Paul et al., 2007; Pekala & Forbes, 1990; Sharma et al., 2014; Tloczynski & Tantriella, 1998; Turankar et al., 2013; Zunhammer et al., 2013) by investigating both breath counting and abdominal breathing.

Physiological measures. This study extends a number of studies that exclusively used self-report measures when studying breathing activities by college and university students (Paul et al., 2007; Pekala & Forbes, 1990; Sharma et al., 2014; Tloczynski & Tantriella, 1998) by combining the physiological measures of skin conductance, heart rate, respiratory rate, abdominal and thoracic breathing magnitude and breath ratio. It also complements a number of studies that used some of the same physiological measurements: (a) skin conductance (Turankar et al., 2013), (b) heart rate (Forbes & Ronald J. Pekala, 1993; Kniffin et al., 2014; Turankar et al., 2013), and (c) respiratory rate (Jokerst et al., 1999; Kniffin et al., 2014; Zunhammer et al., 2013).

Implications

This study provides provisional evidence that supports the idea that the breathing activities of breath counting and abdominal breathing may be useful for some college students to begin the process of establishing breath awareness and also for managing physiological stress elicited by a computer-mediated activity. This is based on the potential relationships between physiological measures and the breathing activities as well as the correlations found in the participant survey responses. The results of the physiological measurements provide initial evidence that supports the use of the three breathing activities for stress management. The survey responses provide unique insight about participant beliefs, values and existing experience with breath awareness and abdominal breathing, which can be used to inform future interventions.

Beyond the physiological and survey questions, perhaps some of the most compelling evidence regarding the perceived usefulness of the breathing activities with college students were 14 (of the 25) participant free-text responses at the end of the survey. Two participants specifically stated that they believed they learned something as a result of participating in the study, which supports Hornik's (2007) priming behavioral intervention based on the TPB. Simply put, exposure to breathing activities in a lab setting (designed to simulate an educational setting) can prime individuals to think about their own breathing behavior and potentially change future breathing behavior. The selected 15 responses to 'Please add any comments or recommendations that you would like to share' follow:

- I am glad I did this study at the end of the day as it gave me time to unwind and focus on myself. I learned more about my breathing pattern as well as some other aspects from the study. (Group 1)
- I never realized that I've done this before. Not abdominal breathing, but like to help focus my mind. I know breathing exercises help my state of mind but never thought about it in what I learned today. (Group 2)
- Great study! I'm more aware of my breathing habits now! (Group 1)
- The abdominal breathing made me tired (Group 2)
- It was great! (Group 3)

- Very well done and relaxing! I definitely felt better and less stressed after the study! (Group 2)
- Thank you! (Group 3)
- This study helped me focus on being aware of my body and breathing and just relaxing my mind to focus solely on the pattern of my breathing. (Group 1)
- Awesome study! The activities were intriguing. (Group 2)
- Great activity to know breathing habits as well. (Group 2)
- It was very interesting. When I was doing the color activity and counting my breaths, I realized that my breathing was different. (Group 1)
- I needed this. Mahalo. (Group 3)
- This research really helped me take the time to really focus on my breathing. (Group 1)
- This activity made me realize breathing exercise could be relaxing. (Group 2)

Study Limitations

Sample. This study had a relatively small in sample size of 96 participants, equating to only 32 participants per group. A greater number of participants would increase the power of statistical analysis and potentially capture more diverse responses. This limitation was due in part to the availability of lab hours and the semester duration. At least 15 potential participants were not able to enroll in the study because of appointment availability at semester end and may have participated if more appointments had been available. In the semester following data collection, at least three students made e-mail queries regarding appointment availability. This indicates continued student interest in the study and supports the possibility of future data collection involving a greater number of participants.

Closely related to the sample size was the location of the study. The results of this study were constrained by the geographical location and further limited by the classes from which the population was drawn. Due to the nature of the convenience sample, one can argue that not every student at the university had the same opportunity to participate; especially since the university has multiple campuses and university system has far more classes than the selected classes in which the study was promoted. This limitation could be addressed by conducting the study over multiple semesters, on multiple campuses and involving students from more university colleges and including more graduate students.

Selection bias may also have been a factor because it is possible that the study participants were ultimately students that had the time and resources to participate. Viewed from this perspective, one could argue that this study favored participations from students who lived on or near campus as well as students who with time in their schedules to allocate to participation. Students working part-time to finance school and/or with family obligations may not have been able to participate, even if they had been interested in the study. Students in these circumstances potentially have higher stress levels and including such students should be a goal of future research.

Study design. Aspects of the design impose limitations on the study. One could say that a 2.5-minute Stroop color-word task is not a realistic simulation of actual computer use in educational settings nor in academic tasks. This limitation can be addressed by varying the duration and types of computer activities.

Participants received extra credit for participating in the study (the one exception being a PhD student). As a result, one could say that the study only included participants who were motivated by extra credit. For the more academically challenging classes, one might posit that receipt of extra credit was a necessity for some and this shaped the population sample. One potential means of addressing this limitation would be to offer participants a choice of compensation options including cash and gift cards.

Another limitation of the study design is that the physiological measurements were too close together, increasing the possibility of autoregressive error. With the protocol lasting less than one hour and all physiological measures occurring within that time, it is possible that all measurements show a certain degree of similarity. A potential means of addressing this limitation would be to follow-up with participants that indicated they were willing to be recontacted regarding the study. The author could follow-up with these participants via survey or interview. Another way of addressing this shortcoming would be to form a longitudinal study in which participants completed the same protocol multiple times over an extended time period.

One analytical challenge in this study was the seemingly similar effects of breathing activities on individual physiological measures. This could be due to the similarity of the breathing activities, especially because the Group 3 activity combined the breathing activities of Groups 1 and 2. This could have caused any statistically significant differences between the groups to be obscured, making actual comparison of the groups challenging. This limitation could be addressed by omitting the combined breathing activity as well as adding a variety of other breathing activities to the study.

Study design did not consider individual suitability of breathing activities. It is possible that certain individuals may have realized greater benefits using breath counting instead of abdominal breathing (or vice versa) yet participants were randomly assigned breathing activities. If there was a way to determine which breathing activity is most suitable for an individual based on a personal attribute, one could explore the possibility of personalized treatments.

Stage of change. The three questions from the post-activity questionnaire (Questionnaire 2) regarding stage of change for stress management (Item 61), breath awareness (Item 63) and abdominal breathing (Item 65) should have been part of the pre-activity questionnaire (Questionnaire 1). Since participants answered these questions after being exposed to breathing activities, it is possible that activity exposure elicited more favorable responses from participants and therefore increased the possibility of measurement error due to priming.

Other variables. Several other variables could have influenced the results of this study, that should be taken into account in future studies. Within-subject design may have been sufficient to mitigate these variables, but the possibility exists that other variables might have impacted participant physiological measurements in some way.

The author did not collect data regarding participant use of caffeine, nicotine, or other medications/substances that could influence individual physiological response. One challenge to gathering this information is individual privacy, especially for medication or illicit substance use. Future studies could feasibly gather information regarding individual consumption of sugar, caffeine, nicotine and other substances within a specified time frame prior to starting the study protocol.

Additionally, the author did not record lab temperature, which could have had an overall effect on participant skin conductance measures. In future studies, researchers could manually record lab temperature from the lab thermostat at the beginning, middle and end of each session, use a digital thermometer integrated with the physiological measurement system.

Future Research.

Follow-up study. Since 89 of 96 participants (93%) indicated they were willing to be recontacted about the study, it is possible to conduct a follow-up study with the same participants. A follow-up study could examine behavior transfer and could involve forming a breathing activity interest group that meets on a weekly basis. Interest group activities could involve (a) practicing abdominal breathing, breath counting or other breath-related behaviors, (b) encouraging individual breathing activity practice through the use of worksheets and journaling activities and (c) sharing individual experiences and best practices. An interest group may also be an effective way to influence individual normative beliefs towards the behaviors related to the breathing activities.

