

Virtual Reality as a Treatment for Irritable Bowel Syndrome

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This article provides support for utilizing a virtual reality treatment intervention for irritable bowel syndrome (IBS). Initially, this investigation reviews current IBS treatments and virtual reality applications, followed by a discussion section that describes how virtual reality may have the ability to deliver a more comprehensive treatment option than current treatments alone. This is attributed to virtual reality's potential to incorporate a diversity of treatment elements found to produce positive outcomes for IBS sufferers, in particular, the analgesic effects of virtual reality as applied to abdominal pain. Abdominal pain in IBS sufferers is given special attention in this article, both because of the virtual reality-pain connection and because it is a pervasive symptom of IBS sufferers. This article concludes that virtual reality has the ability to treat abdominal pain in IBS sufferers while remaining versatile enough to incorporate, or work in conjunction with, other established treatment options.

Keywords: irritable bowel syndrome, virtual reality therapy, virtual reality hypnosis, abdominal pain, functional disorders

As many as one in five people in the United States suffer from irritable bowel syndrome (IBS) with little professional consensus on a clear treatment or cure (National Institutes of Health, 2007). Even with the alarming prevalence of IBS, there is relatively little public awareness and understanding about the condition (Verne, 2004). According to the Rome III diagnostic criteria, irritable bowel syndrome (IBS) is a functional disorder that causes abdominal pain associated with the altered bowel habits of bloating, diarrhea, constipation, or a combination of these symptoms (Rome Foundation, 2006). In addition, there is a high comorbidity between IBS and many psychological conditions – in particular, depression and anxiety (Whitehead, Palsson, & Jones, 2002). The combined indirect and direct costs of IBS are estimated to be 20 billion dollars annually in the U.S., however, less than 1% of National Institutes of Health (NIH) research funding is allocated to the condition (Drossman & Norton, 2006). This seemingly blatant disregard for IBS research funding may

be a result of the social stigma related to the disorder. In a study by Jones et al. (2009), it was found that 57% of those diagnosed with IBS believed they were being treated differently because of their condition. These undermining factors have created gaps within IBS research literature, which in turn hinders the discovery of improved treatment options for IBS sufferers.

Apart from the lack of research funding and social stigma of the disorder, there are several explanations as to why current IBS treatments lead to negative or unsatisfactory outcomes. One major theme seems to be that the variability between IBS sufferers—in terms of their primary symptoms, comorbid conditions, and even personality characteristics—prevents many treatments from providing sufficient solutions to a general IBS population. Furthermore, the development of treatments has been somewhat arbitrary, given the absence of a known etiology for IBS. This often leads to unsatisfactory outcomes despite a range of dietary, pharmacological, and non-pharmacological treatment approaches (Boyce, Talley, Balaam, Koloski, & Truman, 2003). This investigation responds to these treatment inadequacies by proposing a new intervention method that may be able to address more contributing factors to IBS symptoms than currently available treatments. Particular attention will be given to the treatment of abdominal pain, because it is common to all subtypes of IBS sufferers according to the Rome III Criteria for diagnosis (Rome Foundation, 2006). Due

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to this commonality, focusing on abdominal pain yields the strongest possibility of helping the most individuals. Finding successful treatments for IBS may assist in revealing the underlying etiology of the condition.

The intent of this article is to inspire further research into IBS treatments by demonstrating that current treatments are inadequate solutions for a significant number of IBS sufferers, especially for those who are not able to find relief from consistent abdominal pain. The findings of this article propose a theory that virtual reality can be used as an effective treatment for IBS sufferers, because virtual reality may relieve symptoms more effectively and comprehensively than current treatment approaches. This theory is derived from both the IBS treatment literature and from reviewing the efficacy of virtual reality applications in other conditions that share common symptoms with IBS.

Abdominal Pain: The Key Variable?

Although the etiology of IBS is still unknown, the associated abdominal pain may be partially explained by a combination of underlying factors. A recent study performed on colon biopsies found that IBS patients had a significantly higher electrical reactivity in their mucosal neurons than those of normal samples (Buhner et al., 2009). This may explain why IBS sufferers receive higher intensity pain signals from the gut. Additionally, Liebrechts et al., (2007) have shown a relationship between the immune system and IBS gut sensitivity to pain. They suggest that this relationship may be a result of IBS sufferers having elevated secretions of cytokines, which act as proinflammatory agents in the digestive system.

