IRRITABLE BOWEL SYNDROME: A BIOPSYCHOSOCIAL INTERVENTION

by

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ABSTRACT

JENNA NICOLE RAY. Irritable bowel syndrome: a biopsychosocial intervention. (Under the direction of DR. PAULA GOOLKASIAN)

Irritable bowel syndrome (IBS) has made a striking impact on western health systems (Andrews et al., 2005). It is a costly illness psychologically, socially, physiologically, and economically. A common complementary treatment for IBS is the practice of mindfulness: a meditation technique to increase cognitive awareness and acceptance (van Tilburg et al., 2008; Zernicke et al., 2013). This study searched for a way to add low cost and effectiveness to treatment options for IBS individuals through natural ways of activating a balance between the nervous systems, which are imbalanced in the IBS population. It also sought to dissect mindfulness meditation's effects on IBS symptom relief by using three interventions that target each component of the biopsychosocial model. Participants, from a university setting and an online sample, were assigned randomly to one of the three groups (diary, breath training, or mindfulness meditation), and participated in a 3-week intervention with a 6-week follow-up. Outcome measures were focused around IBS symptom occurrence and mental health. Results indicated that the social care (diary) group saw fast recovery in their IBS symptoms without strong psychological benefits. The breathing group saw both symptom and psychological benefits by the 6th week follow-up, and the meditation group only saw increases in their quality of life by the end of the study. Together, these results suggest that when mindfulness is used as a complementary treatment, the breathing component of the meditation may be the most important mechanism.

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LIST OF ABBREVIATIONS

ANS	autonomic nervous system
CRF	corticotrophin releasing factor
ECG	electrocardiograph
FFMQ	Five Facet Mindfulness Questionnaire
HADS	Hospital Anxiety and Depression Scale
HRV	heart rate variability
HF	high frequency, parasympathetic activity
LF:HF	sympathovagal balance
IBS	Irritable Bowel Syndrome
IBSQOL	Irritable Bowel Syndrome Quality of Life
IQR	interquartile range
MDN	median
MRI	magnetic resonance imagining
PNS	parasympathetic nervous system
PSS	Perceived Stress Scale
RMSSD	root mean square of successive differences
SNS	sympathetic nervous system
QOL	quality of life

INTRODUCTION

Irritable bowel syndrome (IBS) has made a striking impact on western health systems (Andrews et al., 2005). It is a costly illness psychologically, socially, physiologically, and economically. Its pervasiveness is seen throughout the community, and it is within the top ten reasons for seeking primary care (Kaptchuk et al., 2010). The need to augment or replace the traditional biomedical attempts at treatment for IBS is evident in the increased number of patients who seek complementary and alternative medicine for relief of their symptoms (van Tilburg et al., 2008). One such treatment is the practice of mindfulness: a meditation technique to increase cognitive awareness and acceptance (Zernicke et al., 2013).

The underlying mechanism as to why mindfulness helps is unknown; but it is speculated that IBS is associated with poor mental health (Dragoş, Ionescu, Ojog, & Tănăsescu, 2012; O'Malley, Quigley, Dinan, & Cryan, 2011) or to an imbalance between the sympathetic and parasympathetic nervous systems in the IBS population (Elsenbruch & Orr, 2001). The current study investigated each of these components by testing the effectiveness of three interventions that target social impacts on symptom reduction, physiological changes in the autonomic nervous system (ANS), and psychological improvements through the emotional and cognitive changes from mindfulness training.

First, it is important to gain an understanding of what IBS is and how it is affecting our society. IBS is considered a functional gastrointestinal disorder with unidentified organic causes (Bommelaer et al., 2004). This classification means that individuals who experience the symptoms of IBS are reported to have no structural or biochemical explanation for their symptoms, with problem areas specific to the mid- to

lower-gastrointestinal tract (Thompson et al., 1999). However, symptoms of discomfort and often symptoms causing patient concern result in IBS's placement on the list of common reasons for seeking medical attention (Bommelaer et al., 2004). Although, diagnosis of IBS is often left to a subjective interview between the patient and the physician (Kay, Jørgensen, & Lanng, 1998), there is an organizational attempt to objectively define the illness. These attempts have been less than coordinated across physicians and researchers. However, agreement on measurement began to emerge in the late 1990's leading to the following timeline of IBS definitions (Kay et al., 1998).

Bommelaer and colleagues (2004) indicate two sets of criteria that were initially developed to help clarify the diagnosis of IBS: the Manning and the Rome I. The Manning criterion requires two or more symptoms to have been experienced by the patient for a diagnosis of IBS, making it a liberal diagnosis (Kay et al., 1998). These criteria which are less restrictive than the Rome, often result in a higher prevalence of IBS, and nearly doubles the appearance of the syndrome in the population (Bommelaer et al., 2004).

The Rome I and, later developed, Rome II measure IBS by both duration of symptoms (at least 12 weeks within the previous year) and combination of symptoms experienced at three criteria levels (Kay et al., 1998). Symptoms in the Rome can be found in Table 1 (Kay et al., 1998, p. 490).

Table 1: Rome qualifications to diagnose Irritable Bowel Syndrome

Continuous or recurrent symptoms of:

1. Abdominal pain, relieved by defecation, or associated with a change in frequency or consistency of stool
   And/or
2. Disturbed defecation (two or more of):
   a. Altered stool frequency,
   b. Altered form (hard or loose/watery)
   c. Altered stool passage (straining or urgency, feeling of incomplete evacuation)
   d. Passage of mucus
   Usually with
3. Bloating or feelings of abdominal distension

More recently, a team representing 18 different countries has developed the Rome III to clarify and refine the previous versions of Rome diagnoses (Thompson, 2006). Now, the Rome III is the diagnostic test used for most research studies and the standard for clinical trials (Thompson, 2006).

Considering IBS is long lasting, living with it has been compared to living with a chronic disease (L. Chang et al., 2006). However, with IBS the chronic disorder is not well understood. It is unstable, associated with stigmas, and not easily controlled by traditional treatments (L. Chang et al., 2006). This irregularity of symptoms that wax and wane over time and the fact that the syndrome is not clearly identified is taxing to someone living with the illness (Longstreth et al., 2006). It is a disorder that is comorbid with psychological illnesses, other functional disorders, and high health care costs (Longstreth et al., 2006). Fortunately, recent research has suggested that there are structural or biochemical mechanisms underlying the illness (Longstreth et al., 2006), and this greater understanding provides hope for all directly and indirectly affected by the syndrome.

Epidemiology and Risk Factors

Various risk factors are concomitant with the development of IBS. Notable are the differing effects seen in association with age and gender. IBS conventionally develops between 30 and 50 years of age (Remes-Troche, Valdovinos, & Hinojosa, 2003). Individuals with IBS outside of this age range have reported lower symptomology and a higher quality of life (Remes-Troche et al., 2003). Remes-Troche and colleagues (2003) hypothesize that the less intense symptomology could be due to lower rates of visceral hypersensitivity in those above 50 years of age, and it may be related to hormonal changes later in life that affect the autonomic nervous system (Palsson et al., 2003).

However, IBS sufferers are reportedly becoming younger in age (Choung & Locke III, 2011). The new average age of IBS is around 20-30 years (Maxion-Bergemann, Thielecke, Abel, & Bergemann, 2006). Alongside this demographic change comes concern about the differing symptomology in the varying age groups. Reportedly, external factors that affect quality of life are important for treatment in older patients (such as lack of social support), while attention to depression and anxiety play a large role in the younger population of IBS sufferers (Y. R. Tang, Yang, et al., 2012). These findings are very important when considering the increase in IBS diagnoses for adolescents (Paul, Barnard, Bigwood, & Candy, 2013). Rates currently found in adolescents include studies reporting 17% of high school students with IBS symptoms and 8% of middle school students (Paul et al., 2013).

When taking gender into account, women predominantly report IBS to physicians with a 3:1 ratio to men (Toner & Akman, 2000). However, when sampling from a population that includes those who do not seek treatment medically, it has been found

that women only experience IBS more often than men at a 2:1 ratio. This rate decrease appears to denote that men seek physicians' help less often than women (Toner & Akman, 2000).

After reviewing the literature from across the globe, it has been found that women experience IBS more than men in our own society, and in Europe, Asia, and Australia (Gwee, 2005). Countering this gender trend, in both the Middle East and India results have suggested a significant male dominant prevalence of IBS. It has been proposed by Gwee (2005) that the contradictory results may be a byproduct of the way that the studies recruit their sample. There are gender differences in physician seeking, and the researchers are selecting participants from a population of individuals who seek medical care from a physician. For example, women consult physicians more often than men in the United States (Gijsbers van Wijk, Kolk, van den Bosch, & van den Hoogen, 1995; Kandrack, Grant, & Segall, 1991).

In lieu of the findings that there is an overwhelmingly female dominance in the IBS population; it is important to investigate the specific gender differences that are causing such a disparity in IBS rates. Toner and Ackman (2000) report significant differences between physical symptoms experienced by men and women. Women have been found to experience more severe abdominal pain, as well as feelings of straining, bloating, and constipation, whereas men report more frequent diarrhea. Toner and Ackman's (2000) literature review indicated insignificant and inconsistent findings regarding psychological differences in men and women with IBS. They hypothesize an importance between gender role expectations imposed in part by culture, and propose that women could be perceiving additional stressors when compared to men. These cultural

expectations and stressors suggest a possible influence in the development of this disorder in American cultures. Nevertheless, these hypotheses would need to be supported in the various nations that also report a strong female dominance in IBS prevalence and the opposite for societies that report male dominance in IBS before any meaningful relationship can be determined between specific stressors and IBS development. Though, in consideration of the complexity of this illness, these hypotheses could support mechanisms that interact with the illness. Underlying mechanisms and their influences are important for a full understanding of IBS.

Current research indicates the importance of a particular mechanism that might explain some of these trends. Women's menstrual cycles have been shown to relate to the expression and interpretation of IBS symptoms (Kuczmierczyk & Adams, 1986; Matsumoto, Ushiroyama, Morimura, Hayashi, & Moritani, 2006; Palsson et al., 2003). Menstrual cycles have a strong effect on the autonomic nervous system. Kuczmiercyzk and Adams (1986) developed a study to assess the differences between women who had been diagnosed with premenstrual syndrome and those who had not. Their findings show that women of the premenstrual syndrome group experienced not only higher pain intensity ratings (irrespective of menstrual cycle phase), but also high ANS arousal, indicative of sympathetic (SNS) dominance, in the premenstrual phase of their cycle. Ten years later, research has continued to maintain these findings, one example being Matsumoto and colleagues' (2006) study that supported a sympathetic dominance for women in their late-luteal or premenstrual phase. With such a high female prevalence in IBS, hormonal SNS dominance could partially explain the SNS dominance found in the IBS population (Elsenbruch & Orr, 2001).

Palsson and colleagues (2003) have also supported a link between IBS menstrual phases and the symptomology by age. Their findings conclude that after the age of 50, around the time of menopause, women's IBS symptoms reduce significantly and health related quality of life increases, whereas men's symptoms and quality of life appear to remain stable. Furthermore, the relationship between gender differences, the role of the menstrual cycle, and its effects on the ANS have been linked to women's increased visceral interpretations of pain and cognitive hypervigilance, two central traits in the IBS profile (O. Y. Lee, Mayer, Schmulson, Chang, & Naliboff, 2001). Therefore, the physiological reactions within women might explain the abundance of IBS in females, with a particular emphasis on the role that the ANS plays. More will be discussed on the role of the ANS in IBS later in this manuscript. First, it is important to consider the great impact IBS has on the lives of individuals who experience it and those around them.

Costs of IBS

From all reports (Choung & Locke III, 2011; Maxion-Bergemann et al., 2006; Paul et al., 2013), IBS prevalence in the population is increasing. Western nations report rates of 12-30% of the population (Wilson, Roberts, Roalfe, Bridge, & Singh, 2004) and even developing nations that have traditionally documented minimal prevalence of the disorder are seeing rates increase in conjunction with the introduction of western lifestyles (Gwee, 2005). The reason behind the high prevalence in industrialized nations is currently unknown (Paul et al., 2013), but it is speculated that there could be an evolutionary mismatch in these societies (Lieberman, 2013).

Lieberman (2013) defines mismatch diseases as a condition that has developed due to the way our bodies have evolved over time. He states that our culture is drastically

changing at a pace that our bodies cannot keep up with. If our bodies have been designed for a certain evolutionary purpose and our environment does not match the environment we evolved for, then our bodies react with confusion: mismatch diseases (Lieberman, 2013). IBS might be one of these mismatches, as shown by the high prevalence of IBS in modern cultures, and considering the high individual, industry, and health service costs associated with IBS, the rise in prevalence should be of concern (Wilson et al., 2004). Currently, there is no knowledge about specific types of mismatches that influence IBS progression.

The high rate of the illness is troubling when considering how costly it is. When looking at the eight most industrialized nations in 1998, it was estimated that a total of 41 billion US dollars were spent annually in direct costs, and economists estimated the annual cost of IBS to be somewhere near 8 billion dollars in direct charges in the United States (Camilleri & Williams, 2000). Direct costs are expenditures directly incurred through the healthcare system, such as inpatient and outpatient costs or consultations (Camilleri & Williams, 2000). Throughout the literature, in the US, direct costs range from $530 to $8750 per person per year (Maxion-Bergemann et al., 2006). The number of annual physician visits for IBS ranged from 1-16, and the average number of days off work from IBS was reported to be between 9-22 days per year (Maxion-Bergemann et al., 2006).