Researchers could collect data from interest groups by conducting group and/or individual interviews, individual surveys, analysis of breath counting activity worksheets and/or journals. Research questions specifically related to behavior transfer for the three breathing activity conditions might include: (a) How do participants actually use breathing activities in their daily lives? (b) Which breathing activities do the participants find most beneficial? and (c) Which factors influence breathing behavior adoption? A potential drawback of this approach might be non-response bias measurement error. Since researchers would only gather data from respondents who agree to be recontacted, and actually participate in the interest group, no information is gained regarding participants who did agree to be recontacted or who chose not to participate in the study.

Repeated study. Future research could involve a replication of this study. Replication of the study could be completed by the author, but it would be better if other researchers conducted the study to eliminate any potential of expectancy bias. Future researchers could also improve the design by adding a double-blind procedure. Results of a replicated study could provide evidence that confirms or does not support the findings of this study.

Independent study. Based on the findings of this study, a new study related to examining the transfer abdominal breathing and breath counting might be conducted in a manner similar to Paul, Elam and Verhulst's (2007) longitudinal study. Abdominal breathing or breath counting activities could be integrated in one or more university course(s) by adding a five-minute breathing activity practice at the beginning or end of each class for one or more semesters. Researchers could administer questionnaires at the beginning and end of the semester to collect information about participants' impressions of the breathing activities. Research questions specifically related to behavior transfer for the three breathing activity conditions might include: (a) How does time influence breathing activity use? (b) Does regular breathing activity practice in class influence personal breathing activity practice? and (c) What are participant perceived benefits to long-term breathing activity use? A potential drawback of this approach might be social desirability response bias measurement error. If the breathing activities are integrated into each class for a particular course, some participants may feel compelled to participate and compelled to respond in a manner that is consistent with their perceptions of the study objectives.

Conclusion. This study contributes to the academic discourse advocating the study and use of breathing activities with students for stress management. It has yielded provisional evidence indicating five-minute periods of breath counting, abdominal breathing, and the combined activity of breath counting and abdominal breathing is effective for some college students to manage stress induced by a computer-mediated activity. Similar to other research endeavors, this study seems to raise more questions than answers, as alluded to in the recommendations for future research. Moving forward, it would be extremely useful to gain fidelity on tailoring breathing activities to individual student needs or to specific scenarios for greatest effect. It would also be beneficial to determine the specific factors related to learning and application of the breathing activities by college and university students to enable more efficient adaptation of these stress management behaviors. It will always be important for researchers to consider individual perspectives, values and goals when deigning activities intended to help students, and the author of this study strived to achieve this objective.

Appendix A
Questionnaire 1 (Pre-Activity)

[Feldt's 11-Item College Student Stress Scale]

1. For the following items, report how often each has occurred within the last week. [Radio buttons permit selection of only one response per row]

	never	rarely	sometimes	often	very often
I felt anxious or distressed about personal relationships	o	o	o	o	o
I felt anxious or distressed about family matters	o	o	o	o	o
I felt anxious or distressed about financial matters	o	o	o	o	o
I felt anxious or distressed about academic matters	o	o	o	o	o
I felt anxious or distressed about housing matters	o	o	o	o	o
I felt anxious or distressed about being away from home	o	o	o	o	o
I questioned my ability to handle difficulties in my life	o	o	o	o	o
I questioned my ability to attain my goals	o	o	o	o	o
I felt anxious or distressed about events not going as planned	o	o	o	o	o
I felt as though I was no longer in control of my life	o	o	o	o	o
I felt overwhelmed by difficulties in my life	o	o	o	o	o

Demographic Information

2. Please choose your age: [Age selection drop-down menu: 18-100]

3. Please indicate your gender [Radio buttons permit only one response.]

- o Male
- o Female
- o Other: [Text Response]

4. Please specify your blood type: [Radio buttons permit only one response.]

- A
- B
- O
- AB
- Unknown

5. Are you [Radio buttons permit only one response.]

- Right handed
- Left handed
- Ambidextrous

General Ethnic Background

6. Please choose the category that best describes you (you will be able to provide additional information in subsequent sections): [Radio buttons permit only one response.]

- Asian [Branches to question 7]
- Hawaiian or Pacific Islander [Branches to question 8]
- Other [Branches to question 9]

Ethnic Background: Asian

7. Please choose the category that best describes you: [Radio buttons permit only one response.]

- Chinese [Branches to question 16]
- Filipino [Branches to question 16]
- Indian (Asian Indian) [Branches to question 16]
- Japanese [Branches to question 16]
- Korean [Branches to question 16]
- Lao [Branches to question 16]
- Thai [Branches to question 16]
- Vietnamese [Branches to question 16]
- Mixed (please specify in next question) [Branches to question 10]

- Other (please specify in next question) [Branches to question 11]

Ethnic Background: Hawaiian or Pacific Islander

8. Please choose the category that best describes you: [Radio buttons permit only one response.]

- Guamanian or Chamorro [Branches to question 16]
- Native Hawaiian/Part Hawaiian [Branches to question 16]
- Micronesian [Branches to question 16]
- Samoan [Branches to question 16]
- Tongan [Branches to question 16]
- Mixed (please specify in next question) [Branches to question 12]
- Other (please specify in next question) [Branches to question 13]

Ethnic Background: Other

9. Please choose the category that best describes you: [Radio buttons permit only one response.]

- African-American/Black [Branches to question 16]
- American-Indian/Alaska Native [Branches to question 16]
- Caucasian/White [Branches to question 16]
- Hispanic [Branches to question 16]
- Mixed (please specify in next question) [Branches to question 14]
- Other (please specify in next question) [Branches to question 15]

Asian-Mixed: Please describe

10. (Asian - Mixed) please describe: [Free Text Response] [Branches to question 16]

Asian-Other: Please specify

11. (Asian - Other) Please specify: [Free Text Response] [Branches to question 16]

Hawaiian or Pacific Islander-Mixed: Please describe

12. (Hawaiian or Pacific Islander-Mixed) Please describe: [Free Text Response] [Branches to question 16]

Hawaiian or Pacific Islander-Other: Please specify

13. (Hawaiian or Pacific Islander-Other) Please specify: [Free Text Response] [Branches to question 16]

Other Ethnic Background-Mixed: Please specify

14. (Other ethnic background-mixed) Please specify: [Free Text Response] [Branches to question 16]

Other Ethnic Background-Other: Please describe

15. (Other ethnic background-other) Please describe: [Free Text Response] [Branches to question 16]

Academic Status

16. Please indicate your academic status:

- Freshman
- Sophomore
- Junior
- Senior
- Masters
- PhD
- Unclassified Post Baccalaureate
- Other: [Free Text Response]

17. Please indicate your Major or Course of Study [Free Text Response]

Appendix B
Questionnaire 2 (Post-Activity)

Breathing Awareness - Able?

1. Were you able to become aware of your breathing during this study? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 4.]
- o No [Branches to question 3.]

—Yes

(Were you able to become aware of your breathing during this study?)

2. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

  - o somewhat strongly
  - o very strongly
  - o extremely strongly [Branches to question 4.]

—No

(Were you able to become aware of your breathing during this study?)

3. How strongly do you feel about your NO response? [Radio buttons permit only one response.

  - o somewhat strongly
  - o very strongly
  - o extremely strongly

4. Breathing Awareness - Easy?

Was it easy for you to become aware of your breathing during this study? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 7.]
- o No [Branches to question 6.]

—Yes

(Was it easy for you to become aware of your breathing during this study?)

5. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 7.]

—No

(Was it easy for you to become aware of your breathing during this study?)

6. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Breathing Activity - Able?

7. Were you able to conduct the breathing activity during this study? [Radio buttons permit only one response.]

- Yes
- Undecided [Branches to question 10.]
- No [Branches to question 9.]

—Yes

(Were you able to conduct the breathing activity during this study?)

8. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 10.]

—No

(Were you able to conduct the breathing activity during this study?)

9. How strongly do you feel about your NO response? [Radio buttons permit selection of only one response]

- somewhat strongly
- very strongly
- extremely strongly

Breathing Activity - Easy?

10. Was it easy for you to conduct the breathing activity during this study? [Radio buttons permit only one response.]

- Yes
- Undecided [Branches to question 13.]
- No [Branches to question 12.]