Research shows that individuals with IBS may have a hypersensitivity to pain, known as hyperalgesia. In a landmark study investigating the hyperalgesia phenomenon in IBS sufferers, Ritchie (1973) used barostat-balloons inflated inside the colons of both IBS and healthy subjects to determine if a discrepancy existed in self-reported pain levels between these groups. The results of the study showed that the IBS participants reported significantly elevated levels of pain when compared to the control group at the same balloon inflation volumes. This phenomenon was further evidenced by a study conducted by Yuan et al. (2003) that followed a similar barostat-balloon inflation procedure, while adding fMRI technology to simultaneously examine brain

activity. During the inflation procedure, there were significant differences in the activations of the insular cortex, prefrontal cortex, and thalamus of IBS sufferers when compared to controls. According to Yuan et al. (2003), these regions of the brain are thought to be important in visceral pain processing in the central nervous system. Given this finding, the Yuan et al. study provides preliminary empirical evidence of hyperalgesia in IBS sufferers.

The research of Yuan et al. (2003) provides evidence for variances in brain physiology but also may support theories of psychological differences in IBS sufferers. The psychological components of abdominal pain are demonstrated by studies showing that trials involving placebo pain treatments can impact the perception of pain in IBS patients (Vase, Robinson, Verne, & Price, 2005). Findings supporting a physiological or psychological basis for IBS pain may initially appear to contradict one another, but it is probable that the mechanism for IBS-related abdominal pain merely reflects the complexity of the IBS condition. The implications from these studies may be that the physiological and psychological mechanisms of pain can be thought of as co-contributors to the overall phenomenon of abdominal pain in IBS sufferers. Melzack and Wall's (1965) gate control theory may help conceptualize the multidimensional nature of IBS-derived pain. According to this theory, the "gate" acts within the dorsal horn of the spinal cord and regulates which pain signals will be allowed to pass on to the interpretive centers of the brain. In this way, pain is comprised of two mechanisms: the amount of signals allowed to enter the brain (physiological), and the way these signals are interpreted and perceived by the individual (psychological). Therefore, it is not surprising that evidence for IBS-derived pain is found at the physiological and psychological levels simultaneously.

Although gate control theory helps to demonstrate one way physiological and psychological components of pain may interact, another way to understand the impact of these components as they relate to IBS is an indirect investigation into the outcomes of various treatment methodologies. By examining various treatment interventions, a broader understanding of how abdominal pain responds to psychological and physiological interventions may be achieved. Furthermore, examining a range of current treatment approaches may help

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to uncover which treatment elements are producing the best overall outcomes for IBS sufferers.

Current IBS Treatments

Current treatments for abdominal pain in IBS sufferers include pharmacological and non-pharmacological approaches. Regarding IBS medications and patient specific IBS treatment plans, Chang (2008) notes that many physicians consider the symptoms mostly benign and not worth the risks that accompany drug interventions. Although IBS is not considered life threatening, the condition has been found to have a dramatic impact on quality of life, aside from the direct symptoms (Mangel & Fehnel, 2008). Even though many treating physicians and psychologists hold the belief that IBS is a relatively minor condition, there is still a vast assortment of pharmacological and non-pharmacological treatment options available to IBS sufferers (Chang, 2008; Chang & Drossman, 2009). This article will focus on a few treatment options that have shown particular promise in the field. A review of all available treatments is beyond the scope of this article. The treatments reviewed herein are intended to provide a distinctly diverse sampling of treatment methodologies. Medications that work on the central nervous system-acting mediations, cognitive-behavioral therapy (CBT), and hypnotherapy will be discussed in the later sections.