However, another main concern with IBS is their indirect costs, costs that accrue from the patient's perspective, such as gas to the doctor or absenteeism (Camilleri & Williams, 2000). This is an issue because of how many days of work IBS individuals are known to miss (Camilleri & Williams, 2000), and up to 50% of IBS individuals self

medicate due to limited symptomatic relief seen from pharmacological treatments (Grundmann & Yoon, 2014). Therefore, all of their costs are indirect, if they are seeking help apart from the medical industry. Lastly, there are intangible costs to consider, which result from the impaired psychological states experienced by the IBS patient, discussed in the next section (Camilleri & Williams, 2000; Dragoş et al., 2012).

Research suggests that there could be a difference in economic burden dependent on the criteria used to diagnose IBS (Badia et al., 2002). They propose that IBS individuals use resources at a rate of 1.6 times that of a healthy counterpart, but that the criteria used to diagnose IBS is affecting the prevalence of the illness. As discussed, the revised Rome II diagnostic criteria result in a much lower prevalence than that of the Rome I (Badia et al., 2002). Thus, individuals who are diagnosed with IBS at the level of the Rome II are experiencing symptoms more severely or more often, but that those with less severe, still burdensome, symptoms are present and not diagnosed. They found that:

> In 1 year more than half the individuals who met the Rome II criteria had consulted a health professional, had followed some kind of treatment strategy and/or had reported a reduction in performance due to the symptoms. Around a quarter of individuals who met the Rome II criteria had undergone some kind of diagnostic test and/or reported some days of incapacitation due to the symptoms (Badia et al., 2002, pp. 755).

They also reported greater expenditures from individuals who were diagnosed with IBS using the Rome II criteria than those using the Rome I criteria (Badia et al., 2002). More recent reports, acknowledging the Rome III, indicate similar numbers but higher prevalence in young individuals (El-Salhy, 2012).

Overall, the literature supports the need for economic relief from this functional disorder. Relief is also needed in the intangible costs of this illness. Individuals with IBS report significantly lower health related quality of life than non-IBS counterparts

(Akehurst et al., 2002). They experience physical limitations, pain, mobility, and generally perceive their health to be lower quality (Akehurst et al., 2002). Not only is IBS affecting their physical well being, but they report much lower mental health scores as well, which is expected due to the comorbidity of the illness with anxiety and depression (Akehurst et al., 2002). These lower mental health scores include less of a social life, less energy, and scores on the SF-36 (Ware Jr & Sherbourne, 1992) comparable to someone with clinical depression (the lowest scores reported) (Akehurst et al., 2002). However, IBS can vary drastically over the course of a short amount of time, and with this, the patient's health related quality of life varies as well (Brazier, Dolan, Karampela, & Towers, 2006). Because this illness can last for any number of years, it is important to take into account the longitudinal variations and related effects (Brazier et al., 2006).

Some proposed ways to reduce the burden that IBS brings economically would be to develop effective and cost efficient therapies for the illness and its comorbidities (depression, anxiety, etc.) (Camilleri & Williams, 2000). However, with the introduction of many treatments, especially pharmacological treatments, both indirect and direct costs could increase as well (Camilleri & Williams, 2000). The direct costs would rise because of the added burden placed on insurance companies, while indirect costs would rise due to the further increase in costs per month to the person who needs to take the medication. Economically there is a need to find a treatment plan that is both effective and cost efficient.

Other options to reduce costs would be to educate the physicians and individuals properly about how they need to handle the illness without adding cost burden. Once diagnosed with IBS, preventive measures must be taken to reduce future costs. Also, the

relationship between patient and doctor needs to be optimized to decrease costs related to an inefficient use of time or errors caused by miscommunication (Camilleri & Williams, 2000). One way to optimize the time doctors and patients have together would be through mindfulness: to increase their ability to describe their problems/treatments, proper observation of the interaction and issues at hand, he physician staying calm and caring, as well as being fully aware of one's intentions and actions (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). These skills would likely need to be introduced to individuals with IBS due to their propensity toward negative emotionality, especially fear and pessimism (Dragoş et al., 2012). This type of patient-physician relationship is also supported by the Rome Foundation, which emphasizes verbal and nonverbal communication (D. A. Drossman, 2006).

The Psychological Effects

IBS has traditionally been thought of as a stress-related disorder associated with the activation of the central nervous system, the peripheral stress system, and the brain-gut axis (O'Malley et al., 2011). Changes in the stress response for individuals with IBS have often been shown to begin after chronic stress or after an early life stressor (defined as experiencing one of the following before the age of 14: physical abuse, sexual abuse, verbal abuse, victim of a crime, accident or disaster, injury or fear of injury, witnessed a death or injury, or extreme illness) (O'Malley et al., 2011; Videlock et al., 2009). After these stressful situations, the individual then becomes hypersensitive to stress, as discussed below, and a generalized immune reaction becomes present in individuals with IBS ridden digestive tracts (O'Malley et al., 2011).

If asked, many individuals will affirm the classification of IBS as a stress disorder because the onset of symptoms is believed to be concurrent with stressful periods in one's life. To test whether or not there is support for a potentially causal role between stress and symptom onset or if it is merely a relationship that intensifies symptoms between stress and IBS flare-ups, Blanchard and colleagues (2007) conducted a longitudinal study recording both stress and symptoms. Results indicated an interesting relationship that emphasizes stress and symptom onset. Specifically, symptoms and stress were reported concurrently, but in addition to this, symptoms can be predicted up to three weeks following the stressful period.

The stress-IBS symptomology relationship has been linked to the ANS. Individuals with IBS show an overall dominance of the sympathetic division of the nervous system, with parasympathetic activation having lower activation patterns in everyday life (O'Malley et al., 2011). The sympathetic nervous system is known for increasing the body's readiness for fight or flight, resulting in increased heart rate and the shutting down of unessential organs, including the digestive tract (Smith & Kosslyn, 2007). This dominance may sustain the exaggerated response seen in those with IBS when exposed to sensory stimuli, visceral sensitivity, and altered bowel motility (O'Malley et al., 2011). Secondly, chronic activation of the HPA-axis through corticotrophin releasing factor (CRF) can result in an increased number of baseline glucocorticoids (stress hormones) in one's system (Vicario et al., 2012). Chronically elevated levels of glucocorticoids activate the up-regulation of the immune system, resulting in chronic inflammation, and initiating up-regulation of the CRF receptors (Vicario et al., 2012). An increase in CRF receptors can mean a higher sensitivity to the

stress response that creates the worsening of this cycle once more, as suggested by the studies above. This is crucial in the physiology of IBS patients, considering that they associate their disorder with stressful life experiences and suffer high rates of poor mental health (Dragoş et al., 2012; O'Malley et al., 2011).

In addition to the relationships above, effects on cognitions have also been demonstrated. Both negative emotions and stress appear to play a key role in the processing of visceral stimuli, resulting in a "top-down" process (Elsenbruch, 2011). An example of this mechanism in those with IBS was demonstrated in Lee and fellow researchers' (2012) MRI study that looked at the differences between healthy individuals and individuals who experience IBS. Each group was then separated into two groups, the placebo group that was told that they would receive an analgesic solution before a rectal distension by balloon, and the control group that did not receive the placebo analgesic. During the visceral sensitivity test, Lee (2012) compared all four groups on pain levels. Image results indicated the same amount of placebo response in both healthy and IBS persons, but in addition to the areas that lit up from rectal distension on healthy brains, those with IBS also showed activation in the affective and cognitive regions. In particular, the insula (related to pain from an emotional state), the mid-cingulate cortex (mediating the pain from fear response), and the ventro-lateral prefrontal cortex (cognitive modulation of pain) were all playing a role in IBS pain experiences (H.-F. Lee et al., 2012). These findings suggest a role for cognitive coping mechanisms in the treatment of IBS symptomology.

Also, it has been found that white matter is important to the pain response in IBS, and that it, in particular, is compromised in these individuals (Chen, Blankstein, Diamant,

& Davis, 2011). White matter consists of fibers that connect homologous structures in the two hemispheres of the brain, connect structures within the same hemisphere that communicate with each other, and controls afferent and efferent communications (signals going from and to specific areas) between cortex and deep gray matter (Wozniak & Lim, 2006). White matter has also long been known to process motor and sensory experiences as well as more recently been shown to be a key player in the neural networking aspect of cognitive functions. It has been found that mindfulness meditation of only 4 weeks can increase white matter in the brain above and beyond relaxation training (Y. Y. Tang, Lu, Fan, Yang, & Posner, 2012). The impacts of this change are still unknown beyond the apparent change, but as discussed, the implications could be promising for those who continue mindfulness practice.

In addition to "top-down" mechanisms, "bottom-up" mechanisms have been suggested such that cognitive decline from chronic activation of the immune response, in particular IL-6, could be found in IBS sufferers. IL-6 is related to learning and memory deficits and IL-1 beta has been shown to inhibit synaptic plasticity (Kennedy et al., 2012). With chronic immune reactions in IBS patients, IBS could be considered a risk factor for early cognitive decline (Kennedy et al., 2012). However, a review of the literature suggests that, though a young field, mindfulness training has been found to offset this cognitive decline and may even help to increase the health of cognition (Gard, Holzel, & Lazar, 2014).

IBS and the Care Effect

Another commonly reported finding with the IBS population is the placebo effect (Kaptchuk et al., 2008). Though the term "placebo" sometimes comes with a negative

connotation, here there are complex reasons behind the success of placebos. Accounting for anywhere between 25 and 81% of the variance, placebos work for reducing IBS pain supposedly by calming the individual emotionally (Vase, Robinson, Verne, & Price, 2005). The psychological benefits mainly derive from the desire for pain relief, the expectation of what the pain level will be (in this case, low), and a reduction in anxiety levels (Vase et al., 2005).

When referring to the IBS population, there are two typical understandings of placebo: the broad definition and the narrow definition (Conboy et al., 2006). The narrow definition comes from the idea that participants in a study are receiving bogus treatment and the results are then false (Conboy et al., 2006). The findings in IBS populations instead point toward the broad definition of placebo: a benefit resulting from a patient-provider interaction and the entire medical experience (Bishop, Jacobson, Shaw, & Kaptchuk, 2012; Conboy et al., 2006). So, an interpretation of placebo effects for those studying the patients (neurologists, psychologists, and anthropologists) and not the treatment alone (pharmaceutical companies) would be that there are contextual factors that contribute to the healing process in these individuals, and those contextual factors should be studied (Bishop et al., 2012).

Specifically, the contextual factors have been separated into three components: a patient's response to being assessed, the patient's response to expecting relief from a treatment, and the patient's response to an interaction or relationship with a provider (Kaptchuk et al., 2008). When separated by components in controlled conditions, it has been found that the support of a practitioner, the social component, is in fact the most

potent when predicting IBS symptom relief: the care effect (Kaptchuk et al., 2010; Kaptchuk et al., 2008).

Not many researchers have looked into the role of social support and IBS symptomology. However, it has been found to be an important predictor of health and longevity in other illnesses (J. Lackner et al., 2010). So, why would it not aid IBS sufferers, especially considering the findings that IBS onset can be predicted by chronic negative social interactions (Blanchard et al., 2007; J. Lackner et al., 2010)? In consideration of their symptoms' strong correlation with stress and negative affect, the resources that can be brought to a person through positive relationships have the potential to help IBS patients. Lackner and colleagues (2010) investigate this relationship and found that the perceived availability of social support decreased the cardinal symptom of IBS: pain.

Since the main interest of this research is the incremental separation of the components that are underlying mindfulness meditation's beneficial effect on IBS symptom reduction, there was an intervention in which the participants only experience "care" aspects of the study where they are interacting with researchers through a daily diary. Diary participants met with the researchers three times in person: beginning of the study, end of the study, and the follow-up. They were also in communication with the researchers throughout the three weeks via email. If they were following instructions, they simply received emails saying that they were doing well. If they were not following instructions, they received emails gently reminding them to continue with the study nightly and recommendations for how to do so. Responses from the participants varied as to how much they chose to communicate with the researchers.

IBS and the Autonomic Nervous System

As stated above, the connection between physiological measures and IBS expression brings rise to the notion of the role that the ANS plays in IBS symptomatology. As a growing area of research, many studies have found that ANS disturbances are represented in a large number of IBS patients (Pellissier, Dantzer, Canini, Mathieu, & Bonaz, 2010). Not only are these disturbances present during IBS symptom flare-ups, but also they are apparent during asymptomatic periods, otherwise known as symptom remission. Concurrently, Pellisier and colleagues' (2010) findings exhibited a profound sympathetic dominance in IBS patients as compared to healthy individuals. In the study, sympathetic dominance was significantly observable after thirty minutes of rest. A higher disturbance of autonomic balance was found as compared to gastrointestinal disorders, such as inflammatory bowel diseases.

Elsenbruch and Orr (2001) also demonstrate a clear relationship between the sympathetic and parasympathetic imbalance. Their measures indicate heart rate variability through electrocardiographic recordings with results that show an asymmetry by way of parasympathetic withdrawal. Parasympathetic withdrawal, otherwise referred to as vagal withdrawal, is followed by symptoms of sympathetic dominance, a secondary effect to the decrease in parasympathetic activity, with deleterious outcomes. These outcomes become evident in the life of an individual who experiences chronically high baseline measures of sympathetic dominance, including an abnormal immune response, neurobiological irregularities, metabolic consequences, depression, anhedonia, fatigue, pain, and cognitive dysfunction (Raison & Miller, 2003).

Though these findings do not yet specify a causal role for the ANS in IBS symptom expression, other studies have focused on the effects produced by disturbances in the ANS and the corresponding adjustment of visceral sensitivity (Musial, Häuser, Langhorst, Dobos, & Enck, 2008; Öhman & Simrén, 2007). Musial and colleagues (2008) discuss the connection in the brain (the insular cortex) between visceral afferent and efferent signaling and the autonomic nervous system. This discussion leads to an interesting inquiry about the two physiological reactions. In which direction does the relationship flow? Would balancing of the ANS be able to affect the interpretation of visceral stimuli?