—Yes

(Was it easy for you to conduct the breathing activity during this study?)

11. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 13.]

—No

(Was it easy for you to conduct the breathing activity during this study?)

12. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Personal Use - Awareness Useful?

Please mark the response that corresponds with your view:

13. Do you believe breath awareness is useful to you personally? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 16.]
- o No [Branches to question 15.]

—Yes

(Do you believe breath awareness is useful to you personally?)

14. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

  - o somewhat strongly
  - o very strongly
  - o extremely strongly [Branches to question 16.]

—No

(Do you believe breath awareness is useful to you personally?)

15. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

  - o somewhat strongly
  - o very strongly
  - o extremely strongly

Personal Use - Activities Useful?

Please mark the response that corresponds with your view:

16. Do you believe breathing activities are useful to you personally? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 19.]
- o No [Branches to question 18.]

—Yes

(Do you believe breathing activities are useful to you personally?)

17. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 19.]

—No

(Do you believe breathing activities are useful to you personally?)

18. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Personal Use - Aware Own Breathing?

Please mark the response that corresponds with your view:

19. Do you believe it is useful to be aware of your own breathing in your daily life? [Radio buttons permit only one response.]

- Yes
- Undecided [Branches to question 22.]
- No [Branches to question 21.]

—Yes

(Do you believe it is useful to be aware of your own breathing in your daily life?)

20. How strongly do you feel about your YES response? [Radio buttons permit selection of only one response]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 22.]

—No

(Do you believe it is useful to be aware of your own breathing in your daily life?)

21. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Personal Use—Aware Others Breathing?

22. Do you believe it is useful to be aware of the breathing of others in your daily life? [Radio buttons permit only one response.]

- Yes
- Undecided [Branches to question 25.]
- No [Branches to question 24.]

—Yes

(Do you believe it is useful to be aware of the breathing of others in your daily life?)

23. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 25.]

—No

(Do you believe it is useful to be aware of the breathing of others in your daily life?)

24. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Personal Use—Time Awareness?

Please mark the response that corresponds with your view:

25. Do you have time in your daily life to focus on breath awareness? [Radio buttons permit only one response.]

- Yes
- Undecided [Branches to question 28.]
- No [Branches to question 27.]

—Yes

(Do you have time in your daily life to focus on breath awareness?)

26. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 28.]

—No

(Do you have time in your daily life to focus on breath awareness?)

27. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Personal Use—Time Activities?

Please mark the response that corresponds with your view:

28. Do you have time in your daily life to focus on breathing activities? [Radio buttons permit only one response.]

- Yes
- Undecided [Branches to question 31.]
- No [Branches to question 30.]

—Yes

(Do you have time in your daily life to focus on breathing activities?)

29. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly [Branches to question 31.]

—No

(Do you have time in your daily life to focus on breathing activities?)

30. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly

Importance—Awareness—Personal?

31. Is breath awareness important to you personally? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 34.]
- o No [Branches to question 33.]

—Yes

(Is breath awareness important to you personally?)

32. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly [Branches to question 34.]

—No

(Is breath awareness important to you personally?)

33. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly

Importance—Awareness—Friends?

Please mark the response that corresponds with your view:

34. Is breath awareness important to your friends? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 37.]
- o No [Branches to question 36.]

—Yes

(Is breath awareness important to your friends?)

35. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly [Branches to question 37.]

—No

(Is breath awareness important to your friends?)

36. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly

Importance—Awareness—Family?

Please mark the response that corresponds with your view:

37. Is breath awareness important to your family? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 40.]
- o No [Branches to question 39.]

—Yes

(Is breath awareness important to your family?)

38. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly [Branches to question 40.]

—No

(Is breath awareness important to your family?)

39. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly

Importance—Awareness—Culture?

40. Is breath awareness important in your culture? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 43.]
- o No [Branches to question 42.]

—Yes

(Is breath awareness important in your culture?)

41. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly [Branches to question 43.]

—No

(Is breath awareness important in your culture?)

42. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly

Importance—Activities—Personal?

Please mark the response that corresponds with your view:

43. Are breathing activities important to you personally? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 46.]
- o No [Branches to question 45.]

—Yes

(Are breathing activities important to you personally?)

44. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly [Branches to question 46.]

—No

(Are breathing activities important to you personally?)

45. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Importance—Activities—Friends?

Please mark the response that corresponds with your view:

46. Are breathing activities important to your friends? [Radio buttons permit only one response.]

- Yes
- Undecided [Branches to question 49.]
- No [Branches to question 48.]

—Yes

(Are breathing activities important to your friends?)

47. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 49.]

—No

(Are breathing activities important to your friends?)

48. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Importance—Activities—Family?

49. Are breathing activities important to your family? [Radio buttons permit only one response.]

- Yes
- Undecided [Branches to question 52.]
- No [Branches to question 51.]

—Yes

(Are breathing activities important to your family?)

50. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 52.]

—No

(Are breathing activities important to your family?)

51. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Importance—Activities—Culture?

Please mark the response that corresponds with your view:

52. Are breathing activities important in your culture? [Radio buttons permit only one response.]

- Yes
- Undecided [Branches to question 55.]
- No [Branches to question 54.]

—Yes

(Are breathing activities important in your culture?)

53. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 55.]

—No

(Are breathing activities important in your culture?)

54. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Prior experience: Awareness—Own Breath

55. Prior to this study, did you have experience with awareness your own breath? [Radio buttons permit only one response.]

- Yes
- No [Branches to question 57.]

Experience—Own Breath Awareness

56. Please describe your previous experience with awareness of your own breathing: [Free Text Response]

Prior Experience: Awareness Others Breath

57. Prior to this study, did you have experience with awareness of others breathing? [Radio buttons permit only one response.]

- Yes
- No [Branches to question 59.]

Experience—Others Breath Awareness

58. Please describe your previous experience with awareness of others breathing: [Free Text Response]

Prior Experience: Breathing Activities

59. Prior to this study, did you have experience with breathing activities? [Radio buttons permit only one response.]

- o Yes
- o No [Branches to question 61.]

Experience—Breathing Activities

60. Please describe your previous experience with breathing activities: [Free Text Response]

Stage of Change—Stress Management

Stress management includes regular relaxation and physical activity, talking with others, and/or making time for social activities. [(Evers et al., 2006)]

61. Do you manage stress regularly according to this definition? [Radio buttons permit only one response.]

- o Yes, I have been for MORE than 6 months.
- o Yes, I have been for LESS than 6 months.
- o No, but I intend to in the next 30 days.
- o No, but I intend to in the next 31 days to 6 months.
- o No, and I do NOT intend to in the next 6 months.

Confidence—Stress Management

62. How confident are you about your previous response regarding stress management? [Radio buttons permit only one response.]

very confident	confident	somewhat confident	undecided	somewhat not confident	not confident	not at all confident
o	o	o	o	o	o	o

Stage of Change—Breath Awareness

Breath awareness is the regular act of being aware of or attending to one's breath including (but not limited to) noticing one's breathing, counting breaths and focusing on breath-related sensations. It is also known as attending to breath, awareness of breathing, breath attention, breath-focused attention, breath-focused awareness, breath-focused concentration, breath-focused meditation, focused breathing, meditation breath attention, mindful breathing, mindfulness of breathing.

63. Are you regularly aware of your breath according to this definition? [Radio buttons permit only one response.]

- o Yes, I have been for MORE than 6 months.
- o Yes, I have been for LESS than 6 months.
- o No, but I intend to in the next 30 days.
- o No, but I intend to in the next 31 days to 6 months.
- o No, and I do NOT intend to in the next 6 months.

Confidence—Breath Awareness

64. How confident are you about your last answer regarding breath awareness? [Radio buttons permit only one response.]

very confident	confident	somewhat confident	undecided	somewhat not confident	not confident	not at all confident
o	o	o	o	o	o	o

Stage of Change—Abdominal Breathing

Abdominal breathing is the regular act of slow and deliberate respiration in which one purposefully and fully moving the diaphragm down during inhalation and up during exhalation which results in moderate abdominal expansion and reduction of the during breathing. It is also known as diaphragmatic breathing, slow-deep breathing and belly breathing.