Pharmacological Treatment Approaches

Apart from over-the-counter remedies, there are a number of drugs currently prescribed for IBS. Chang and Drossman (2009) group these drugs into an effective categorized model: altered motility and secretion, sensation altering, and central nervous system (CNS) drugs. Motility and sensation altering medications, such as laxatives and antispasmodics, work to temporarily relieve symptoms of IBS at the site of discomfort (e.g. muscle relaxing agents for cramping), whereas CNS drugs act upon the processing and interpretive centers of the body (Chang & Drossman, 2009). Of these options, CNS drugs may prove to be the most comprehensive and effective long-term treatment for IBS sufferers, because they act upon structures critical for both the physiological and psychological bases of pain and behavior. Specific examples of these structures include the insular cortex, prefrontal cortex, and thalamus, as well as the interactions between the personality, emotion, and perception centers of the brain.

The following will focus on the use of CNS drugs, as they are more systemic treatments than other symptom-specific prescriptions, and therefore may better address the multidimensional nature of IBS derived pain.

The drugs prescribed for IBS that affect the CNS include a large group of antidepressants and anti-anxiety medications. Of these, selective serotonin reuptake inhibitors (SSRIs) are the preferred psychotropic medications prescribed by clinicians because of their comparatively lower side effect profile to the tricyclic antidepressant class (Talley, 2004). The effectiveness of these drugs for IBS is not well understood, due in part to the fact that a large quantity of the data is non-empirical (Talley, 2003). However, in a comprehensive meta-analysis review of antidepressants and their efficacy as a general IBS treatment, Ford, Talley, Schoenfeld, Quigley, and Moayyedi (2009) found that SSRIs, tricyclic medications, and psychotherapy treatments were comparable in their effectiveness. These findings can be easily misinterpreted to mean that there is little difference between the types of treatments and the forms of CNS affecting antidepressants offered to treat IBS. However, it is more likely that each of the treatment interventions has its own benefits and drawbacks, leading to a similar net outcome. For example, a comprehensive review by Lynch (2001) determined that SSRIs were far less effective at relieving pain than those of the tricyclic group, but that tricyclics tended to have more negative side effects. Furthermore, Talley (2003) suggested that SSRIs and other psychotropic medications can produce overall positive outcomes for IBS sufferers; however, they may have a less significant impact on the physiological symptoms of IBS and a greater impact on commonly occurring comorbid psychological conditions. This concept is supported by Tabas et al. (2004) who showed that IBS sufferers taking the SSRI Paroxetine reported an improved overall well-being when compared to controls, even when the ratings of abdominal pain by the IBS subjects did not improve significantly. These findings suggest that SSRIs and tricyclics are able to treat specific elements of IBS by different means but, by themselves, are not acting as comprehensive treatments (i.e. tricyclics may be addressing more pain symptoms, while SSRIs might be acting more on the comorbid psychological conditions).

Aside from SSRI and tricyclic classes of medication, the use of 5-HT₃ antagonist drugs, a relatively new form of pharmacotherapy, has shown potential in IBS

treatments. Even though many 5-HT₃ antagonist drugs are still in the trial phases for use with IBS, studies thus far have indicated that 5-HT₃ antagonist medications can provide significant pain relief for a majority of IBS sufferers (Cremonini, Delgado-Aros, & Camilleri, 2003). However, Chang (2008) implies that these new drugs can have severe side effects, making the risk-to-benefit ratio unsatisfactory in all but extreme cases of IBS. Even though the drugs may not yet be a safe solution for IBS sufferers, the analgesic nature of the drug deserves further investigation. Due to the limited number of empirical studies on 5-HT₃ antagonists drugs for IBS treatments, the research done on their effectiveness in treating fibromyalgia, another chronic pain inducing condition, may provide clues into their potential effectiveness with IBS. Stratz and Müller (2000) speculated that 5-HT₃ antagonist drugs work in fibromyalgia by inducing the release of the neurotransmitter substance P, a pain and inflammatory modulator in the body. Incidentally, substance P was discovered when researchers noticed an agent that was inhibiting the tone and rhythm of contractions in rabbit intestines (Euler & Gaddum, 1931). The unique properties of substance P may allow 5-HT₃ antagonist drugs to be effective not only in pain relief, but also in IBS sufferers with irregular gut contractions, such as hypermotility and/or cramping.