IBS patients have traditionally been characterized by their visceral hypersensitivity, a key feature of the pathophysiology that leads to IBS symptomatology (Öhman & Simrén, 2007). However, this hypersensitivity to pain has been demonstrated to converge on the gastrointestinal tract, leaving other internal sensory reactions at normal levels (Musial et al., 2008). Particularly important to visceral sensitivity is the adjustment of hormonal and ANS balance, as seen in the gender differences expressed in IBS patients. Musial and colleagues (2008) and Van-Oudenhove and researchers (2004) assert that the ANS's influence on IBS, declaring its accepted role in symptom development. Therefore, both top-down (efferent signals) and bottom-up (afferent signals) effects have been confirmed in IBS patients, leaving possible interventions to approach the problem from either or both angles (Musial et al., 2008; Van Oudenhove et al., 2004).

More specifically, the parasympathetic system is important to the health of those with IBS because the vagal nerve regulates it. The vagal nerve branches to affect most of

the gut (Vermeulen, De Man, Pelckmans, & De Winter, 2014). Therefore, by using the calming parasympathetic mechanisms, it is expected to decrease cognitive and emotional biases of hypervigilance to pain and hypersensitivity to physical stimuli (Vermeulen et al., 2014). Thus, by calming the gut physiologically (bottom-up) and psychologically (top-down) visceral sensitivity is expected to decrease in IBS patients.

Physiological studies indicate a complex, multifactorial etiology in IBS, with any disturbance on the bidirectional "brain-gut axis" (from the intestines to the brain or vice-versa) causing an array of symptoms' expression (Van Oudenhove et al., 2004). Therefore, the stress response seen in the IBS population and the resulting symptom expression signifies that IBS can be considered a biopsychosocial disorder.

The biopsychosocial model is an integral principle in current health research, and was originally developed due to public dissatisfaction with the biomedical model, a model that solely focuses on the biological processes that underlie illness (Engel, 1979). There is more to health than anatomical malfunction, and the biopsychosocial model sought to answer the public dissatisfaction with a more inclusive approach, one that defines the causes of disordered health by adding both psychological and social influences to the initial biological focus (Engel, 1979). IBS appears to be a disorder in need of a biopsychosocial approach to treatment. However, findings such as the aforementioned studies that connect the ANS and cognition to IBS etiology reveal great need for an intervention connecting the entire biopsychosocial system, particularly when a significant proportion of individuals seeking physician care leave disenchanted and in search for additional complementary care (Wilson et al., 2004).

A Current Look into Complementary Treatment

Presently, medical treatments have been less than ideal for individuals seeking IBS relief. A third of these individuals have been found to seek alternative medicines (Borum, Chutkan, Johnson, & Farmer, 2000). This proportion, however, does not include those who do not seek care or those who initially seek alternative methods. Paralleling this finding, studies have branched away from traditional pharmaceutical approaches (Faber, 2001).

Others (Jones, Koloski, Boyce, & Talley, 2011; J. M. Lackner et al., 2009) have used Cognitive Behavioral Therapy with mixed findings. These findings suggest a tenuous connection between the treatment and symptom reduction. Lastly, a successful exploratory attempt at Mindfulness Based Stress Reduction training found moderate effects with a significant reduction in symptom report (Ljótsson et al., 2010). Physiological connections were not proposed in this study, though the psychological components of IBS were suggested to play a key role in reduced symptom report. Greater understanding of the mechanisms that play in the successful use of mindfulness meditation to treat IBS is needed. Trends within the literature reveal a concentration of research assessing psychological effects or traditional treatments concerning the intestinal tract with few articles searching for an intervention that incorporates the interplay between the physiological and psychological components of the illness.

The Autonomic Nervous System and the Breath

To account for this issue, the literature that connects psychophysiological interventions to ANS functioning suggest a promising role for breath training in the search for an increase in parasympathetic activity. Courtney's (2009) literature review on the purpose and importance of breath therapy demonstrates its value in both healing and

homeostasis of the body. Research has shown that slow breathing acts through stabilizing bodily functions, while bringing restful states via the parasympathetic activation and assuaging emotional and mental distress. Due to these promising effects many breathing therapies have been designed, and multiple forms of them have been used throughout research and rehabilitation (Courtney, 2009).

Breath training has been shown to have almost immediate distinct effects on heart rate variability in hypertensive patients (Joseph et al., 2005; Mourya, Mahajan, Singh, & Jain, 2009). Slow breathing (defined as 6 breaths per minute) has also been able to normalize patients with chronic obstructive pulmonary disease after twenty minutes of breath change (Raupach et al., 2008).

Those who practice yoga have a well established and practical breathing therapy known as pranayama breathing. It has been recognized for centuries and has numerous forms (Ong, 2007; Villien, Yu, Barthélémy, & Jammes, 2005). It is also suitable for many modern individuals because of its versatility and accessible nature. As Jerath and colleagues (2006) explain, pranayama focuses on the three basic mechanisms of the breath: inhalation, retention, and exhalation. The difference between pranayama and common breathing is the emphasis on the practice being consciously under the control of the individual instead of involuntary. Novice pranayama breathers begin with very basic breathing techniques, whereas advancement in the breathing practice increases the ability to control and lengthen the breath.

Pranayama has also shown to be effective in both psychological and physiological treatments. The increase in oxygen flow throughout the body has beneficial results for the brain (neural plasticity and neurogenesis, an important contribution to cognitive decline

in the IBS population) (Jerath et al., 2006). It has promising effects for emotional balance, social interactions, stress reduction, increased vagal tone while shifting cellular processes to parasympathetic dominance, and ultimately decreasing sympathetic dominance (Jerath et al., 2006). Pranayama has also been shown to change the state of brain waves in normal and epileptic individuals, significantly reducing epileptic EEG patterns in only a month of training (Vialatte, Bakardjian, Prasad, & Cichocki, 2009). The expectation in the IBS population would be to allow for such an accessible and simple therapy to affect these psychophysiological states in a way that is under the individual's control and to view observable and genuine results that are purely due to a physiological change.

Mindfulness Meditation: Taking it One Step Further

Mindfulness has been shown to aid IBS sufferers by reducing bloating and pain perception (Ljótsson et al., 2010). With bloating being reported as the most bothersome of the IBS symptoms, this is a great success (Houghton & Whorwell, 2005). Though, underlying mechanisms as to how it is helping are unknown (Ljótsson et al., 2010). Consequently, a look into mindfulness training is warranted because of the need to enhance the lives of those suffering with IBS. Mindfulness offers possible physiological changes and addresses the need for a low cost, psychologically enriching treatment.

Mindfulness meditation is defined as concentration in the present moment and awareness of one's current state without emotionally judging the situation (Grossman, Niemann, Schmidt, & Walach, 2004). When deconstructing the practice of mindfulness, there are five elements that stand out: ability to describe one's experience, not emotionally judging a situation, skills in observation, cognitive ability to acknowledge

and separate emotional arousal from reaction, and acting with awareness (Baer et al., 2006). Honing these abilities has been shown to improve general coping mechanisms in regard to chronic ailments, resulting in less stress (Grossman et al., 2004). Therefore, there is no surprise that due to its accessibility and mind-body method, it has recently been introduced into the medical world as an approach to integrated medicine (Barker, 2014).

Most noticeably, mindfulness meditation is a tool to lessen stress by way of decreasing rumination, thought suppression, fear of emotion, and difficulties with emotion regulation (Keng, Smoski, & Robins, 2011). By investigating how these psychological findings are affecting the brain, one can begin to see the importance of mindfulness in regard to healthy thinking. For those who meditate, quantifiable changes have been demonstrated in brain locations that influence attention skills, awareness of what is happening around them, and control over emotion states at a neurological level (Keng et al., 2011). By gaining this control, one can gain a great advantage over their reaction to stressful stimuli.

Taking into consideration the negative effect found on cognition from unhealthy thinking patterns in IBS patients, practicing mindfulness is a possible way to counteract some of the losses (Chen et al., 2011; Y. Y. Tang, Lu, et al., 2012). The ability to learn how to interpret situations as less threatening and how to react to these situations in a less stress-inducing manner have been shown to positively impact IBS quality of life (Kearney, McDermott, Martinez, & Simpson, 2011).

Taken together these studies suggest that mindfulness predominantly plays a psychological role in symptom relief, improving quality of life, reducing anxiety, and

strengthening emotional coping mechanisms (Garland et al., 2011; Kearney et al., 2011). Moreover, there is reason to believe that through the slow deliberate breathing that is emphasized in meditation training, one's IBS could also be aided physiologically.

There are currently some researchers who are looking into mindfulness's effects on IBS, but they are doing so through self-report mechanisms and not by addressing the biological changes that are taking place in the body (Garland et al., 2011; Zernicke et al., 2013). Garland and colleagues (2011) focused on the nonreactive awareness of emotional and physiological stimuli, and suggest that the learned skill of non-reactivity is greatly beneficial to the IBS population, specifically in regard to anxiety and catastrophic appraisals and how they affect symptoms. Zernicke and colleagues (2013) also looked at psychological components in regard to mindfulness. They found that by being a part of the study, including on a waitlist, improved quality of life, stress levels, and spirituality occurred. Compared to the waitlist group, the mindfulness group saw greater improvements in their IBS, with reports of symptoms decreasing from constantly to occasionally present.

In this study, it is suggested that there is a need to study mindfulness' physiological role in health, due to the lack of research operationalizing and understanding the components of how mindfulness is aiding chronic ailments (Grossman et al., 2004).

One way of incorporating quantitative measurements of physiology into mindfulness research would be to look at the stress response through heart rate variability (HRV). HRV can measure the level of sympathetic *vs*. parasympathetic dominance and causal agents of that dominance (Malik et al., 1996). A relevant example of this

measurement would be that there is a sympathetic dominance in IBS sufferers secondary to the suppression of the parasympathetic response (Elsenbruch & Orr, 2001). It has already been found that individuals with high trait mindfulness see a reduced negative effect (baseline sympathetic dominance) on HRV when looking at generalized anxiety, suggesting a mitigating role for mindfulness when HRV is abnormal (Mankus, Aldao, Kerns, Mayville, & Mennin, 2013). Therefore, tracking longitudinal changes in the ANS to mindfulness training could be telling in an IBS population for both the mindfulness meditation and the IBS literature.

Research Design

Due to the increased search for complementary treatments in IBS patients (Borum et al., 2000; Wilson et al., 2004) as well as the clear need for therapies involving biopsychosocial approaches, this study incorporated the components currently found to influence the presence of IBS and further clarifies the roles of social impacts, effects of psychology, and the regulation of physiology through an intervention approach.

In this study, IBS participants were separated into three groups that incrementally isolated the variables found to help in IBS treatments. These three groups were the mindfulness meditation training group that incorporated psychological benefits, physiological benefits, and social benefits; the breath-training group that focused on physiological changes and social changes; and the diary group that is the social care group who were monitored but did not engage in any additional intervention. The study uses this design to attempt to explain the distinct effects of social support, physiological balance, and psychological control.

Measures were taken before and after a three-week intervention with a 6-week follow-up to assess changes in IBS symptoms, HRV, and any beneficial changes in quality of life and psychological traits. IBS is defined by the individuals' scores on the Rome III (D. A. Drossman, 2006), and symptoms were reported daily with the Bristol Stool Scale (O'Donnell, Virjee, & Heaton, 1990) and the IBS Daily Symptom Diary (Francis, Morris, & Whorwell, 1997). Trait mindfulness is measured using the FFMQ (Baer et al., 2006). Also of interest are the effects seen on IBS patients' quality of life: IBS-QOL (Patrick, Drossman, Frederick, Dicesare, & Puder, 1998), stress levels: PSS (Cohen, Kamarck, & Mermelstein, 1983), anxiety, and experienced depression: HADS (Zigmond & Snaith, 1983) to assess what intervention conditions contribute most to these variables: diary, breathing, or mindfulness.

It was expected that the diary group would see similar benefits as shown in the care literature. A diary was chosen because stress and IBS symptoms need to be tracked daily to reduce the likelihood of retrospection and recall inaccuracy (Travers, 2011). However, positive effects on health have been found from writing about emotions and experiences. In particular, structured writing exercises help individuals the most (Bugg, Turpin, Mason, & Scholes, 2009). This study uses a structured approach because of the need for specific information: stressors, stress levels, and IBS symptoms experienced (Guastella & Dadds, 2008). Consequently, the diary group is present to control for these effects as well as for social benefits (the care effect) that result in IBS relief.

The breath-training group was expected to show more symptom reduction and a calmer psychological state than the diary group due to the increased parasympathetic activity and decreased perceived stress, leading to lowered symptom report for IBS

patients. As aforementioned, breath training has been shown to increase positive social interactions, bring emotional balance, reduce stress, and stabilize autonomic functions. A comparison of the breath-training group with the diary group allows for an analysis of any specific benefits of breath training alone.

Lastly, it was expected that the mindfulness meditation group would show the most benefits during the 3-week and the 6-week post intervention tests. Since focusing on the breath is supposed to be included in the mindfulness mediation training, this group was expected to receive the benefits of increased vagal tone from periods of slow breathing, but they are also increasing their cognitive and emotional control through mindfulness training. With the inclusion of the breath-training group and the diary group, the size of the effect of emotional and psychological improvements can be found with comparisons to the other two groups.

This research hopes to add several innovative techniques to investigating the relationship between the ANS and IBS. In addition to the inclusion of the psychophysiological mechanism through breath training, mindfulness, and corresponding measurements, it is noteworthy that a longitudinal design is employed to track the effects found within and between the diary control and intervention groups.