65. Do you regularly conduct abdominal breathing according to this definition? [Radio buttons permit only one response.]

- o Yes, I have been for MORE than 6 months.
- o Yes, I have been for LESS than 6 months.
- o No, but I intend to in the next 30 days.
- o No, but I intend to in the next 31 days to 6 months.
- o No, and I do NOT intend to in the next 6 months.

Confidence—Abdominal Breathing

66. How confident are you about your last answer regarding abdominal breathing? [Radio buttons permit only one response.]

very confident	confident	somewhat confident	undecided	somewhat not confident	not confident	not at all confident
o	o	o	o	o	o	o

Participation—Recommend?

Please mark the response that corresponds with your view:

67.Would you recommend that your friends participate in this study? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 70.]
- o No [Branches to question 69.]

—Yes

(Would you recommend that your friends participate in this study?)

68. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly [Branches to question 70.]

—No

(Would you recommend that your friends participate in this study?)

69. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly

Participation—Time Use?

Please mark the response that corresponds with your view:

70. Do you believe participating in this study was a good use of your time? [Radio buttons permit only one response.]

- o Yes
- o Undecided [Branches to question 73.]
- o No [Branches to question 72.]

—Yes

(Do you believe this study was a good use of your time?)

71. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- o somewhat strongly
- o very strongly
- o extremely strongly [Branches to question 73.]

—No

(Do you believe this study was a good use of your time?)

72. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Participation—Help Long Term?

Please mark the response that corresponds with your view:

73. Do you feel that participating in this study may help you personally for the long term? [Radio buttons permit only one response.]

- Yes
- Undecided [Branches to question 76.]
- No [Branches to question 75.]

—Yes

(Do you feel that participating in this study may help you personally for the long term?)

74. How strongly do you feel about your YES response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly [Branches to question 76.]

—No

(Do you feel that participating in this study may help you personally for the long term?)

75. How strongly do you feel about your NO response? [Radio buttons permit only one response.]

- somewhat strongly
- very strongly
- extremely strongly

Comments and Recommendations

76. Please add any comments or recommendations that you would like to share: [Free Text Response]

Appendix C
Literature Review Table

Study	Participants	Length	Activity Description	Activity Duration	Applicable Measure(s)	Effect
(Forbes & Pekala, 1993)	231 nursing students (age range not specified)	One session: unspecified length	Deep abdominal breathing	Periods of unspecified duration: three rounds practice and three rounds for measurement	Self-measured: skin temperature, pulse rate	"Deep abdominal breathing was associated with a significant reduction in physiological responsivity (skin temperature) relative to baseline" (p. 19)
(Jokerst et al., 1999)	46 undergraduate students ages 17-26	One 22-minute session	Slow deep breathing, counting breaths	Periods: six minute baseline; 16-minute event period	EGG, Breath rate and self-report of motion sickness symptoms	"Slow deep breathing prevented the onset of tachygastria and effectively reduced symptoms of vection-induced motion sickness" (p. 1191) Breath counting was not effective in this regard.
(Kniffin et al., 2014)	63 female undergraduate students, mean age 18.97	One one-hour session	Diaphragmatic breathing technique	Eight 12-minute role play scenario in which participants were to apply the exercise	Heart rate, heart rate variability, breath rate	"Participants in the breathing training condition had lower respiration rates [*sic*] and higher heart rate variability measures than those in the control condition" (p. 310)
(Paul et al., 2007)	64 post baccalaureate medical preparatory minority students (age range not specified)	Two 10-month periods (two academic years)	Deep breathing: instructor guided using script; one 10-minute session with biofeedback device	Five minutes prior to class, 99 sessions per academic year	Non-standardized self-reported perceptions	"Students reported having perceptions of decreased test anxiety, nervousness, self-doubt, and concentration loss, using the technique outside of the two classes, and believing it helped them academically and would help them as a physician." (p. 287)

Study	Participants	Length	Activity Description	Activity Duration	Applicable Measure(s)	Effect
(Pekala & Forbes, 1990)	246 nursing students (age range not specified)	One session: unspecified length	Deep abdominal breathing	Periods- unspecified duration: three rounds practice and three rounds for measurement	Self-report: Dimensions of Attention Questionnaire (DAQ)	"Deep abdominal breathing as a quick-and-easy strategy [helped] clients decrease vigilance and cognitive rumination and increase detachment from negative affect" (p. 42)
(Sharma et al., 2014)	84 university healthcare students ages 18-25	12 weeks	Fast and slow pranayama breathing: one-hour breathing techniques training before intervention	35 minutes a day, three times a week	Self-report: Perceived Stress Scale (PSS)	Statistically significant improvements in PSS scores
(Tloczynski & Tantriella, 1998)	75 undergraduate students ages 17-40	Six weeks	Deep breathing: one-hour training session followed by individual practice with written instructions	Self-determined: recommended at least 20 minutes daily (77% compliance)	Self-Reports: College Adjustment Scale (CAS), Taylor Manifest Anxiety Scale (TMAS)	“Anxiety and depression scores significantly decreased for the meditation and relaxation groups. Interpersonal problem scores also significantly decreased for the meditation group.” (p. 32)

Study	Participants	Length	Activity Description	Activity Duration	Applicable Measure(s)	Effect
(Turankar et al., 2013)	11 teaching staff and postgraduate residents ages 18-30	Seven days	Slow pranayama breathing techniques: instructor guided, Anuloma-Viloma pranayama with Kumbhak	Two 20-minute sessions each day	Pulse, galvanic skin response (GSR), blood pressure (BP) and pulmonary function: forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV1)	"An overall reduction in pulse rate was observed in all the eleven volunteers… Statistically significant changes were observed in the Pranayama group volunteers in the GSR values during standing phases indicating that regular practice of Pranayama causes a reduction in the sympathetic tone within a period as short as 7 days." (p. 916)
(Zunhammer et al., 2013)	19 undergraduate students ages 20.7–28.6	Four weeks	Paced deep slow breathing	One 60-minute session per week plus one training session	ECG, breath rate, end tidal respiratory CO_2, physiological pain perception protocol	"No significant differences in the effect of different slow-paced breathing frequencies on four variables on pain perception" (p. 846)

Appendix D
Lab Layout

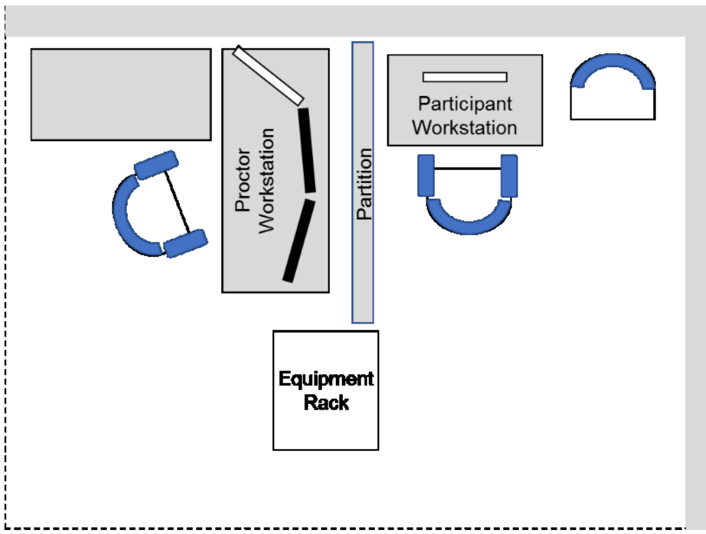


Figure D.1. Experimental area layout. The proctor and participant workstations are separated by a five-foot by five-foot fabric-covered office partition.