The findings of Stratz et al. (2000) and Euler and Gaddum (1931) draw attention to another important implication about the 5-HT₃ antagonist drugs and CNS-acting drugs, namely that the CNS is not the only system in the body being affected by them. The nervous system of the gastrointestinal (GI) track, known as the enteric nervous system (ENS), may react to the changes in neurotransmitters caused by medications, regardless of whether or not the drugs used were designed to act on the CNS or ENS. This is an important consideration for IBS patients, because the ENS and CNS combined are known as the brain-gut axis, and normal GI function is characterized by their interaction and coordination (Lackner, 2005). It is difficult to decipher to what degree each of these systems causes or relates to IBS symptoms. In fact, it is unclear if the symptom-producing mechanisms of IBS are fully contained within the brain-gut axis. As previously discussed, Liebrechts et al. (2007) argue that the immune system, which is not confined to the brain-gut axis, plays an important role in IBS symptoms. Furthermore, it is unclear if psy-

chotropic medications for IBS are effective or harmful, because while they can target multiple systems of the body, they can also act indiscriminately on possible non-etiological body systems. Ultimately, the potential benefits of these drugs may come at too high a cost, with a high incidence of severe side effects amongst participants of controlled clinical studies (Chang, 2008; Talley, 2004). It is important to consider that the pharmacological treatments mentioned were not designed to cure IBS. While they can provide symptomatic relief, it is often only temporary and dependent upon continued use.

Psychotherapeutic Interventions Focusing on CBT

One of the preferred forms of psychotherapy for IBS is CBT. CBT is goal-oriented, typically involves fewer than 20 sessions, and is by far the most empirically researched and supported form of psychotherapy for IBS sufferers (Blanchard, 2005; Hunt, Moshier, & Milonova, 2009). In addition, the structured format of CBT may help lower the variability between treatment studies, allowing for easier cross-analysis of the treatment. Corney, Stanton, Newell, Clare, and Fairclough (1991) were some of the first researchers to demonstrate in a clinical trial that cognitive behavioral-based psychotherapy can be as effective as specialty (gastroenterology) medical care in treating overall IBS symptoms, even when the medical treatments included prescription medication. In a similar study utilizing psychodynamic therapy and medical care, Creed et al. (2003) argued that psychotherapies tend to have better outcomes than pharmacological interventions over time, because they can produce long-lasting benefits (greater remission of symptoms) with less treatment maintenance (e.g. the patients don't need to take pills every day to reduce or prevent their symptoms). Furthermore, psychotherapies may provide a safer alternative to traditional medication treatments, which have been shown to have a high side effect rate (Chang, 2008).

CBT can treat many symptoms of IBS but may be particularly effective at treating the comorbid psychological conditions, specifically depression and anxiety, which have been found to affect between 54% and 94% of IBS sufferers (Whitehead et al. 2002). One hypothesis as to why treating the comorbid conditions can simultaneously treat the underlying condition is that interventions focusing on the psychological factors may

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be able to break a cycle known as the positive feedback-loop. This concept is based on a theory that psychological conditions intensify symptoms, which then further intensify the psychological conditions – creating a cyclical pattern difficult for an individual to break. For example, an IBS sufferer may experience anxiety about their abdominal pain, increasing their pain perceptions, which then increases their anxiety as a result (Lydiard & Falsetti, 1999). This may indicate that CBT treatments can indirectly influence pain perceptions via the treatment of comorbid psychological conditions. If the feedback-loop can be interrupted by CBT, a person would at least be able to return to their baseline level of functioning, which could result in significant reductions in symptom severity. In a large study on CBT's effectiveness for treating functional bowel disorders including IBS, Drossman et al. (2003) demonstrated that CBT treatment was significantly more effective than educational treatment at improving quality of life and lowering anxiety for IBS sufferers. However, a study by Boyce, Talley, Koloski, Balaam, and Nandurkar (2001), contended that CBT is beneficial to IBS sufferers' well-being, but perhaps no more so than relaxation therapy or even routine medical care. Similarly, Blanchard et al. (2007) found that CBT treatments delivered in a group format were no more effective at treating IBS than educational support groups, particularly relating to bowel regularity and overall well-being amongst IBS sufferers. More research on IBS treatment groups are needed to determine the impact the group setting has on treatment outcomes for IBS sufferers.