Furthermore, training with each of the interventions occurs online through a Qualtrics web site. Participants practiced with the assistance of a video and their interactions with the web site were time stamped. Patterns of the participants' adherence to the intervention and documentation of additional breath training practice throughout the day were collected. A distinction could then be made between the demographics of the types of individuals who adhere to the study, those who report seeking more practice,

those who do not, and all of their resulting outcomes. The timeline of the intervention's effects, the inclusion of all components of the biopsychosocial model, and the patterns of behavior for an at-home treatment are novel to the current literature.

Because the organic cause of IBS is not well understood, a solution that treats all of the symptoms has not been found. Instead conventional practices treat specific symptoms that are bothersome to the patient (F.-Y. Chang & Lu, 2009). Again, it is believed that half of the individuals seeking care decide to leave specialists' costly supervision or never seek physician treatment and attempt to self-medicate (Grundmann & Yoon, 2014). This research searched for a way to add the important components of low cost and effectiveness to treatment options for individuals with IBS through natural ways of activating a balance between the SNS and PNS and increasing emotional and cognitive health. It is also sought to dissect the interventions, and to measure the effect sizes of each component of the biopsychosocial model.

METHOD

Participants

Volunteers were recruited from two locations: students from the University of North Carolina Charlotte and online through a post by the International Foundation for Functional Gastrointestinal Disorders at these two sites: http://www.giresearch.org/site/studies/nih#ibs and http://www.aboutibs.org/site/treatment/studies. Participant inclusion criteria were any person who has IBS as indicated by the Rome III, has Internet access, and is above the age of 18 years. Individuals who smoke or who had an organic gastrointestinal disease were excluded from the study.

At the University of North Carolina Charlotte three groups were used: Diary, Breathing, and Mindfulness for a total of 28 college aged participants ($M = 23.61$, $SD = 7.54$). At the International Foundation for Functional Gastrointestinal Disorders website, because of the monetary related restrictions, we recruited only two of the groups: Diary and Mindfulness for a total of 10 participants with a wide range of ages ($M = 46.75$, $SD = 16.31$). Because of the low numbers recruited, data from the two samples (38 participants with an average age of 28.75 ($SD = 13.87$). are combined for the purpose of data analysis. Participant recruitment occurred from fall of 2013 to spring of 2015.

Table 2 compares the participants who were randomly assigned to each of the groups on demographic variables. The results of the chi-square tests did not find any differences among the groups on any of the relevant background variables. From the tabled data, it is apparent that a majority of the sample were university students, many were diagnosed with IBS by a physician, most were Caucasian, and were female.

Table 2: Demographic variables and baseline differences organized by group

	Diary	Breathing	Meditation			
	% [a] (n)	*% (n)*	*% (n)*	*N*	χ^2	*p*
University	63 (10)	100 (10)	67 (8)	28	4.91	.09
Online	37 (6)	0 (0)	33 (4)	10		
Diagnosed	69 (11)	100 (10)	75 (9)	30	2.83	.24
Not Diagnosed	19 (3)	0 (0)	25 (3)	6		
Caucasian	100 (16)	70 (7)	83 (10)	33	5.04	.08
Minority	0 (0)	30 (3)	17 (2)	5		
Male	12 (2)	20 (2)	42 (5)	9	3.33	.19
Female	88 (14)	80 (8)	58 (7)	29		

Note. N indicates the total number of participants. *n* signifies that total number of participants in that group. *%* represents the percentage of the total number of participants in that category.
[a] Instances in which the percentages that do not add up to 100 represent variables with missing data.

Of the 67 participants who were successfully recruited, 20 dropped out, and 8 were not included in data analysis due to noncompliance with instructions or lack of IBS symptomology at baseline. Minorities who signed up for the study, *N*=13, were all African American, bi-racial, and Hispanic participants. No Asian Americans signed up for the study. Many minorities, 62%, dropped out (*N*=3), or were non-adherent (*N*=7), leaving few (*N*=5) remaining.

Online, a total of 90 individuals signed up to be contacted about the study. Of those, 32 showed interest in beginning the study. For the 10 individuals who were randomly assigned to the meditation group and continued with the study, 4 completed the

study. For the 13 individuals who were randomly assigned to the diary group and continued with the study, 6 completed the study. All of the participants in the study who dropped out slowly stopped participating throughout the three weeks or requested to stop for personal reasons, such as the date of a surgery was during the intervention timeline.

Recruitment style differed by location. The SONA research study system advertised the study to the student population at the university location. A Rome III prescreen was used to screen the student population in the SONA system to identify those who qualify for the study. For completion of the study, participants received six research credits to benefit their classes, while those who did not complete the study received partial credits depending on the length of their participation.

Online participants were recruited to volunteer for the study through the website posted above. The study information was placed on the ad together with contact information. Patients from the website participated in all aspects of the study with the exception of the in-person heart rate monitoring collections. For completion of the study, participants were rewarded with a $15 Target gift card.

Measures

All of the measures with the exception of HRV were administered online through the Qualtrics website. The pre intervention, post intervention, and follow-up (baseline, week 3, and week 6) surveys were taken in a research laboratory together with measures of HRV for the university sample. The daily diary entries and the weekend surveys were taken at the discretion of the participant, with only weekend questions from baseline, week 3, and 6 collected from the online sample. A number of self-report measures were

taken for this study and are described below. All of the instruments are available in the Appendices.

Rome III

The Rome III (found in Appendix C) was used as the primary diagnostic criteria of the IBS syndrome (D. A. Drossman, 2006). The original version was used for the baseline measurement. However, a weekly version has been adapted to determine the symptoms that are present during week one, two, and three of the study. A third version was created to determine the symptoms experienced between the end of the intervention and the sixth week follow-up, allowing for reflection on the three weeks of changes in their IBS. The differences between these versions are only in the presence of the words "within the last___" with the amount of time referred to represented in the blank. These additional versions will allow us to track those who go into remission across the intervention period.

This scale includes collecting information on the length of discomfort or pain, verification that the pain is not only present during menstrual bleeding, and how often they experience specific bowel problems. Ten questions are used to determine whether or not the abdominal pain is related to IBS, and within those ten questions it distinguishes between the four different types of IBS: constipation, diarrhea, mixed, and unsubtyped.

After a search through the literature, there is a clear need for psychometric testing on the Rome III. The results of a psychometrics search resulted in many translations into various languages (Y. Y. Lee et al., 2013; Ngoenmak, Yimyam, & Treepongkaruna, 2013; Reisswitz, Mazzoleni, Sander, & Francisconi, 2010; Song et al., 2013; Sorouri et al., 2010)and many assessments of the Rome III on children. Results indicate test-retest

reliability, but lack of support for validity in children (Chogle, Dhroove, Sztainberg, Di Lorenzo, & Saps, 2010; Ngoenmak et al., 2013; van Tilburg, Squires, Blois-Martin, Leiby, & Langseder, 2013). The lack of reliability was also supported by a study looking at constipation in adult women as well (Digesu et al., 2010).

Perceived Stress Scale

The Perceived Stress Scale (PSS) is a widely accepted, 14-item questionnaire with a five point Likert scale, where the sum of the individual's scores will be used to transform the overall score into one that is based on a standard 100-point scale (Cohen et al., 1983). The PSS (found in Appendix D) was designed to assess an individual's perceived level of chronic stress in the last month (Cohen et al., 1983; Herrero & Meneses, 2006). The measure was designed to be "global," therefore it is not specific to events that happened in a person's life, which are usually measured by other objective-stress scales (Cerclé, Gadea, Hartmann, & Lourel, 2008).

The creators of the scale report reliability support for its use (Cohen et al., 1983). Also provided is a second reliable psychometric assessment of properties for both the 14-item questionnaire and shorter versions (Bruchon-Schweitzer, 2002; Cohen, 1988; Herrero & Meneses, 2006). The PSS will be used in this study as a measure of the chronic stress that is perceived subjectively by the participant.

IBS – Quality of Life

The IBS Quality of Life Questionnaire (IBS-QOL) is a measure developed specifically for IBS patients (found in Appendix E) (Patrick et al., 1998). It consists of 34 condition specific questions that assess eight domains of quality of life in IBS patients: dysphoria, interference with activity, body image, health worry, food avoidance, social

reactions, relationships, and sexual quality of life (Bushnell et al., 2006). Each question includes a five point Likert scale to assess how much it describes the patient's life in the past month (the bi-weekly assessments will measure how the participant has felt since the last evaluation) (Bushnell et al., 2006). This study appraised overall scores on the quality of life measure by summing the 34 question responses, and will look for difference among the subscales to see what is affecting the participants in this intervention. Higher scores represent lower quality of life.

In development and further testing of the measure, it was shown to have high internal consistency, reproducibility, and cross-sectional (discriminant and convergent) validity, as well as having undergone responsiveness testing for longitudinal construct validity (D. Drossman, Corazziari, Talley, Thompson, & Whitehead, 2000). Patrick and Drossman (2002) specifically address the validity of their measure and defend their rationale behind the careful testing of construct validation as compared to the IBS-36.

Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS) is a fourteen-question survey that asks questions about anxiety and depression (found in Appendix F) (Zigmond & Snaith, 1983). The answers range from "yes, definitely" to "no, not at all" on a 4-point Likert scale. Half of the questions relate to an anxiety score of 0-21, and the other half relate to depression on a scale of 0-21. Ratings of 0-7 result in a non-case diagnosis, 8-10 result in a borderline case diagnosis, and 11-21 result in anxiety and/or depression.

As per Bjelland et al.'s (2002) review of 71 studies covering the validity of the HADS, it has been shown that this measure was designed for individuals who were not depressed or anxious at clinical levels, but instead were patients in a non-psychiatric

hospital setting. A cut off score of +8 for both anxiety and depression scales, indicate a patient who has a high level of anxiety and/or depression. The scale was deemed internally consistent across all studies (Cronback's coefficient alpha at least .60). Concurrant validity, bidimensionality, and HADS as a case finder for anxiety and depression were also exhibited and clearly supported (Bjelland et al., 2002). HADS has been chosen for this study for its common use in IBS literature, strong psychometric properties, and relevant target population (Bjelland et al., 2002).

Five Facets of Mindfulness Questionnaire

The Five Facets of Mindfulness Questionnaire (FFMQ) (found in Appendix G) by Baer and colleagues (2006) was chosen to assess the change in level of mindfulness in this sample's mindfulness participants. The FFMQ was created after analyzing the psychometric properties of five previously developed measures. A total of 39 of the most psychometrically sound items were kept from the five measures. The Questionnaire is separated into five facets: nonreact, observe, act with awareness, describe, and nonjudge.

The participants answer questions about each of the facets on a five-point Likert scale from 1 (never or very rarely true) to 5 (very often or always true). When scoring the overall mindfulness facet, as suggested by Baer and colleagues (2006) for non-meditating samples, the observe facet is not included. For each of the factors, all reverse coded items are recoded, and the items are then summed to create an overall score.

Previously, construct validity was assessed and determined to show moderate to good (range .72 to .92) internal consistency across the samples evaluated (n = 1,017) (Baer et al., 2008).

Heart Rate Variability

HRV was measured using a Polar RS800CX watch capable of the 1000 Hz sampling required for reliable assessment of HRV (Gamelin, Berthoin, & Bosquet, 2006). Participants' HRV was recorded for five minutes at each meeting before filling out the questionnaires. There were no distractions while HRV was monitored. Data was collected on each individual at baseline, week three, and week six of the intervention study. The data were transferred to Polar ProTrainer 5 software, and interpreted with Kubios with the resulting root mean square of successive differences (RMSSD), high frequency (HF), and low to high frequency ratio (LF:HF) reported.

Study Websites

Websites (Moodle and Qualtrics) were created to record practice with the interventions and to administer the daily diaries and the pre and post test surveys. All of the surveys are organized in chronological fashion by participation week: daily diary, intervention (if applicable), baseline questionnaires, week one, week two, week three, and week six questionnaires. Participant compliance with the research protocol was monitored by noting the dates and times that they accessed the web site and surveys.

Daily Diary

The daily diary was created for a multifunctional purpose. Originally, it was an easy way to track the number of stressors that the participants perceive throughout their day, and to record when the subjects report having completed their interventions. Intervention reports were used to verify if the participants both comply and correctly report their usage. Also, the diary included reports of IBS symptoms. They filled out the Bristol Stool Scale (O'Donnell et al., 1990) to verify the consistency of their stool for that day, and they reported symptoms from the IBS Daily Symptom Diary (Francis et al.,

1997). The meditation daily diary can be found in Appendix A including the Bristol Stool Scale and the IBS Daily Symptom Diary. All of the groups were required to complete the daily diary entries. For the control group, this is all they have to do during the 3-weeks intervention time, but the participants in the other groups were required to practice with their respective interventions as well.

Breath Training Intervention

The breathing technique consists of breaths that activate the parasympathetic nervous system. To do so, individuals breathe at a rate of approximately 6 breaths per minute (four second inhales and six second exhales) for fifteen minutes. The participants were told that activating this calming mechanism may help decrease their symptoms. The breathing technique was then described to them and the video demonstrated. After the participant was confident in the breathing technique, they were required to practice the breathing technique at home for fifteen minutes a day for 3 weeks. To reinforce proper use of the breathing technique, an online video was used as a guide during each home session.

The 15-minute breath training video includes two visual guides to help the participant breathe alongside it; a circle that grows and shrinks and the words inhale and exhale (respectively) to indicate how to breathe. The video also has sound cues to indicate when to inhale and when to exhale, so that participants can close their eyes while breathing. The rate of breathing was chosen to be six breaths per minute to activate the parasympathetic response (Schwartz, Gibb, & Tran, 1991). It can be found at the following link: https://vimeo.com/59535980 and can be viewed with the password “IBS”.