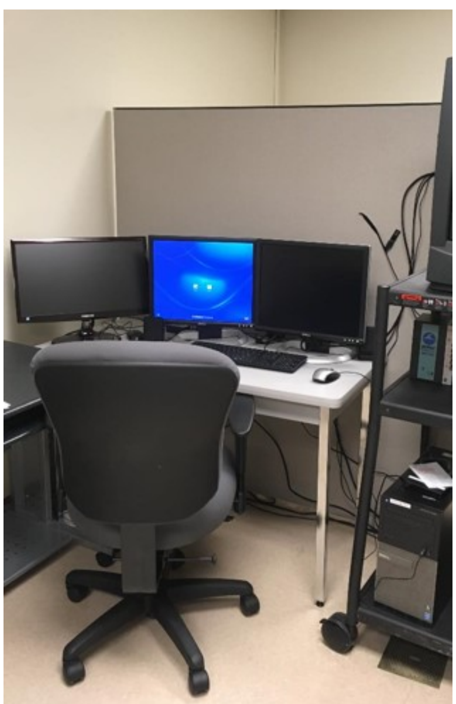


Figure D.2. Researcher workstation. Left-most computer monitor mirrors participant workstation screen.

Figure D.3. Participant workstation.

Appendix E
Informed Consent Form

University of Hawai'i
Consent to Participate in a Research Project
Dr. Randall Minas, Principal Investigator
Hubert Brumback Co-Investigator
Dissertation Study: Investigation of Breath Counting, Abdominal Breathing and Physiological Responses in Relation to Mental Load.
IRB Protocol Number 2017-00222

You are invited to take part in a research study designed explore how people respond to a demanding computer-based task after performing a breathing exercise. You were selected as a possible participant because you volunteered through class recruitment or responded to a study-related e-mail or flyer. Please read this form in its entirety and ask any questions you may have before agreeing to participate in this study.

Study participants must be healthy volunteers, age 18 or older, with normal color vision. If you are or may be pregnant, have been diagnosed with a chronic breathing disorder, are recovering from abdominal surgery, or presently have an abdominal injury, including hernia, you are asked not to participate in this study.

The study is being conducted by the co-investigator: Hubert Brumback, a PhD candidate at the University of Hawai'i at Mānoa in the Department of Educational Psychology. This is a PhD dissertation project study.

Time Commitment: Your participation will take no longer than 1.5 hours. The data collection is scheduled to take one hour and there is one-half hour scheduled for administrative tasks including sensor placement. You will be one of about 60 people in this study.

Study Procedures: During the entire experiment, we will be measuring how your body reacts. Specifically, we'll be measuring your skin conductance, heart rate, and breathing. To do this, we will put two small sensors on your foot, one on each of your forearms, as well as a belt sensor around your body across the chest and another around your body on the abdomen. Before putting the sensors on your forearms and foot we will cleanse the skin with a cotton pad saturated with rubbing alcohol and pumice. These pads are specifically designed to remove dead skin and assist in the measurement of your heart rate and skin conductance. The sensors on your foot and forearms are filled with a water-soluble gel that is hypoallergenic, non-staining, non-drying and non-corrosive. The belt sensors are applied over your clothes, and do require any gel or skin preparation.

If you agree to be in the study, you will complete the following tasks. First, you will complete a brief questionnaire. After the questionnaire, the sensors will be applied and you will complete Fifteen sequential activities, which, in total, will take approximately fifty minutes.

1.	2.	3.	4.	5.	6.	7.	8.
Sitting Quietly	Computer Task Rehearsal	Computer Task	Sitting Quietly	Computer Task	Sitting Quietly	Computer Task	Sitting Quietly
2.5 min	2.5 min	2.5 min	5 min	2.5 min	5 min	2.5 min	5 min

9.	10.	11.	12.	13.	14.	15.
Breathing Exercise Rehearsal	Computer Task	Breathing Exercise	Computer Task	Breathing Exercise	Computer Task	Breathing Exercise
2.5 min	2.5 min	5 min	2.5 min	5 min	2.5 min	5 min

(1) Sit quietly for 2.5 minutes

(2) You will then have 2.5 minutes to read instructions for a computer-based task and rehearse it.

(3) Complete the computer-based task again for 2.5 minutes.

(4) Sit quietly again for 5 minutes.

(5) Complete the computer-based task again for 2.5 minutes.

(6) Sit quietly again for 5 minutes.

(7) Complete the computer-based task again for 2.5 minutes.

(8) Sit quietly again for 5 minutes.

(9) You will be given instructions for a breathing exercise, which you will rehearse for 2.5 minutes.

(10) Complete the computer-based task again for 2.5 minutes.

(11) Conduct the breathing exercise for 5 minutes.

(12) Complete the computer-based task again for 2.5 minutes.

(13) Conduct the breathing exercise for another 5 minutes.

(14) Complete the computer-based task again for 2.5 minutes.

(15) Conduct the breathing exercise for another 5 minutes.

After you complete a final, brief questionnaire you will be debriefed, asked if you have any questions and released.

Risks: There is little risk to you in participating in this research project.

Placement of the sensors on your skin presents a very slight risk of electrical shock, but the sensor equipment has a history of safe use. This laboratory follows strict safety procedures. All equipment is inspected prior to each day of data collection.

There may be a small risk of redness of the skin or a rash where the sensors are placed. If this happens, it should not last long. But, if it is bothersome, you can use any cream or lotion to relieve the irritation. If the redness or rash persists, please consult with clinic personnel at the University Health Services 1710 East-West Rd, Honolulu, HI 96822, (808) 956-8965, https://www.hawaii.edu/shs/ or your personal doctor.

There is a slight possibility that the breathing exercises in this study could cause you to feel discomfort. While versions of these breathing exercises have a history of safe use, if you experience any pain, dizziness, shortness of breath or other discomfort while conducting the breathing exercise, please stop the exercise and inform the investigator immediately. If, after you have left the experiment, you experience any of the above, please consult with clinic personnel at the University Health Services 1710 East-West Rd, Honolulu, HI 96822, (808) 956-8965, https://www.hawaii.edu/shs/, your personal doctor, or call 911.

If you feel uncomfortable at any time during this experiment, you may discontinue your participation and still receive full compensation.

Benefits: The benefits to participation that one may reasonably expect are being exposed to breathing exercises that may have health benefits and well as getting an opportunity to become aware of and observe one's own breathing.

Privacy and Confidentiality: We have an unwavering commitment to your personal privacy. Study records containing your personal information are stored securely in a locked filing cabinet in a locked office. Study electronic data files from physiological not contain any personal identifying information and are stored on an encrypted, password protected media device, which is locked in a separate storage container in a locked office when not in use. Only the principal investigator and co-investigator will have access to the information. Other agencies that have legal permission have the right to review research records including the University of Hawaii Human Studies Program. Your name or personal identifying information will never be used in any reports or publications from this study. All findings from this study will be reported in a way that protects your privacy and confidentiality to the extent allowed by law.

We would also like to request that you maintain the confidentiality of this study by not disclosing the details of this study with other potential participants. We are happy to discuss this project with others so please refer us to anyone who is interested in the details of this endeavor.

Voluntary Participation: Your participation in this project is completely voluntary. You may stop participating at any time. If you end your participation before your session is complete, there will be no penalty or loss to you.

Compensation: You will receive extra credit for participating in this study. If you withdraw from the study prior to completion, you will still receive compensation.

Alternative: If you decide that you do not want to participate in this study but still would like to receive the potential benefits, a post-study information session will be scheduled after the data collection is complete. The information session will be an opportunity to experience the breathing exercises used in this study and will be an opportunity to learn about the study results.

Please inform the investigator if you would like us to contact you about the information session.

Questions: If you have any questions about this study, please e-mail the PhD candidate at brumback@hawaii.edu or contact the candidate's advisor, Dr. Marie Iding, at 808.956.7507 or miding@hawaii.edu. You may also contact the principal investigator, Dr. Randall Minas, at 808.956.7082 or rminas@hawaii.edu. You may contact the UH Human Studies Program at 808.956.5007 or uhirb@hawaii.edu to discuss problems, concerns and questions; obtain information; or offer input with an informed individual who is unaffiliated with the specific research protocol. Please visit https://www,hawaii.edu/researchcompliance/information-research-participants for more information on your rights as a research participant.

If you agree to participate in this project, please sign and date the following signature page and return it to the study investigators.

Keep this copy of the informed consent for your records and reference.