There are many possibilities as to why CBT-based studies demonstrate mixed results. Reme, Kennedy, Jones, Darnley, and Chandler (2010), after analyzing the results of a clinical trial comparing the effectiveness between an antispasmodic medication trial group and an antispasmodic medication combined with CBT group, argued that baseline (pre-trial) coping skills, anxiety levels, and depression levels can predict the outcomes of a treatment, perhaps more so than the form of therapy or medication. For example, they argued that those with a high level of psychological distress would perform poorly in a medication-only group, but that those same individuals would benefit from a treatment involving psychotherapy. Furthermore, those with low psychological distress might perform with comparable or better results in a variety of treatments,

such as an antispasmodics regime or routine medical care. This explanation suggests that the differences in screening factors between studies are accounting for the variability between the findings. The resulting implications may be that individuals should be better matched to specific treatments to yield the best results. Alternatively, the findings of Reme et al. (2010) may suggest that more comprehensive and generalizable treatments, which are less dependent upon preconditions for successful outcomes, should be utilized or developed.

After researching the effectiveness of psychodynamic therapy for IBS sufferers, Hyphantis, Guthrie, Tomenson, and Creed (2009) suggested that in order to find a treatment that could be appropriate for a larger population of IBS sufferers, the "mechanism of action" that made specific treatments more or less effective in different populations would have to be studied (p. 202). Because many psychotherapy treatments have been found to have a comparable effectiveness for treating psychologically distressed IBS sufferers (see Reme et al., 2010; Hyphantis et al., 2009), it is plausible that these treatments are working by fundamentally similar methods. In order to provide a diversity of treatment approaches that may be working by unique mechanisms, the following section will investigate hypnotherapy. Not only is hypnotherapy a novel approach to treating IBS, but it is also the only other non-pharmacological treatment in popular use that has been researched to a degree comparable to that of CBT for IBS (Whitehead, 2006).

Hypnotherapy

Whorwell, Prior, and Faragher (1984) were some of the first researchers to test the clinical effectiveness of hypnotherapy on IBS subjects. They conducted a comparative study between the outcomes of hypnotherapy and a standardized supportive psychotherapy. Hypnotherapy was found to be significantly more effective than psychotherapy at treating IBS in terms of abdominal pain relief after five weeks of treatment. Furthermore, participants reported improved overall well-being when measured weekly and at the end of the three-month long trial. The effectiveness of hypnotherapy is further demonstrated by the research of Wilson, Maddison, Roberts, Greenfield, and Singh (2006), who conducted a meta-analysis of 20 studies that investigated hypnotherapy treatments for IBS sufferers. They

concluded that hypnotherapy is associated with positive patient outcomes in the vast majority of hypnotherapy treatments, specifically regarding long-lasting symptom remission and improved patient-reported overall well-being. Although many of the studies investigated by Wilson et al. (2006) did not indicate hypnotherapy's ability to act on one specific symptom, such as abdominal pain, a case study by Walters and Oakley (2006) showed that hypnotherapy reduced pain intensity in their IBS patient by 54% and pain frequency by 77%. Both Worwell et al. and Walters and Oakley may have been able to produce specific symptom improvements in their participants, especially regarding the abdominal pain symptom, through the use of a visualization technique. Walters and Oakley (2006) describe their technique as "gut-focused imagery" (p. 141). An example of gut-focused imagery is having clients imagine their GI track as a flowing river, then having their clients focus on changing their motility and pain intensity by adjusting the flow of water in their "rivers" to become more like calm streams (Zimmerman, 2003).