This video was added into to the daily survey on Qualtrics and a record was kept of the participant code, the date, and when the participant started/stopped the video.

Mindfulness Meditation Intervention

The participants who have been randomly assigned to the mindfulness meditation training group were given instructions on the practice of mindfulness during the initial session by the researcher and informed about some possible benefits for relief of IBS symptoms. A copy of the training script can be found in Appendix B. Once it was clear that the participant understood what mindfulness is, the meditation audio was introduced to them. They practiced one meditation session in the lab, and then were instructed to meditate daily.

This follow-up practice with the mindfulness technique was required at home for fifteen minutes a day for 3 weeks. Participants are instructed to complete 15 minute sessions a day, but are told that if they cannot do so, any meditation is better than none. They then recorded how long they actually practiced in the daily diary. During each of the follow-up home sessions, participants logged into an online site (housed at Qualtrics) and accessed a recording that guided and reinforced proper use of the meditation technique. Questions at the site also allowed participants to record how long they practiced alongside the video, and if there was practice outside of the online session. Mindfulness training outside of the session was recorded in minutes. Weekly email reminders were sent to the participants. The email was a simple reminder to complete their training that week. The meditation audio was provided through the UCLA Mindful Awareness Research Center's free guided-meditations: http://marc.ucla.edu/mpeg/02_Breath_Sound_Body_Meditation.mp3. This meditation

was chosen for the study because of its reputable academic designer and ease of availability to the participants

Participants were instructed to try to focus on the present moment and to not worry about the past or future. Mindfulness is about appreciation of the now and to non-judgmentally accept sensations/thoughts that occur.

Procedure

This research involves a 3-week intervention in which participants were assessed before and after the intervention with a 6-week follow-up. During the pre intervention session, participants were randomly assigned to one of the intervention groups (mindfulness meditation, breath training, or a control/diary group). The initial session was conducted in a research laboratory or online via email and the study website. Participants were introduced to the study and to the intervention condition. They also had their heart rate taken for 5 minutes and then completed the pre intervention surveys in the following order: Rome III (D. A. Drossman, 2006), PSS (Cohen et al., 1983), IBS-QOL (Patrick et al., 1998), HADS (Zigmond & Snaith, 1983), and FFMQ (Baer et al., 2006).

The intervention involved a three-week period during which the participants accessed the web site daily to practice with the assigned intervention (if appropriate) and to complete the daily diary entries to record their symptoms and /or stressors. On the weekends during the intervention period, the following measures were also taken online: the Rome III (D. A. Drossman, 2006), the PSS (Cohen et al., 1983), the IBS-QOL (Patrick et al., 1998), and the HADS (Zigmond & Snaith, 1983).

For the post intervention session, participants returned to either the laboratory, in the university sample, for heart rate monitoring and the post interventions survey, which

includes the following measures: Rome III (D. A. Drossman, 2006), PSS (Cohen et al., 1983), IBS-QOL (Patrick et al., 1998), HADS (Zigmond & Snaith, 1983), and FFMQ (Baer et al., 2006). The online sample completed their questionnaires at home. A follow-up testing at six weeks repeated the measures taken from the first post intervention session to assess whether any of the gains in IBS symptom reduction or quality of life were still present.

The control/diary group was exposed to the exact same conditions for the same amount of time. However, they did not experience the mindfulness or breath training. Therefore, they completed all the measures, they filled out the daily diary (minus the mindfulness and breathing reports), but they did not use the breathing video or were not introduced to mindfulness practices at all.

Websites to help guide all online participants can be found at the following links: http://www.psych.uncc.edu/pagoolka/IBSmind.html and http://www.psych.uncc.edu/pagoolka/IBSDiary.html. Websites to help guide the university participants are on Moodle2 project sites that can only be seen when participants are added to the project.

Design and Analysis

The study was a longitudinal design with three intervention groups. Each group received three weeks of training and participated in pre and post (3-week, and 6-week) intervention assessments. Participants were randomly assigned to one of the intervention groups. All three groups were asked to fill out a daily diary online to record stressors and symptoms experienced during a 24 h period. Those in the breath-training group were also instructed to breathe for 15 minutes a day at a rate that activated the parasympathetic

system. The last intervention was a mindfulness intervention where participants were taught the components of mindfulness and what to do while meditating. These participants meditated for 15 minutes a day and completed the daily diary.

For the analysis, the data from both samples are combined, except for the HRV data, which was only collected at the university. The data from the baseline measures were averaged across groups and compared with one-way analyses of variances (ANOVAs) to look for preexisting differences among the participants who were randomly assigned to each of the groups. To isolate the effects of the intervention across time within each of the groups, nonparametric tests are used because a small number of participants completed the 3 week intervention with the 6 week follow-up.

RESULTS

IBS Data

The results combined the data from both samples when available. All participants began the intervention with IBS present according to the Rome III measure. The Rome III was then used as a dichotomous variable to analyze whether IBS continued to be present across the intervention or went into remission. A related samples Cochran's Q test was chosen to look for significant changes in each group across the 3 and 6 week period of time because of the dichotomous dependent variable.

There was an overall decrease in IBS presence, increase in remission, from baseline through the sixth week follow-up for the diary group, p=.01, and the breathing group, p=.03. Only the meditation group did not see a significant change in IBS presence throughout the six weeks as a whole, p=.08. When analyzing the intervention portion of the study, baseline to week 3, there are only significant reductions in the diary group, p=.03. None of the groups saw a significant change from the end of the intervention to the sixth week follow-up. Group differences are shown in Table 3.

Using odds ratios, by the end of the intervention, at week 3, the odds of the breathing intervention successfully treating IBS were less than that of diary group, at .24 times the rate. Thus, the diary group had 4 times the likelihood of helping IBS than the breathing group at week 3. Zero meditators reported remission by week 3, so both breathing and diary groups performed 100% better than the meditation group. By the sixth week follow-up the breathing intervention appeared to be more successful in the long run with remission rates at 2.5 times that of the diary group, and the diary group performed 2 times better than the meditation group.

Table 3: IBS remission rates for the 3- and 6-week test according to the Rome III: The data in the table are the number (%) of participants who are no longer classified with IBS

	Overall		0 vs 3 wks		3 vs 6 wks	
	N (%)	*p*	N (%)	*p*	N (%)	*p*
Diary	6 (38)	.01*	5 (31)	.03*	6 (38)	.71
Breathing	5 (50)	.03*	1 (10)	.32	5 (50)	.10
Meditation	3 (25)	.08	0 (0)	1.00	3 (25)	.08

Note. N = number of participants in remission at the end of the time period. %= the percentage of participants in remission at the end of the time period. * = significance at the .05 level. *P* values are from the Related Samples Cochran's Q test. Total number of participants who went in remission across the study was 14 out of 38.

Physiological Data

Table 4 shows the medians and interquartile ranges (IQR) for the groups' RMSSD, parasympathetic activity (HF), and sympathovagal balance (LF:HF) at baseline, week 3, and week 6. The data are organized by group. An independent samples Kruskal-Wallis test was used to compare groups' baseline physiological rates, which resulted in no significant differences between groups at baseline for RMSSD (p=.13), HF (p=.33), or LF:HF (p=.95).

A Related Samples Kendall's Test was used to compare scores on the physiological measures across time, organized by group. It resulted in no statistical differences across the intervention in RMSSD, HF, or LF:HF in any of the groups. Power may have been too low to analyze the data reliably. Specifically, p-values for the diary

group ranged from .53 - .66, for the breathing group ranged from .10-.53, and for the meditation group from .71 -1.00.

An Independent Samples Kruskal-Wallis Test did not find that the groups significantly differed on any measure at any time other than at the sixth week follow-up. Figure 1 shows that LF:HF at the follow-up resulted in significantly worse results for the meditation group, $p = .05$.

Table 4: List of medians and interquartile ranges of physiological HRV measures between groups at baseline, week 3, and week 6

	Baseline		*Week 3*		*Week 6*	
	Mdn	*IQR*	*Mdn*	*IQR*	*Mdn*	*IQR*
RMSSD						
Diary	46.00	17.35	50.20	21.20	45.60	59.85
Breathing	35.80	33.57	41.95	24.43	33.00	74.13
Meditation	38.40	24.05	48.60	31.30	39.20	20.20
HF						
Diary	791.50	1142.00	743.00	951.00	707.00	1954.50
Breathing	479.50	967.50	895.50	400.50	435.00	3341.50
Meditation	662.00	485.25	1895.00	2300.00	1439.00	1340.00
LF:HF						
Diary	1.24	1.23	1.27	2.65	.79	.76
Breathing	1.07	1.91	.54	3.65	.87	1.55
Meditation	1.00	1.44	.89	2.08	1.74	1.75

Note. $N = 38$. Higher RMSSD is healthier; higher HF is better; and lower LF:HF is better.

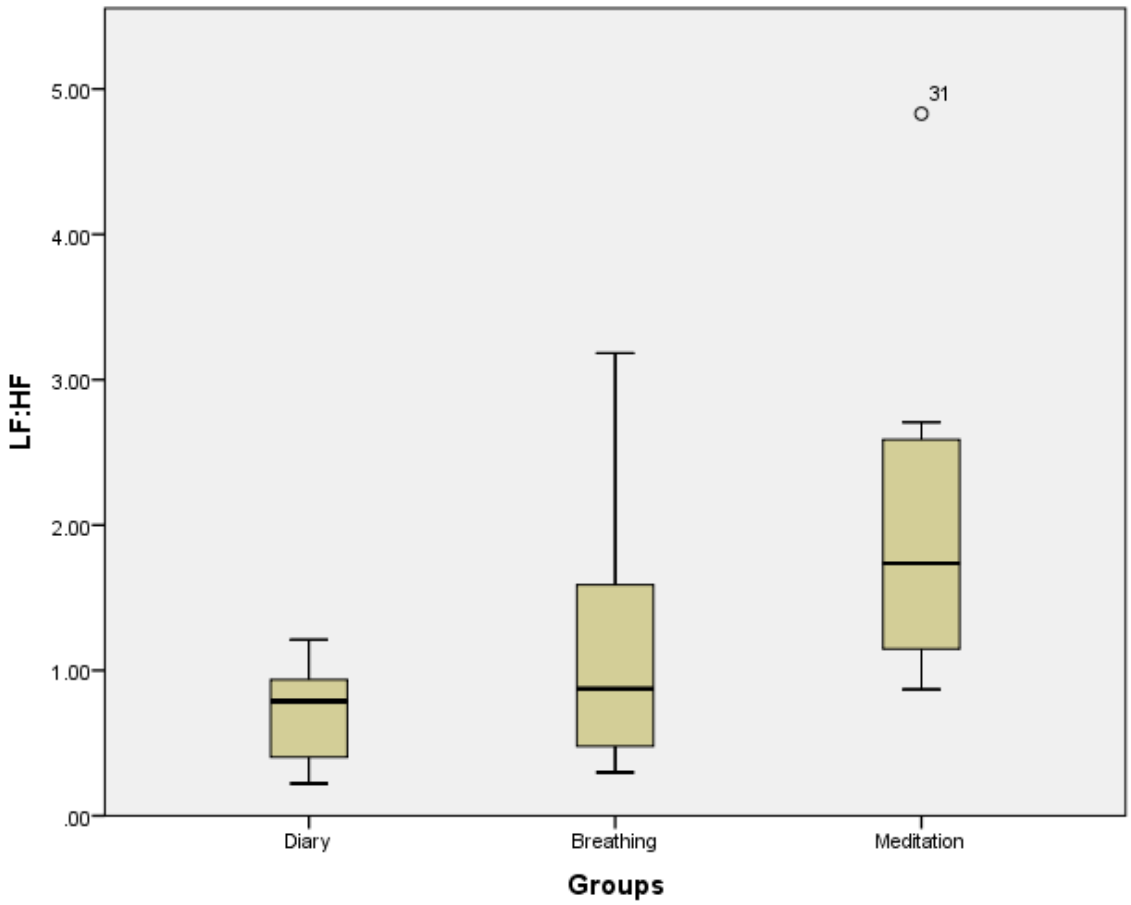

Figure 1. The sympathovagal balance group differences at the sixth week follow-up.

Questionnaire Data

Table 5 shows the medians and interquartile ranges for the questionnaire data between the groups. Using an independent samples Kruskal-Wallis test, all baseline measures were found to be statistically the same across the groups (IBSQOL p=.54, HADS p=.63), other than the stress scale (PSS p=.04). The diary group began the study with significantly lower stress scores than the other two groups.

To assess the changes across time on the stress scale (PSS), a related samples Kendall's coefficient was employed. Across the entirety of the study, baseline to week six, there was only one significant change in stress scores. The breath training group's

stress scores decreased significantly (p=.03) throughout the study. The same trend was found in the intervention portion of the study. The breathing group's stress scores significantly decreased (p=.03) from baseline to the end of the intervention at week 3. None of the other groups reported a significant decrease in stress scores from the intervention section of the study. After the intervention was completed, from week 3 to week 6, there were no significant changes in stress in any of the groups. Changes focusing on the breathing group's significant stress score changes can be seen in Figure 2.

The participants' self-perceived quality of life as related to IBS was assessed next. The lower the quality of life score, the higher they perceive their quality of life to be, and the less IBS is affecting their quality of life. Across the entirety of the study, there is a significant change in IBSQOL in the breathing (p<.01) and meditation groups (p=.02). From baseline to week 3 there was only a significant change in IBSQOL for the diary group (p=.03), and no significant changes were seen from week 3 to 6. All changes within IBSQOL were for the better.