Signature(s) for Consent:

I give permission to join the research project titled, *Dissertation Study: Investigation of Breath Counting, Abdominal Breathing and Physiological Responses in Relation to Mental Load (IRB Protocol Number 2017-00222).*

Name of Participant (Print): ____

Participant's Signature: ____

Signature of the Person Obtaining Consent: ______________________________

Date: _________________________

☺

Thank You!

Appendix F
Stroop Interface Adopted From Yang (2005)[1]

The following instructions describe what to do once you have started the task:

- Focus your eyes on white dot that will appear in the middle of the gray rectangle at the bottom of the screen.
- When word-color combination appears, press the key corresponding to the **color of the font**, not the word itself (Color to Key).
- If you make an error, the combination will appear again later.
- After starting, you will have two minutes to complete this task.
- **It is important to complete this task as quickly and accurately as possible.**

Color to Key							
Red:	r	Green:	g	Yellow:	y	Blue:	b

When you are certain that you understand the instructions, click in the white rectangle. You will then be prompted to press the space bar, which starts the exercise:

[1] Yang's (2005) web interface is published online with a Creative Commons Attribution-NonCommercial-ShareAlike License.

Appendix G
Breath Counting Activity Worksheet

The proctor will inform you when to start and when the activity is finished (2.5 minutes for familiarization and 5 minutes for the actual activity). Please do not attempt this activity if you are injured or ill. If you feel dizzy or uncomfortable during this activity, please stop and inform the proctor.

I_S-Inhale Start **I_E**-Inhale End **E_S**-Exhale Start **E_E**-Exhale End

1. Sit up comfortably with your back straight and both feet on the floor.
2. Breathe Comfortably and focus your attention on your breathing.
3. When the time starts, mark the worksheet with the next breath event that occurs: inhale start, inhale end, exhale start, exhale end.
4. Continue to mark the worksheet with each subsequent breath event as it occurs: inhale start, inhale end, exhale start, exhale end.
5. Continue to breathe comfortably.

I_S	I_E	E_S	E_E/

The proctor will inform you when to start and when the activity is finished (2.5 minutes for familiarization and 5 minutes for the actual activity). Please do not attempt this activity if you are injured or ill. If you feel dizzy or uncomfortable during this activity, please stop and inform the proctor.

I_S-Inhale Start **I_E**-Inhale End **E_S**-Exhale Start **E_E**-Exhale End

I_S	I_E	E_S	E_E

I_S	I_E	E_S	E_E

I_S	I_E	E_S	E_E

Appendix H
Abdominal Breathing Activity Instructions

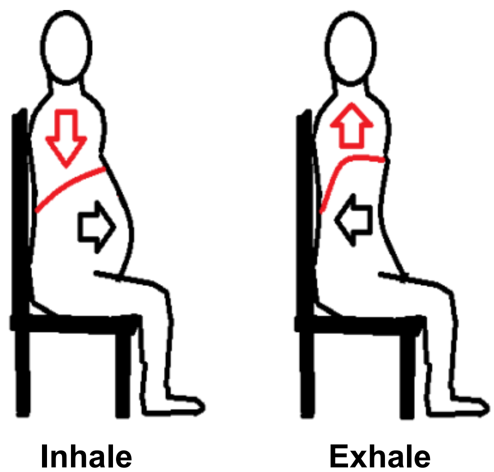
The proctor will inform you when to start and when the activity is finished (2.5 minutes for familiarization and 5 minutes for the actual activity). Please do not attempt this activity if you are injured or ill. If you feel dizzy or uncomfortable during this activity, please stop and inform the proctor.

1. Sit up comfortably with your back straight and both feet on the floor.

2. Place your dominant hand on the center of your chest and your other hand on the center of your abdomen.

3. Inhale slowly through your nose and permit your abdomen to expand as your diaphragm descends and your lungs fill; while at the same time keeping your chest and upper body as still as you can.

4. Exhale slowly through your nose and permit your abdomen to reduce and move toward your spine as your diaphragm rises and your lungs empty; while at the same time keeping your chest and upper body as still as you can.



5. Keep your eyes open and observe your abdomen as it moves.

6. Focus your attention on the sensations of breathing and when you notice that your mind has wandered, bring your attention back to your breathing sensations.

7. Continue to breathe slowly, deeply and comfortably.

Appendix I
Breath Experience Comments

Questionnaire 2, Question 56, free text responses: Please describe your previous experience with awareness of your own breathing.

- I notice that I can control the length of my breath, I can control to go through the lung or the abdomen. Especially right before sleeping.
- When I'm angry or crying, I'll try to control my breathing to calm myself down or relax myself. Try to gain control over myself.
- Shorter breaths in general with short exhales.
- Through vocal training and playing musical instruments.
- Focus breathing for sports, lifting weights at the gym, and relaxing.
- Take a Breath app on Apple Watch.
- Meditation, minute breathing, slow inhale and exhale to calm down.
- Problems with Anxiety/Panic Attacks. Got help for breathing exercises.
- Apple Watch takes account to how many breaths you take.
- Utilizing breathing guides on my Fitbit and following breathing to the timing provided.
- Meditation and exercises.
- Became very calm and felt Zen.
- Breathing exercises to relieve anxiety and for sleeping.
- Meditation, sports, music performance.
- Focused on breathing during past yoga classes.
- With my Apple Watch doing the daily Breathe exercises.
- When taking deep breaths, I am able to calm down when I am mad.

- Meditation.
- I like to be aware of how I'm breathing, especially when I'm playing sports, or running. I feel that it's very important to maintain a steady breath when jogging especially, to have a longer endurance.
- A little bit of meditation experience.
- When I am surfing or doing physical activities or under stress.
- Enrolled in meditation classes (at a mindfulness center) since middle school, and continue to practice every day.
- Controlling breathing during exercise.
- I use the meditation app "headspace" which teaches you to be aware of your breaths.
- Meditation exercises.
- Being athlete, we focus a lot on breathing. It can be when we are training, preparing for a race, or visualizing and meditating.
- Practiced yoga, meditation, mindfulness.
- Yoga, hiking, any sort of physical activity. When I am stressed, I focus on my breathing. When my mind is running, I try to take deep breaths to take away from my thoughts and control my mind.
- Consistent short breaths, with a deep breath every once in a while.
- Falling asleep - inhaling / exhaling for certain amounts of time.
- Meditation, and mindfulness in general.
- I have done yoga before and learned a few breathing exercises.
- Yoga and meditation.
- Meditation.

- My Apple Watch has a breathing app and it reminds me every day that I should try to breathe for at least 1 min and focus on my breathing.
- Coursework in previous master's program and daily practice.
- Lab study of breath in physiology as well as during workouts.
- Yoga, and playing the saxophone. I needed to constantly monitor my breath in both of these activities.
- Whenever I trying to fall asleep, I become very aware of my breathing.
- Just making sure to breathe when I'm stressed out or flustered. An example would be in sports or in the middle of an exam.
- Before, I had high blood pressure, and my doctors told me breathing helps lower anxiety and high blood pressure.
- With music your need to be aware of your breathing.
- When you are nervous and doing new things, talking to girls, public speaking.
- "Exercise/warmups."
- Voice lessons.
- For swimming and for band.
- Going to the gym and pacing breath when doing cardio or lifting weights.
- Apple Watch has a breathing app that helps you control your breathing for one minute.
- I just come to aware of my own breathing at random timings. But I was aware of how fast and how deep I breath.
- I breathe every second of my day like one day I've sat there and thought about it.
- My Apple Watch sends a reminder once in a while that gives us a reminder to breathe for a minute.