The effectiveness of imagery-based techniques is compelling and may indicate that hypnotherapy improves outcomes in IBS sufferers by addressing a uniquely different etiological mechanism than psychotherapies. Whorwell et al. (1984) may have inadvertently theorized this concept when attempting to explain the significant differences in treatment outcomes between the hypnotherapy and psychotherapy groups within their controlled IBS treatment study. Although the specific mechanism (or multiple mechanisms) that hypnotherapy is able to work upon is still unknown, there are several hypotheses being investigated. One intriguing hypothesis, based on a PET scan study by Rainville, Duncan, Price, Carrier, and Buschnell (1997), suggests that hypnosis can enhance the neuronal signal modulation within the midcingulate cortex, an area of the brain thought to be associated with pain perception and pain sensory networks throughout the body. This would indicate that hypnosis could alter brain functionality to reduce pain perceptions, rather than simply changing how people cope with their pain (Lioffi, Santarcangelo, & Jensen, 2009; Rainville, et al. 1997; Vanhaudenhuyse, Boly, Laureys, & Faymonville, 2009). Further research is needed to confirm this hypothesis; nevertheless, hypnotherapy's apparent ability to act as an analgesic for abdominal pain in IBS suffer-

ers is impressive.

Even though hypnotherapy appears to be a viable treatment option for IBS sufferers, especially for abdominal pain through the use of gut-focused imagery, Whitehead (2006) notes that there is a significant gap in research literature regarding controlled comparative studies between hypnotherapy and other treatments, especially psychotherapies such as CBT. It is difficult to determine the degree to which hypnotherapy provides an improvement upon other treatment methods, if at all. Furthermore, a critique of this treatment should note that the outcomes for this form of therapy depend upon the characteristics of the individuals, as is the case for standard psychotherapy. In hypnotherapy these characteristics or screening factors are most likely different from the predictors of psychotherapy success, such as levels of anxiety and coping skills (Reme et al. 2010). Carli, Huber, and Santarcangelo (2008) highlight suggestibility, hypnotizability, ability to relax, expectancy from the therapy, and clients' ability to change their perception of control over symptoms as crucial aspects to the overall outcome of a hypnotherapy treatment.

Because the success of IBS treatments may be dependent upon IBS patient-specific symptoms, traits, or preconditions, certain treatments may be innately better for some populations and not others. Assuming this concept is correct, the implications for IBS sufferers may be that they are in need of a standard assessment screening and treatment matching protocol, or that they require a more general treatment technique that can accommodate a greater diversity of IBS patients.

Current Virtual Reality Treatments

At first glance, computer technology, interactive environments, and virtual reality may appear quite unrelated to IBS and abdominal pain. However, virtual reality has greatly expanded its usefulness as a technology and continues to evolve, adapting its use from purely entertainment and military training purposes to potential psychotherapy, medical, and hypnotherapy treatments. The following will discuss the implementation of virtual reality for treating psychological disorders using virtual reality exposure (VRE), the use of virtual reality as an analgesic, and the delivery of hypnosis through virtual reality environments.

The Use of VRE Treatments

Virtual reality integrates computers, visual displays, and body sensors to immerse people into realis-

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tic-looking digital worlds. One use of this immersive technology is VRE therapy, a treatment designed as an alternative to live exposure therapy for anxiety-related disorders (Rothbaum et al. 1999). It has shown particular promise in the treatment of arachnophobia, aerophobia, and acrophobia, while also being a viable treatment option for posttraumatic stress disorder (PTSD; Rothbaum, 2009). After comparing the effectiveness of live exposures with spiders to VREs with spiders for patients with arachnophobia, Emmelkap et al. (2002) concluded that VREs are a comparable, if not a better, treatment method for exposure therapies. VREs may improve upon live exposures because they can produce scenes that are too difficult or too dangerous to recreate live (Rothbaum, 2009). Good examples of this concept are the use of VREs for treating PTSD patients by exposing them to war scenes (Reger & Gahm, 2008), as well as treating survivors of the World Trade Center attack by virtually placing them inside the buildings that no longer exist (Difede & Hoffman, 2002).