Specifically, the subscales of the IBSQOL indicated that from baseline to the sixth week follow-up, the breathing group saw significant improvement in the subscales of interference with activity (p=.02), social reactions (p=.01), and sexual quality of life (p=.01). The subscales of the IBSQOL also indicated that from baseline to the sixth week follow-up, the meditation group saw significant betterment in the subscales of dysphoria (p<.01), interference with activity (p=.02), and sexual quality of life (p=.05). To see the medians and interquartile ranges please refer to Table 6.

No significant changes were found across the intervention for HADS, the anxiety and depression scale. Across the study there were also no significant changes in mindfulness scores on the FFMQ within the meditation group, which suggests that the study might not have been long enough for the meditation participants. Median scores with interquartile ranges from baseline to week 6 follow respectively: 86 (25), 98 (27), & 102 (38). Significance values were as follows: p=.10 from baseline to the end of the sixth week follow-up, p=.10 from baseline to week 3, and p=1.00 from week 3 to week six.

Lastly, the online vs. the university samples are compared on the three outcomes that showed significant results above: IBS remission, stress levels, and quality of life. Table 7 includes the medians and interquartile ranges when separated by location of the study. An independent samples Kruskall-Wallis test found no significant differences between the university and online samples on quality of life across the study. There were significant differences between the two samples when comparing stress levels. At both week 3 and 6 the online sample was perceiving significantly more stress in their lives than the university sample (p<.01 for both times). It also appears that a higher percentage of online participants went into remission at both week 3 and 6 than the university sample.

Table 5: Medians and interquartile ranges for all groups separated by time

	Baseline		*Week 3*		*Week 6*	
	Mdn	*IQR*	*Mdn*	*IQR*	*Mdn*	*IQR*
PSS						
Diary	35.50	23.50	31.00	22.00	29.00	27.50
Breathing	45.00	6.50	30.00	7.75	34.50	14.25
Meditation	47.00	9.25	46.50	7.00	44.50	9.00
IBSQOL						
Diary	78.00	22.25	65.00	26.00	67.00	31.00
Breathing	77.00	23.00	74.50	18.25	70.50	40.25
Meditation	86.00	29.00	74.50	48.75	75.50	40.75
HADS						
Diary	23.00	8.00	28.00	10.50	28.00	13.00
Breathing	20.00	12.50	21.50	14.50	14.50	8.25
Meditation	21.00	9.00	29.00	16.50	28.50	16.25

Note. $N = 28$. PSS is a stress score; QOL is the IBS Quality of Life scale; and HADS is a depression and anxiety scale. IQR = interquartile range. Lower scores are better on all scales.

Table 6: List of medians and interquartile ranges of significant changes in the IBSQOL subscales for baseline and week 6 of the breathing and meditation groups

	Baseline		*Week 6*	
	Mdn	*IQR*	*Mdn*	*IQR*
Dysphoria				
Meditation	19.00	6.00	16.00	10.50
Interference with Activities				
Breathing	17.00	4.50	14.00	6.50
Meditation	15.00	5.50	13.00	7.00
Social Reactions				
Breathing	10.00	6.50	6.00	7.50
Sexual Quality of Life				
Breathing	4.00	3.50	2.00	3.50
Meditation	4.00	5.50	2.00	3.00

Note. $N = 28$. Lower scores represent better quality of life. The subscales are not standardized to compare scores to the other subscales.

Table 7: Comparison of median differences on measures when separated by location

	Baseline		*Week 3*		*Week 6*	
	Mdn[a]	*IQR*[b]	*Mdn*	*IQR*	*Mdn*	*IQR*
Rome III						
University	0%	(0)	11%	(3)	37%	(10)
Online	0%	(0)	30%	(3)	40%	(4)
PSS						
University	40.00	23.00	30.00	21.00	32.00	19.00
Online	45.00	6.00	45.50	6.00	47.00	4.00
IBSQOL						
University	77.00	17.00	64.00	30.00	71.00	31.00
Online	81.00	17.00	70.00	50.00	74.00	33.00

Note. The university sample consisted of 28 participants in all three groups. The online sample consisted of 10 participants in diary and meditation only. Rome III indicates whether or not participants have gone into remission with the percentage showing those in remission. PSS is a stress score; QOL is the IBS Quality of Life scale. IQR = interquartile range. Lower scores are better on the PSS and IBSQOL. Higher percentages are better on the Rome III.

[a] For the Rome III *Mdn* represents percentage

[b] For the Rome III *IQR* represents the number of participants

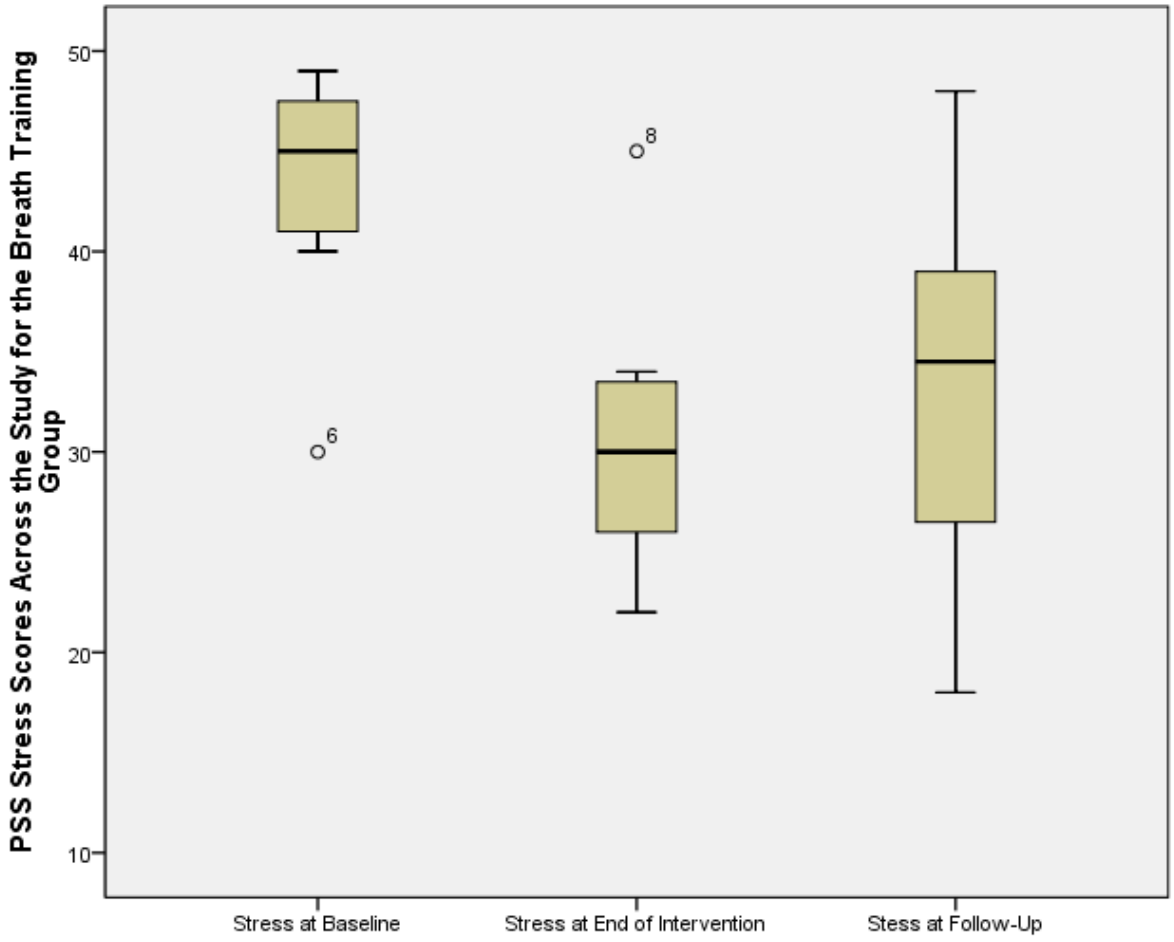

Figure 2. Significant changes in the breath-training group for stress scores across the study. There was a significant decrease in stress from baseline to week 3 and it persisted to the sixth week follow-up.

Qualitative Data

At the end of the study, the participants were asked to rate how effective the study was at helping to reduce their IBS symptoms using a Likert scale from 1, very effective, to 6, very ineffective. An independent samples Kruskal-Wallis test indicated that there were significant group differences in participants' opinions about how well the study worked in reducing their IBS (p=.02). The diary group reported a median score of 4 – somewhat ineffective; the breathing group reported a median score of 3 – somewhat effective, and the meditation group reported a median score of 3.5 – somewhat effective

to somewhat ineffective. Results indicate that the breathing group reported the most study effectiveness for their IBS symptoms.

The same question was asked about how successful the study was at reducing stress in the participants' lives. Using an independent samples Kruskal-Wallis test, there were no significant differences between the groups when assessing if the study helped to reduce participants' stress. The diary group reported a median score of 2 – effective; the breathing group reported a median score of 2.5 – effective to somewhat effective, and the meditation group reported a median score of 2 – effective. It appears by the effectiveness ratings that the participants found the study reduced their stress more than their symptoms. Medians and interquartile ranges can be seen in Table 8.

Table 8: Participants' ratings of effectiveness of the intervention, separated by groups

	Diary Group		Breathing Group		Meditation Group	
	Mdn	*IQR*	*Mdn*	*IQR*	*Mdn*	*IQR*
IBS Symptoms	4.00	.50	3.00	1.50	3.50	1.00
Stress Reduction	2.00	2.00	2.50	1.00	2.00	1.00

Qualitative, open ended, reports were also gathered from the participants at the end of the study. It is apparent after a content analysis that most participants, in all groups, reported an increase in awareness (*N*=16). This awareness was related to both their IBS symptoms and how they react to the world. Another repeated comment was about how the study calmed, relaxed, or decreased stress in the participants' lives (*N*=16).

Separately, and of note, many individuals from the breath training group reported that the breathing, specifically, helped to decrease stress and symptoms (*N*=8). In both diary and meditation group participants, many individuals found that when they stopped their intervention, their symptoms quickly returned (*N*=6). Some individuals commented on the fact that the study was enjoyable (*N*=4), didn't help symptom (*N*=4), was best when done alongside the video or audio (*N*=3), and that they really noticed a decrease mainly in pain (*N*=3). Lastly, of importance, a couple of participants mentioned that they believe the interventions would be more beneficial if they were longer than 3 weeks and that they noticed that the changes were taking place longer into the study. A few qualitative responses that expressed their thoughts fully from each group are included in Appendix H.

DISCUSSION

Of the three intervention groups that were investigated, the results indicated that the diary group and the breath training group performed as expected, with significant reductions in IBS symptomology. However, no changes in the autonomic nervous system or psychological questionnaires were found for the diary group. Within the study timeline, breath training significantly reduced symptoms as well as increased quality of life and decreased stress. Contrary to expectations the current study did not find that mindfulness meditation was the best three-week intervention for IBS sufferers. Instead, it appears that mindfulness showed some beneficial changes on psychological measures only. Lastly, significant changes in the heart rate variables were not found with any of the intervention groups.

Diary

As hypothesized, the diary group's expected care effect, which is believed to be the cause of placebo (Kaptchuk et al., 2008), was supported in this study with immediate decreases in IBS symptoms. Whereas, the breath training results took longer than three weeks to show, and the trends suggest that meditation effects would take longer than six weeks. Vase and his colleagues (2005) suggest that a calming mechanism could explain why placebos work so well for IBS samples in relieving their IBS symptoms. However, participants in the diary group did not report an increase in relaxation as measured by the perceived stress scale, where the other two groups did. This demonstrates that relaxation alone is not why the placebo effect is working for this population.

It is interesting to note that the care effect was supported in the diary group, but when interventions (breathing or meditation) were added to the diary, a decline in IBS

symptoms took longer time, 3 weeks for the breathe intervention and 6 weeks for mindfulness meditation. The reason behind why the diary group saw fast results is unknown, but it supports the notion of the broad definition of placebos instead of the narrow definition (Conboy et al., 2006) since the diary group is seeing IBS reduction at a rate not even found in the intervention groups. It is possible that it might result from a simple interaction between the participant and the study that works better without adding the stress of learning a new intervention.

The contextual factors believed to be the cause of this effect are clearly still working when the participant is completing the study online (Bishop et al., 2012). A very promising result was that the online sample's IBS remission rates were above those found at the university. However, stress rates did not decline by participating online. Stress might have declined more at the university due to increased interaction with the researchers. This is important when considering technologically evolving medical care. Telemedicine, or medical consultation/management through a mobile device, has become more popular with each year (Mosa, Yoo, & Sheets, 2012). A recent literature review found that mobile interventions are already being used for diabetes, cardiac patients, pulmonary rehabilitation, asthma, hearing, sleep, and accident prevention (Mosa et al., 2012). The findings from this research show that the pattern of data from the online sample was the same as the group tested in a university lab environment. This study supports that a similar technique would be useful for IBS patients.

Breathing

Training an individual to breathe at a rate that activates the parasympathetic system shows that perceived stress levels decrease and quality of life increases within this

sample. IBS participants found that their symptoms went into remission by the end of the six weeks, and they were able to live a more normal lifestyle. IBS quality of life subscale results suggest that the biggest impact of breath training on quality of life is that IBS is not affecting their daily activities as much. The comments made by the participants at the end of the study support this finding. Specifically, it was found that individuals are scoring better on the subscales related to how embarrassing IBS is in a social environment and in sexual situations.