- I deal with anxiety, so I am able to recognize when I'm experiencing it the most through my breathing.
- Meditation, yoga, working out.
- My Dad would always tell me to do a specific stretch while I do specific breathing exercise to make sure that my lungs are good and healthy. I would also be trained a lot for swimming and learning how to breathe while I swim. I also would practice singing which I would learn when I could breathe and how fast I can breathe at that moment.
- Bikram Hot Yoga.
- Martial art training had a meditation session.

abdomen (1), about (1), account (1), activity (1), always (1), amounts (1), angry (1), any (1), art (1), athlete (1), attacks (1), away (1), band (1), became (1), become (1), being (1), bikram (1), bit (1), both (1), but (1), cardio (1), center (1), certain (1), come (1), consistent (1), constantly (1), continue (1), controlling (1), could (1), coursework (1), crying (1), dad (1), deal (1), doctors (1), done (1), endurance (1), enrolled (1), exam (1), example (1), exhale (1), exhales (1), exhaling (1), experience (1), experiencing (1), fall (1), falling (1), feel (1), felt (1), few (1), Fitbit (1), flustered (1), focused (1), following (1), from (1), gain (1), girls (1), gives (1), going (1), good (1), got (1), guides (1), headspace (1), healthy (1), help (1), hiking (1), hot (1), important (1), inhale (1), inhaling (1), instruments (1), I'll (1), I've (1), jogging (1), lab (1), learn (1), learned (1), learning (1), least (1), length (1), lessons (1), little (1), longer (1), lower (1), lung (1), lungs (1), mad (1), maintain (1), make (1), making (1), many (1), martial (1), master's (1), meditating (1), min (1), moment (1), monitor (1), most (1), musical (1), need (1), needed (1), nervous (1), new (1), notice (1), over (1), own (1), pacing (1), panic (1), past (1), performance (1), physiology (1), practiced (1), preparing (1), previous (1), problems (1), program (1), provided (1), public (1), race (1), random (1), recognize (1), relax (1), relaxing (1), relieve (1), reminds (1), right (1), sat (1), saxophone (1), school (1), second (1), sends (1), session (1), shorter (1), should (1), since (1), singing (1), slow (1), sort (1), speaking (1), steady (1), stress (1), stretch (1), study (1), surfing (1), swim (1), takes (1), taking (1), talking (1), teaches (1), tell (1), there (1), these (1), things (1), thought (1), thoughts (1), time (1), timing (1), timings (1), told (1), trained (1), trying (1), under (1), use (1), utilizing (1), visualizing (1), vocal (1), voice (1), warmups (1), was (1), well (1), whenever (1), working (1), workouts (1), Zen (1), able (2), activities (2), also (2), asleep (2), blood (2), classes (2), daily (2), fast (2), general (2), gym (2), had (2), has (2), have (2), helps (2), high (2), just (2), lifting (2), like (2), lot (2), middle (2), mind (2), music (2), once (2), one (2), out (2), physical (2), pressure (2), reminder (2), running (2), short (2), sleeping (2), specific (2), stressed (2), sure (2), swimming (2), weights (2), which (2), before (3), down (3), during (3), especially (3), exercise (3), mindfulness (3), minute (3), myself (3), playing (3), practice (3), through (3), training (3), very (3), anxiety (4), app (4), calm (4), can (4), day (4), deep (4), doing (4), every (4), focus (4), sports (4), take (4), try (4), while (4), you (4), your (4), would (5), apple (6), aware (6), breaths (6), control (6), exercises (6), how (6), watch (6), with (6), breathe (7), that (7), yoga (8), breath (9), for (11), meditation (14), when (14), breathing (23)

Figure I - 1. Experience, awareness own breathing—*Single word* frequencies identified using the Concordle-Ordered feature on the Condordle (2008) Website; omitted words: the, and, is, are.

Questionnaire 2, Question 58, free text responses: Please describe your previous experience with awareness of others' breathing.

- One of my pet peeves is when people breathe loud and obnoxiously!
- Breathing and Meditation apps.
- Body language.

- I notice when people are nervous or scared (anxiety) their breaths become shorter. For example, when students give presentations in class or in a crowded elevator.
- When they are doing physical activities or stressed.
- When people inhale loud its noticeable.
- As an academic advisor at work when speaking with students who are anxious. And particularly now with my dad who has had surgery less than a month ago.
- I can tell sometimes when a person is sick or is having difficulty breathing based on the sound of their breath.
- A while ago my boyfriend would gasp for air sometimes and he would tell me he forgot to breathe but he has not done it in a while so it leads me to believe that he had a hard time breathing when we would go over the Pali.
- See people getting nervous and breathing heavy.
- Meditation.
- For band it is important to breathe at the right times so you notice when someone doesn't.
- My girlfriend meditates in order to relieve stress.
- Sometimes people breathe too deep or say strong, I will notice it.
- A friend told me to download the CALM app, and said it helped with his anxiety. But did I keep up with the app, no lol.

academic (1), activities (1), advisor (1), air (1), anxious (1), apps (1), band (1), based (1), become (1), believe (1), body (1), boyfriend (1), breathe (1), breaths (1), calm (1), can (1), class (1), crowded (1), dad (1), deep (1), did (1), difficulty (1), doesn't (1), doing (1), done (1), download (1), elevator (1), example (1), forgot (1), friend (1), gasp (1), getting (1), girlfriend (1), give (1), hard (1), having (1), heavy (1), helped (1), his (1), important (1), inhale (1), its (1), keep (1), language (1), leads (1), less (1), lol (1), meditates (1), month (1), not (1), noticeable (1), now (1), obnoxiously (1), one (1), order (1), over (1), Pali (1), particularly (1), peeves (1), person (1), pet (1), physical (1), presentations (1), relieve (1), right (1), said (1), say (1), scared (1), see (1), shorter (1), sick (1), someone (1), sound (1), speaking (1), stress (1), stressed (1), strong (1), surgery (1), than (1), that (1), they (1), time (1), times (1), told (1), too (1), will (1), work (1), you (1), ago (2), anxiety (2), app (2), but (2), had (2), has (2), loud (2), meditation (2), nervous (2), students (2), tell (2), their (2), while (2), who (2), for (3), notice (3), sometimes (3), would (3), breath (4), breathing (4), with (4), people (5), when (9)

Figure I - 2. Experience, awareness others' breathing—*Single word* frequencies identified using the Concordle-Ordered feature on the Condordle (2008) Website; omitted words: the, and, is, are.

Questionnaire 2, Question 60: Please describe your previous experience with breathing activities:

- Yoga - it was meditative.
- My classmates are doing presentation about breathing activity.
- I read an article about a breathing exercise to help with falling asleep.
- Breathing exercises done before playing a musical instrument or singing and breathing done through yoga.
- With sports, gym, relaxing.
- Apple Watch application.
- App that lets you breathe (iWatch3), meditation.
- Anxiety/Panic Attacks. Got help for breathing.
- In secondary school, we learned a number of mindful breathing exercises
- Cross country/track practicing breathe exercises.
- During hot yoga, the instructor informs the students to be aware of their breathing techniques in order for our mind to be centered in our environment.

- Cardio exercise.
- Going to yoga and practicing Buddhism with my Grandma.
- Breathing activities for anxiety and sleeping.
- Same.

  (*Note.* This participant was in Group 3—combined breathing activity an may be referring to abdominal breathing and/or breath counting.)
- During yoga classes.
- 4 Deep exhales and inhales to calm.
- In wrestling in high school we would practice them before meets.
- Meditation.
- We had to do breathing exercises to help with lung capacity for swimming.
- During meditation.
- Sports physical activities, how to deal with stress.
- So many different methods to focus on breathe, best is meditation in my mind.
- Swimming in high school I learned to use minimal amounts of breaths while swimming, because when you breathe you slow yourself down.
- Smart watch sets daily breathing goals.
- I use breathing activities when I am stressed or overwhelmed.
- Meditation exercises.
- Focusing on breathing during meditation.
- Yoga, meditation, calm anxiety.
- Exercising; at the doctors.
- I had learned about belly breathing before.

- Yoga activities.
- Yoga and meditation.
- The breathing app on my Apple Watch reminds me that I should breathe for at least 1 min a day to help with mindfulness.
- Practice mindfulness mediation. focus on deep breathing alone and with my daughter, Father, Mom.
- Lab study of breath in physiology as well as controlling my breathing during workouts.
- Meditating, and breathing exercises for playing the saxophone.
- Breathing exercises during choir class.
- Yoga, meditation.
- When I was learning how to swim, they put a lot of focus on learning to breathe properly.
- Taking deep breaths after exercise to lower my heart rate.
- I took a drama/acting class and the professor always made us do breathing exercises before class for our voice.
- I had to do breathing activities for band in high school to try to get fast and focused air into my instrument.
- I learned that I had to count to three when breathed to help relax me.
- Playing music requires you to practice your breathing.
- Meditation.
- Breath control along with vocal warm-ups.
- Swimming for keeping a pace while you swim you breathe on specific intervals. For band practicing abdominal breathing in order to produce better sound.
- Acting/theater classes taken in high school.