Qualitative reports have found that taking control of daily life is one of two factors that are important to self-care and coping within the IBS population (Jakobsson Ung, Ringstrom, Sjövall, & Simrén, 2013). They found that some ways of succeeding in control over daily activities are through self-discipline, routines, and social support (Jakobsson Ung et al., 2013). The breathing intervention IBS quality of life results suggest that these individuals will be better able to comfortably find and rely on social support as well as take control over daily activities than before participating in the study. The literature (McCormick et al., 2012). also suggests that feeling lack of control over daily activities and the need for social support are two repeated troubles that appear to cause the most harm to IBS patients' well-being and symptom management. This could mean both the breathing and mindfulness interventions are tapping into an important area in the life of an IBS suffer (McCormick et al., 2012).

However, the causal mechanism expected for the breathing group's effects was the change in heart rate variability. In this study, no change in heart rate variability was found. Though this was surprising, there are a few reasons this might have occurred. First, there were a limited number of participants who made it through the entire study.

Secondly, there may be an immediate effect for breathing and HRV change, but not a longitudinal effect. Studies on breathing have found that there is a change directly after breathing interventions for as much as twenty minutes following the breath training (Joseph et al., 2005; Mourya et al., 2009; Raupach et al., 2008). However, there appear to be no longitudinal studies of breathing on HRV. This study found that if there is a long lasting effect of breath training on HRV, that it would need more than three and possibly more than six weeks to show. Nevertheless, symptoms are going into remission by six weeks and psychological variables are reported to be positive.

Mindfulness Meditation

In regard to mindfulness meditation, participants' effectiveness reports (reported in Appendix H) suggest that it is helping. However, participants mention in these reports that it takes a while to see the changes. They implied that they might need to practice mindfulness longer to see stronger effects. Considering, the Five Facet Mindfulness Questionnaire scores did not significantly increase across the six weeks, but rose steadily, it is believed that a more traditional mindfulness meditation practice, such as Mindfulness Based Stress Reduction's eight-week length, might be necessary. Other studies (Gotink et al., 2015) have found that the program does successfully improve many types of health outcomes by eight weeks. There is no support in this study to say that eight weeks is the magic number, but three to six weeks was too short to see changes in symptoms as well as changes in HRV. It has been found in the literature that mindfulness meditation can help with experimentally induced pain within a few days of training (Zeidan, Gordon, Merchant, & Goolkasian, 2010). However, this study suggests that though there is possibly an immediate effect on the body, it must dissipate quickly within their day until

the individual has practiced longer than six weeks of meditation. IBS is a chronic condition and, although mindfulness meditation has been shown to provide some benefit to acute pain conditions, such as experimentally induced pain; its effect on chronic pain conditions has not received much research attention.

Another finding that is important to note is that the breathing component of meditation should not be dismissed when creating or participating in meditations. Results suggest that simple focused breathing at six breaths per minute is a fast acting mechanism on the body as compared to meditation, particularly in the IBS population, where their symptoms are reducing up to three weeks faster than mindfulness meditators' symptoms. Feldman, Greeson, and Senville (2010) found that mindful breathing produces more decentering, a believed mechanism underlying mindfulness's success, than progressive muscle relaxation and loving kindness meditation. The meditation used in this study may not have emphasized breathing as much as it could have. It did include all three of the types of meditation mentioned above. The trends suggest that the meditation group was the only group that showed an increase, though not significant, in parasympathetic activity across time. Perhaps, with the addition of focused breathing, better results could be possible.

Though results indicated no significant improvement in symptoms or in HRV, mindfulness meditation did significantly improve participants' quality of life as related to IBS. Meditators are finding that across the intervention they experience less interference in daily activities, higher sexual quality of life, and less dysphoria, a similar negative mood state to depression. The meditators were the only group to report less dysphoria across the study.

Heart Rate Variability

Though there were too few participants in this study to reliably find significant results, when focusing on the trends seen in the physiological data, interesting patterns appear. With HRV, it seems that in all groups, HRV slightly increases during the intervention portion of the study and drops back down as soon as the intervention is no longer required. This trend might mean that HRV is a physiological measure that quickly reacts to changes in the environment and may not show long lasting effects. Few studies have looked at trying to train HRV to become healthier over time. One study focused on training HRV with music therapy and showed similar findings to this study, inconclusive (Chuang, Han, Li, Song, & Young, 2011). Still, most of the literature investigating HRV only focuses on exercise's effects over time (Wichi, De Angelis, Jones, & Irigoyen, 2009).

On the other hand, parasympathetic activity does differ by group, at a non-significant level. Only the breathing and meditation groups saw patterns where parasympathetic activity increased, but the breathing group's parasympathetic activity drops back to baseline levels by week six. Meditation levels stay higher than baseline levels at week six. These trends suggest a further look into these relationships with more participants and a longer intervention.

Lastly, the sympathovagal balance shows the breathing group's scores improving the fastest, the diary group's scores improving by the end of the study, and the meditation group's scores becoming worse. These results were not significant, however, more research is needed before drawing any conclusions about the interventions effect on sympathovagal balance.

Limitations

One design technique that may have limited the benefits to the intervention training was the fact that all interventions asked participants to list their stressors. The new field of positive psychology emphasizes the fact that, focusing on negative thoughts could be detrimental to well-being (Stein & Grant, 2014). Listing stressors might have been a form of rumination, which actually predicts heightened responses to stressful life events, not the effect desired in this study (Ruscio et al., 2015). The diary was used as a way of recording stress throughout the intervention, in hopes that negative stress would go down and positive events go up. However, it could have had an inadvertent negative effect on participants' evaluations of their day. This might explain why we did not see any psychological benefits for the diary group. The increased focus on negative events could also have attenuated the results in the other groups as well.

Other limitations were also the small sample with a short intervention of three weeks. Although there were some promising trends in the data with the heart rate data for example, better results might have been obtained if the intervention were longer and the sample size were larger. The greatest obstacle was the fact that there were many participants who did not complete the study (N=28).

Overall, of the two samples that were collected, a higher percentage of participants began the study after requesting more information at the in-person location (the university). In contrast, a vast majority of the online requests to be a part of the study never followed-up (73%). Nevertheless, dropout rates after the beginning of the study were nearly equal in both the online and university samples. This should be kept in mind

when designing future online vs. in-person studies. In spite of a data collection effort that took two years, the resulting number of participants was very small.

Conclusions

These findings are of note considering they add much to the current literature, including a dissection of the parts of mindfulness and how it works, showing that breath training is the strongest component when interested in both physiological and psychological symptoms, a look into online vs. in person participation rates, support for the care effect as opposed to placebo, and a new inquiry about best ways for diaries to be constructed. This study's main interest was the breakdown of mindfulness into three groups based on the biopsychosocial model: just being a part of the study, adding on breath training, and adding on mindfulness training. Of these groups, it is clear that the biological group of breath training performed the best in this short intervention. Because of this, the results indicate that within mindfulness meditation, individuals should not leave out the breathing component of meditation if they are looking for physiological benefits such as pain or symptom reduction.

The timeframe of the interventions was telling as well. It appears that with most outcomes, after the three weeks of required intervention, baseline levels return. This means that continual practice is needed to see long-term results. Also, the different interventions resulted in differently timed benefits. The diary group, which represented placebo or social care, reported healthier symptoms by week three with no significant psychological changes. The breathing group, which represented biological changes, found that it took about six weeks to see symptom reduction, but stress was reduced quickly. Lastly, the meditation, or psychological intervention, took the longest to improve

on all measures, determining that it is important to include biologically supported stress reductions to see quicker changes in an IBS population. Considering mindfulness meditation is one of the most popular complementary treatments (van Tilburg et al., 2008), if one is interested in integrating it into one's life, it should be expected that it will take time to see results. These findings suggest that patience and diligence in one's practice will be needed to see long lasting effects.

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APPENDIX A: DAILY DIARY

 Participant ID Code:

 Date:

 This daily diary is intended to capture aspects of the study that are not captured in the other measures. You'll be recording positive stressors (anything throughout your day that caused you to feel excited, a sense of thrill, or a challenge you feel confident in being able to overcome). For example, you could record good test grades, an exciting sporting event, a new relationship, or a marriage. You will also be recording negative stressors. For example, you can write about having to study for an exam, a break-up, a car accident, or too much homework. Lastly, you should record in minutes any breathing practice time you participated in outside of the 15 minute time-stamped online session.

 Emotional Intensity Scale

1) Barely above average intensity, slightly felt emotion

2) Noticeably above average intensity, emotion is clear

3) Strong intensity, strong emotion

4) Extreme intensity, emotion notably affected your day

 Record your positive stressors from today (list as many as you would like and rate the intensity from 1-4):

 Record your negative stressors from today (list as many as you would like and rate the intensity from 1-4):

 Approximately how many minutes, if at all, did you practice on Moodle today?

 When did you practice alongside the Moodle audio?

Morning - Between 4am and 12pm

Afternoon - Between 12pm and 5pm

Evening - Between 5pm and 9pm

Night - Between 9pm and 4am

 Approximately how many minutes, if at all, did you practice offline?

 When did you practice offline/on your own?

Morning - Between 4am and 12pm

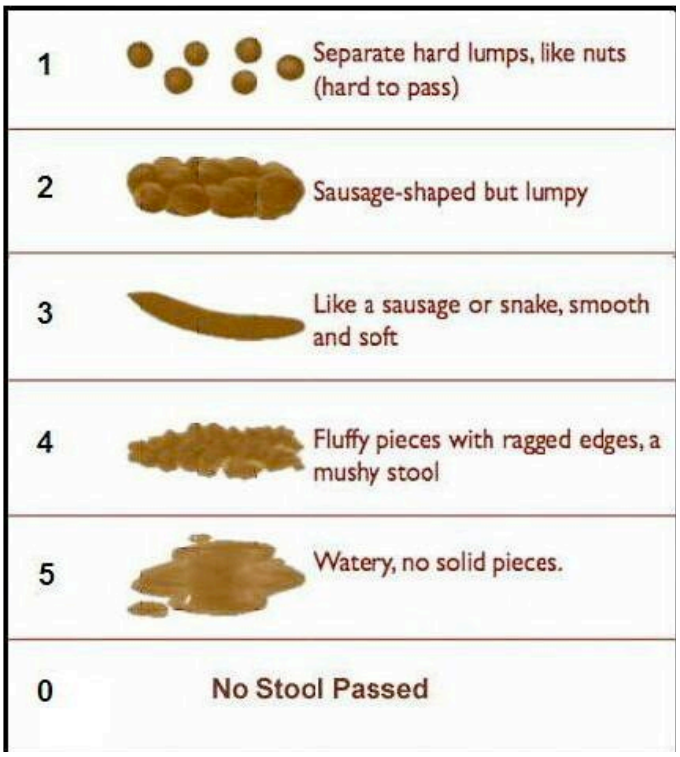
Afternoon - Between 12pm and 5pm

Evening - Between 5pm and 9pm

Night - Between 9pm and 4am

 Choose the number above that matches the average of your stool today.

If you did not pass stool this day, choose "0" at the bottom.



 How severe was your abdominal pain over the past 24 hours? Please indicate a number from 0 to 10, with 0 meaning you had no pain during that period, and 10 meaning it was “very severe".

 How severe was your abdominal bloating over the past 24 hours? Please indicate a number from 0 to 10, with 0 meaning you had no bloating during that period, and 10 meaning it was “very severe”.

 How dissatisfied are you with your bowel habits as they were in past 24 hours? Please indicate a number from 0 to 10, with 0 meaning “very happy” and 10 meaning “very unhappy”.

 Please indicate how much abdominal pain or discomfort or altered bowel habits affected or interfered with your life in general in the past 24 hours. Please indicate a number from 0 to 10, with 0 meaning “not at all” and 10 meaning “completely”.

APPENDIX B: MINDFULNESS INSTRUCTIONS

"In this study, you will be taught the practice of mindfulness. Mindfulness is a state of being where you will bring your attention to the present moment. In the present moment, you will be aware of all of your surroundings, yourself in relation to your surroundings, and your internal states: such as emotions. When you bring your attention to the present moment, mindfulness allows you to non-judgmentally acknowledge all that you perceive. Non-judgmental awareness is acceptance of the situation rather than reacting to the situation.

Research has shown this to be effective in producing positive qualities, such as awareness throughout one's day, insight, wisdom, compassion, and self-control. Many positive research outcomes have also been found. Here, we will be using mindfulness to both teach psychological aspects of the skill as well as train the body's parasympathetic system (the relaxation portion of the autonomic nervous system) to activate more regularly.

This is important for your IBS because it has been found that the parasympathetic system has decreased in individuals with IBS, which seems to cause visceral (internal) sensitivity and reactiveness. During this study, we hope to bring your body's reaction back to a healthy state."

APPENDIX C: ROME III

Rome III

Please type your study ID code:

Date:

In the last 3 months, how often did you have discomfort or pain anywhere in your abdomen?

- ❍ Never (1)
- ❍ Less than one day a month (2)
- ❍ One day a month (3)
- ❍ Two to three days a month (4)
- ❍ One day a week (5)
- ❍ More than one day a week (6)
- ❍ Every day (7)

If Never Is Selected, Then Skip To End of Survey

For women: Did this discomfort or pain occur only during your menstrual bleeding and not at other times?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Does not apply because I have had the change in life (menopause) or I am a male (3)

Have you had this discomfort or pain 6 months or longer?

- ❍ Yes (1)
- ❍ No (2)

How often did this discomfort or pain get better or stop after you had a bowel movement?

- ❍ Never or rarely (1)
- ❍ Sometimes (2)
- ❍ Often (3)
- ❍ Most of the time (4)
- ❍ Always (5)

When this discomfort or pain started, did you have more frequent bowel movements?
- ❍ No pain or discomfort (1)
- ❍ Never or rarely (2)
- ❍ Sometimes (3)
- ❍ Often (4)
- ❍ Most of the time (5)
- ❍ Always (6)

When this discomfort or pain started, did you have less frequent bowel movements?
- ❍ No pain or discomfort (1)
- ❍ Never or rarely (2)
- ❍ Sometimes (3)
- ❍ Often (4)
- ❍ Most of the time (5)
- ❍ Always (6)

When this discomfort or pain started, were your stools (bowel movements) looser?
- ❍ No pain or discomfort (1)
- ❍ Never or rarely (2)
- ❍ Sometimes (3)
- ❍ Often (4)
- ❍ Most of the time (5)
- ❍ Always (6)

When this discomfort or pain started, how often did you have harder stools?
- ❍ No pain or discomfort (1)
- ❍ Never or rarely (2)
- ❍ Sometimes (3)
- ❍ Often (4)
- ❍ Most of the time (5)
- ❍ Always (6)

In the last 3 months, how often did you have hard or lumpy stools?
- ❍ Never or rarely (1)
- ❍ About 25% of the time (2)
- ❍ About 50% of the time (3)
- ❍ About 75% of the time (4)
- ❍ Always, 100% of the time (5)

In the last 3 months, how often did you have loose, mushy or watery stools?

- ❍ Never or rarely (1)
- ❍ About 25% of the time (2)
- ❍ About 50% of the time (3)
- ❍ About 75% of the time (4)
- ❍ Always, 100% of the time (5)

APPENDIX D: PERCEIVED STRESS SCALE

PSS

Please type your study ID code:

Date:

The questions in this scale ask you about your feelings and thoughts during the last week. In each case, you will be asked to indicate how often you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

In the last week, how often have you been upset because of something that happened unexpectedly?

- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you felt that you were unable to control the important things in your life?

- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you felt nervous and "stressed"?

- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you dealt successfully with irritating life hassles?
- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you felt that you were effectively coping with important changes that were occurring in your life?
- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you felt confident about your ability to handle your personal problems?
- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you felt that things were going your way?
- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you found that you could not cope with all the things that you had to do?
- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you been able to control irritations in your life?
- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you felt that you were on top of things?
- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you been angered because of things that happened that were outside of your control?
- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you found yourself thinking about things that you have to accomplish?
- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you been able to control the way you spend your time?
- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

In the last week, how often have you felt difficulties were piling up so high that you could not overcome them?

- ❍ Never (1)
- ❍ Almost never (2)
- ❍ Sometimes (3)
- ❍ Fairly often (4)
- ❍ Very often (5)

APPENDIX E: IBS QUALITY OF LIFE

IBSQOL

Please type your study ID code:

Date:

Please answer the following questions about your experiences over the last week.

I feel helpless because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I am embarrassed by the smell caused by my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I am bothered by how much time I spend on the toilet
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I feel vulnerable to other illnesses because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I feel fat because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I feel like I'm losing control of my life because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I feel my life is less enjoyable because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I feel uncomfortable when I talk about my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I feel depressed about my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I feel isolated from others because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I have to watch the amount of food I eat because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

Because of my bowel problems, sexual activity is difficult for me.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I feel angry that I have bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I feel like I irritate others because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I worry that my bowel problems will get worse.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I feel irritable because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I worry that people think I exaggerate my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I feel I get less done because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I have to avoid stressful situations because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

My bowel problems reduce my sexual desire.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

My bowel problems limit what I can wear.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I have to avoid strenuous activity because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I have to watch the kind of food I eat because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

Because of my bowel problems I have difficulty being around people I do not know well.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I feel sluggish because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I feel unclean because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

Long trips are difficult for me because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

I feel frustrated that I cannot eat when I want because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

It is important to be near a toilet because of my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

My life revolves around my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I worry about losing control of my bowels.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I fear I won't be able to have a bowel movement.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

My bowel problems are affecting my closest relationships.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ A great deal (5)

I feel that no one understands my bowel problems.
- ❍ Not at all (1)
- ❍ Slightly (2)
- ❍ Moderately (3)
- ❍ Quite a bit (4)
- ❍ Extremely (5)

APPENDIX F: HOSPITAL ANXIETY AND DEPRESSION SCALE

HADS

Please type your study ID code:

Date:

Please answer these questions to best indicate how you have felt in the past week.

I wake early and then sleep badly for the rest of the night.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I get very frightened or have panic feelings for apparently no reason at all.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I feel miserable and sad.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I feel anxious when I go out of the house on my own.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I have lost interest in things.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I get palpitations, or sensations of 'butterflies' in my stomach or chest.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I have a good appetite.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I feel scared or frightened.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I feel life is not worth living.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I still enjoy the things I used to.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I am restless and can't keep still.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I am more irritable than normal.
- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

I feel as if I have slowed down.

- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

Worrying thoughts constantly go through my mind.

- ❍ Yes, definitely (1)
- ❍ Yes, sometimes (2)
- ❍ No, not much (3)
- ❍ No, not at all (4)

APPENDIX G: FIVE FACETS OF MINDFULNESS QUESTIONNAIRE

FFMQ

Please type your participant ID code:

Today's date:

I perceive my feelings and emotions without having to react to them.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

When I'm walking, I deliberately notice the sensations of my body moving.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I find it difficult to stay focused on what's happening in the present.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I'm good at finding the words to describe my feelings.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I criticize myself for having irrational or inappropriate emotions.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I watch my feelings without getting lost in them.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

When I'm walking, I deliberately notice the sensations of my body moving.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

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

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I can easily put my beliefs, opinions, and expectations into words.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I tell myself that I shouldn't't be feeling the way I'm feeling.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

In difficult situations, I can pause without immediately reacting.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

When I take a shower or a bath, I stay alert to the sensations of water on my body.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I rush through activities without being really attentive to them.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

It's hard for me to find the words to describe what I'm thinking.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I believe some of my thoughts are abnormal or bad and I shouldn't't think that way.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

Usually when I have distressing thoughts or images, I am able just to notice them without reacting.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I do jobs or tasks automatically, without being aware of what I'm doing.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I have trouble thinking of the right words to express how I feel about things.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I make judgments about whether my thoughts are good or bad.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

Usually when I have distressing thoughts or images, I feel calm soon after.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I pay attention to sensations, such as the wind in my hair or sun on my face.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I find myself doing things without paying attention.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

When I have a sensation in my body, it's hard for me to describe it because I can't find the right words.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I tell myself I shouldn't't be thinking the way I'm thinking.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

Usually when I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

When I do things, my mind wanders off and I'm easily distracted.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

Even when I'm feeling terribly upset, I can find a way to put it into words.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I think some of my emotions are bad or inappropriate and I shouldn't feel them.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

Usually when I have distressing thoughts or images, I just notice them and let them go.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I notice the smells and aromas of things.
- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.

- 1) never or very rarely true (1)
- 2) rarely true (2)
- 3) neutral (3)
- 4) often true (4)
- 5) very often or always true (5)

My natural tendency is to put my experiences into words.

- 1) never or very rarely true (1)
- 2) rarely true (2)
- 3) neutral (3)
- 4) often true (4)
- 5) very often or always true (5)

I disapprove of myself when I have irrational ideas.

- 1) never or very rarely true (1)
- 2) rarely true (2)
- 3) neutral (3)
- 4) often true (4)
- 5) very often or always true (5)

I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.

- 1) never or very rarely true (1)
- 2) rarely true (2)
- 3) neutral (3)
- 4) often true (4)
- 5) very often or always true (5)

I am easily distracted.

- 1) never or very rarely true (1)
- 2) rarely true (2)
- 3) neutral (3)
- 4) often true (4)
- 5) very often or always true (5)

I can usually describe how I feel at the moment in considerable detail.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

Usually when I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

I pay attention to how my emotions affect my thoughts and behavior.

- ❍ 1) never or very rarely true (1)
- ❍ 2) rarely true (2)
- ❍ 3) neutral (3)
- ❍ 4) often true (4)
- ❍ 5) very often or always true (5)

APPENDIX H: QUALITATIVE RESPONSES OF EFFECTIVENESS

Qualitative reactions to the study at the sixth week follow-up

Group	Comment
Diary	"I found that the final three weeks that I did not keep a diary of emotional stressers, my IBS symptoms got worse. I will be going back to keeping a journal."
	"I think what really helped with this study was being able to write down my positive and negative stressors. Seeing what irritated my bowels the most was pretty interesting. I am not sure if it helped my bowel itself but it helped me know what situations bother my body the most."
	"Overall, I think the daily stressor journal link did help with my IBS and especially seemed to help lower my stress levels (except for those nights when I realized I forgot to do it, lol). There were still certain food triggers that affected my IBS despite the intervention, such as FODMAPs, but I think dietary changes along with some sort of awareness helps IBS and stress management tremendously. I would like to expand on the daily stressor journal and try meditation, yoga, etc. in the future."
Breathing	"I notice the first few days of the change in bowel; i felt more relaxed when using the bathroom. Much more easy, and i did not feel stress about how long it took to us the bathroom. It seem to

come more quick then it done in the past. I also notice that I was not so anxious to rush the time i need to empty my bile. This breath technic help me to see that relaxation is the key to having a smooth stool process. I have not excising on a regular, so with breathing exercise it help me to relief stress and I notice too in doing that it made more relax. Mind was more clear and I could think things through."

"The breathing helped to lessen my symptoms a great deal. I noticed that if my body was not agreeing with something that I ate that the breathing would help to ease my symptoms. It also aided me with stress and I would catch myself going through the breathing exercises throughout the day. I tend to have road rage while driving and as long as I remembered to breathe I was able to regulate my anger better. / Overall I agree that the breathing techniques are a good way to help ease the pain of having IBS. I still experience symptoms but they have decreased and I have been able to find a way to help manage them."

"During the first 6 weeks I have definitely seem a difference in my IBS because of the breathing. I released a lot of stress during that and constantly do it. This past week just has been the worst because of my break up with my boyfriend and a finding out a close family remember doesn't have much time, but I have still been doing the breathing and it has helped me out a lot. With all

	the horrible things going on I am very glad I decided to do this study because I learned to cope with the stress that sometimes I can not control. Thanks you were great!"
Meditation	"It is obvious that since I last answered these questions that my health is right back where I started because I stopped practicing meditation. Meditation has a great affect on reducing the symptoms of IrriTable Bowel Syndrome."
	"The first three weeks of this study was a very different expirence for me. It opened my mind to the usefuless of meditation, both as a tranquilizer and a mental pacemaker. Because the first half of the session required twelve minutes of meditation a day, there was more an incentive to dedicate the time. Through this routine adjustment, I learned that settting side this few minutes was less difficult than I believed to be. / One of the things that I observed during this time was the costant continuance of life that was going on around me. This including a variety of things, from such things as the ticking of a clock to the noise of traffic. Becoming aware of these happenings, I began to develop an eye for the things of life that are outside of my control. At the same time, I was learning to both pace my thoughts and to appreciate the continuity of time. / The meditations were also somewhat effective in reducing my day-to-day anixety levels. It became increasingly less difficult to talk with people without feeling like I needed to be hesitant when the

subject matter turned personal. This is also where I began to expirence a change in the intensity of certain bowel syndromes. One of the first difference that I noticed between passings prior to the study and those during was the improved timing. The passings began to occur once a day at similar times (within a thirty minute timeframe), and the stools were similar in shape and consistency. As long as I had practiced meditating for at least two days in a row, this pattern was never broken. / The following three weeks, we were not asked to follow a strict regiment, and thus the temptation to fall back into a routine without as much scheduling became relevant. While I did not remain as consistent in daily meditations or diary entries, this time period helped me to realize that the effects of consistent meditation were not fathomed. Passing patterns became steadily inconsistent during this time. / Unintentionally, I also grew to be mindful of my eating patterns during this time. Because my stools were consistent during the previous three weeks, it was not hard to aslo notice that I was eating on actual schedule during that time as well. The following three weeks, however, I felt less disciplined to follow either of those routines, and there was a noticable change in passing times and stool composition. / Lastly, I began to expirence a recall effect that was triggered by a chiming noise similar to the one made at the end of every mindfulness meditation. Although the twelve

minute meditations had undoubtedly the more significant effect on my personal attitudes and mental pacing, the rare occurance that I would hear a chiming noise outside of the twelve minutes would also remind me to embrace the moment."

"I really liked the mediation and I feel if it wasn't a requirement of this study I probably wouldn't have done it. It was a great way to have some time to not worry about school or work or whatever else might have been stressing me out. Everyday almost I had a negative stressor but with the mediation it let me wind down and realize nothing is that big of a deal. My stomach always has bothered me and will continue for a long time. With the relaxation though I could feel my stress level go down and be able to have a more positive outlook. Once my stress level go down i felt my stomach hurt less and i was able to handle my stress in a more appropriate way. my bowel movements didn't change a whole lot but my stomach pain was subsided."

"I feel as though it is going to take longer than 3 weeks for me to have more than a 'somewhat effective' experience with the mindfulness meditation. I will absolutely continue to practice the meditation as I have noticed slight improvements in my ability to lessen the anxiety felt in certain circumstances. I had a great experience on 12/4/2014 when I went into the dentist for the extraction of all four wisdom teeth. I went in for 11am with my

husband and I utilized some of the techniques learned during the meditation audio. I focused on my breathing and sensations of my body (such as me applying pressure to my thumb with my pointer finger). I was able to proceed with the dentist appointment with only using the restroom once while passing time in the waiting room beforehand (and it wasn't even loose stool!). My husband commended me for me bravery and my ability to control my bowel movements before the high intensity negative stressor. It takes a great deal of concentration to focus my way out of an anxious moment / IBS attack, but I am hoping to become more skilled with practice and time. / I would be more than happy to work with your study and answer any questions that your group may have. While it can be embarrassing, I am hoping that the more people talk about their issues with IBS the closer we will get to answers."

Note. Grammar and spelling errors have been left in the participants' comments.