- Meditating in class and my Apple Watch.
- I have been trying to convince myself to meditate, but the most I do is breathe to telling myself different attributes I want to be in the shower daily.
- Yoga, working out, meditation.
- Stretching and doing a specific breathe ins and outs, swimming, and singing.
- Deep breathing activities in yoga.
- Martial art training had a meditation session where we had to breathe in a specific way.

after (1), air (1), alone (1), along (1), always (1), amounts (1), application (1), art (1), article (1), asleep (1), attacks (1), attributes (1), aware (1), because (1), been (1), belly (1), best (1), better (1), breathed (1), Buddhism (1), but (1), capacity (1), cardio (1), centered (1), choir (1), classmates (1), combined (1), control (1), controlling (1), convince (1), count (1), counting (1), country (1), cross (1), daughter (1), day (1), deal (1), doctors (1), down (1), drama (1), environment (1), exercising (1), exhales (1), falling (1), fast (1), father (1), focused (1), focusing (1), get (1), goals (1), going (1), got (1), grandma (1), group (1), gym (1), have (1), heart (1), hot (1), informs (1), inhales (1), ins (1), instructor (1), intervals (1), into (1), iWatch3 (1), keeping (1), lab (1), least (1), lets (1), lot (1), lower (1), lung (1), made (1), many (1), martial (1), may (1), mediation (1), meditate (1), meditative (1), meets (1), methods (1), min (1), mindful (1), minimal (1), mom (1), most (1), music (1), musical (1), number (1), out (1), outs (1), overwhelmed (1), pace (1), panic (1), participant (1), physical (1), physiology (1), presentation (1), produce (1), professor (1), properly (1), put (1), rate (1), read (1), referring (1), relax (1), relaxing (1), reminds (1), requires (1), same (1), saxophone (1), secondary (1), session (1), sets (1), should (1), shower (1), sleeping (1), slow (1), smart (1), sound (1), stress (1), stressed (1), stretching (1), students (1), study (1), taken (1), taking (1), techniques (1), telling (1), theater (1), their (1), them (1), they (1), this (1), through (1), took (1), track (1), training (1), try (1), trying (1), ups (1), vocal (1), voice (1), want (1), warm (1), way (1), well (1), where (1), working (1), workouts (1), would (1), wrestling (1), your (1), yourself (1), abdominal (2), acting (2), activity (2), app (2), band (2), breaths (2), calm (2), classes (2), daily (2), different (2), doing (2), done (2), how (2), instrument (2), learning (2), meditating (2), mind (2), mindfulness (2), myself (2), order (2), singing (2), sports (2), swim (2), three (2), use (2), while (2), about (3), anxiety (3), apple (3), exercise (3), focus (3), our (3), playing (3), practice (3), practicing (3), specific (3), that (3), was (3), before (4), class (4), deep (4), high (4), learned (4), watch (4), when (4), help (5), school (5), swimming (5), activities (6), breath (6), during (6), had (6), you (6), breathe (7), exercises (8), with (8), for (10), yoga (11), meditation (12), breathing (25)

Figure I - 3. Experience, breathing activities—Single word frequencies identified using the Concordle-Ordered feature on the Condordle (2008) Website; omitted words: the, and, is, are.

Appendix J
Final Comments and Recommendations

Questionnaire 2, Question 76, free text responses. Please add any comments or recommendations that you would like to share:

- I am glad I did this study at the end of the day as it gave me time to unwind and focus on myself. I learned more about my breathing pattern as well as some other aspects from the study.
- I never realized that I've done this before. Not abdominal breathing, but like to help focus my mind. I know breathing exercises help my state of mind but never thought about it in what I learned today.
- Great study! I'm more aware of my breathing habits now!
- Outside noises can interfere with thinking and the temperature could possibly affect the test subject. The beginning questions can bring up memories for the test subject which may alter or affect the study unless it's intended to do so. Is this test done with traumatized people or people who are experiencing depression? Just wondering.
- Perhaps getting a silent mouse for the conductor. The occasionally clicking is an outside factor for an otherwise controlled situation.
- Personally, I've struggled with abdominal breathing (I learned it in elementary school through choir) but have found that I manage stress better when I breathe with my chest and am able to exhale and collapse my chest, helping the stress relief. I do understand the random assignment of breathing exercise and enjoy the time to be mindful about my breathing.
- The computer exercise was fun.

- The abdominal breathing made me tired.
- Very clear instructions and setup.
- It was great!
- Very well done and relaxing! I definitely felt better and less stressed after the study!
- Thank you!
- This study helped me focus on being aware of my body and breathing and just relaxing my mind to focus solely on the pattern of my breathing.
- Awesome study! The activities were intriguing.
- This study was not bad and I didn’t mind completing it.
- Digital recording for the breath counting activity.
- I’m sure practice effect had an impact especially as I was unaware the first two rounds that I was incorrectly pressing keys other than r.
- Study is well organized, and easily understood.
- It was well put together.
- Great activity to know breathing habits as well.
- It was very interesting. When I was doing the color activity and counting my breaths, I realized that my breathing was different.
- Use a game controller for the color exercise, only because pressing the different letters felt uncomfortable because they are placed in different locations.
- I needed this. Mahalo.
- This research really helped me take the time to really focus on my breathing.
- This activity made me realize breathing exercise could be relaxing.

able (1), activities (1), after (1), alter (1), aspects (1), assignment (1), awesome (1), bad (1), before (1), beginning (1), being (1), body (1), breath (1), breathe (1), breaths (1), bring (1), choir (1), clear (1), clicking (1), collapse (1), completing (1), computer (1), conductor (1), controlled (1), controller (1), day (1), definitely (1), depression (1), did (1), didn't (1), digital (1), doing (1), easily (1), effect (1), elementary (1), end (1), enjoy (1), especially (1), exercises (1), exhale (1), experiencing (1), factor (1), first (1), found (1), from (1), fun (1), game (1), gave (1), getting (1), glad (1), had (1), have (1), helping (1), impact (1), incorrectly (1), instructions (1), intended (1), interesting (1), interfere (1), intriguing (1), i'm (1), keys (1), less (1), letters (1), like (1), locations (1), mahalo (1), manage (1), may (1), memories (1), mindful (1), mouse (1), myself (1), needed (1), noises (1), now (1), occasionally (1), only (1), organized (1), otherwise (1), perhaps (1), personally (1), placed (1), possibly (1), practice (1), put (1), questions (1), random (1), realize (1), recording (1), relief (1), research (1), rounds (1), school (1), setup (1), silent (1), situation (1), solely (1), some (1), state (1), stressed (1), struggled (1), sure (1), take (1), temperature (1), than (1), thank (1), they (1), thinking (1), thought (1), through (1), tired (1), today (1), together (1), traumatized (1), two (1), unaware (1), uncomfortable (1), understand (1), understood (1), unless (1), unwind (1), use (1), were (1), what (1), which (1), who (1), wondering (1), you (1), affect (2), aware (2), because (2), better (2), can (2), chest (2), color (2), could (2), counting (2), felt (2), habits (2), help (2), helped (2), I've (2), just (2), know (2), made (2), more (2), never (2), not (2), other (2), outside (2), pattern (2), people (2), pressing (2), realized (2), really (2), stress (2), subject (2), when (2), abdominal (3), about (3), but (3), different (3), done (3), great (3), learned (3), relaxing (3), test (3), time (3), very (3), activity (4), exercise (4), mind (4), that (4), with (4), focus (5), for (5), well (5), this (8), study (9), was (9), breathing (14)

Figure J - 1. Final comments and recommendations—Single word frequencies identified using the Concordle-Ordered feature on the Condordle (2008) Website; omitted words: the, and, is, are.

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