One theory that explains how VRE is capable of treating such a diversity of conditions is Foa and Kozak's (1986) emotion processing model for exposure to corrective information. In this model, exposures can modify memory structures that underlie emotions by inducing physiological responses to an emotion, and then allowing the individual to habituate to the stimuli. For example, an individual with acrophobia may be immersed in a virtual environment depicting the rooftop of a tall building. After a series of exposures, their fear of heights may diminish as they begin to habituate to the environment, no longer associating heights with a feeling of danger. Although this theory also holds for non-virtual exposure therapies, virtual reality is a unique form of exposure that may have advantages over other forms of therapy currently available for anxiety disorders (Rothbaum, 2009). Firstly, Rothbaum (2009) suggests that virtual reality treatments occur in controlled (programmed) environments, which has the benefit of standardizing treatments to remove extraneous variables that may be present in clinical trials or therapy, while allowing the therapist or physician to modify or select environments best suited to the individual's needs. These aspects of virtual reality therapies may make them particularly well-suited for treating complex conditions such as IBS, given that IBS sufferers have both common features, such as abdominal pain,

and unique characteristics, such as variable levels of comorbid psychological conditions. For example, virtual reality could deliver a standardized abdominal pain therapy program, while having an adjustable level of anxiety provoking stimuli to allow for individuals with comorbid anxiety disorders to habituate to fear-evoking events over time.

Virtual reality is also able to expose patients to environments too challenging to create in real life, a feature that may be important for treating IBS when attempting to create guided imagery environments (Rothbaum, 2009). This is not to say that virtual reality use is completely risk-free however, as McCauley and Sharkey (1992), use the term cybersickness to describe a short-term and generally mild motion sickness that can occur as a result of disorientation in virtual environments. Nevertheless, these studies have shown that virtual reality can be a powerful tool for treating anxiety disorders while being adaptable to the needs of the patient and having a minimal health risk. However, these applications alone do not fully illustrate virtual reality's potential as a treatment intervention.

Virtual Reality as an Analgesic

Aside from treating psychological conditions, virtual reality is also utilized for its ability to provide analgesic effects. Virtual reality treatments have been used for pain relief in a variety of fields, including dental procedures (Hoffman, Garcia-Palacios, et al., 2001), phantom limb syndrome (Murray et al., 2007), as well as treating burn victims (Hoffman et al., 2004). The effectiveness of virtual reality therapy (VRT) as an analgesic has been explained in a variety of ways. One of the most supported theories for VRT's analgesic nature may be found in a study by Gold, Kim, Kant, Joseph, & Rizzo (2006) on the use of VRT during intravenous needle placement in a pediatric care unit. The authors suggest that VRTs are effective at lowering self-reported patient pain by serving as a powerful form of distraction. Additionally, they contend that the distraction, provided by a fully surrounded head-mounted display (HMD), appears to work better at relieving pain than lesser distractions, such as those created from a cartoon on a television set. This phenomenon is further evidenced by studies showing that virtual reality outperforms video games in relieving pain in burn victims (Hoffman, Doctor, Patterson, Carrouger, & Furness,

2000; Hoffman, Patterson et al., 2001).

The amount of attention virtual reality draws from its users can be described by using the VRT terms presence and immersion, which are loosely defined and are often interchangeable. One interpretation is that presence is a more subjective perception the user has of actually being inside the virtual environment, whereas immersion is a more objective term used to describe the physical system the user is placed in, such as the screen resolution or the field of vision (Schuemie, Van Der Straanten, Krijn, & Van Der Mast, 2001; Slater & Wilbur, 1997). Both presence and immersion appear to be important components for the distraction-pain perception concept. Nevertheless, distraction alone may not fully explain the analgesic nature of all treatments with this technology.

Virtual Reality and Hypnosis

Hypnosis may be integrated into virtual reality treatments to theoretically amplify its effectiveness as a pain intervention. The addition of hypnosis to virtual reality may improve the analgesic effects of VRTs, because hypnosis has been shown to be more effective in reducing pain than simple distraction (Freeman, A. Barabasz, M. Barabasz, & Warner, 2000). This is particularly important for IBS sufferers with severe abdominal pain, who may find added relief from the amalgam of analgesic properties virtual reality hypnosis (VRH) can provide.

VRH is similar to regular hypnosis and uses some of the same procedures, which may include relaxation, altered breathing, suggestions for deepening the process, guided imagery, and other interventions (Patterson, Wiechman, Jensen, & Sharar, 2006). However, the main difference between VRH and regular hypnosis is that VRH replaces many of the stimuli that are left up to the clients' imaginations in regular hypnotherapy (e.g. imagery tasks) and automates the therapist's interpersonal communications and suggestions (Patterson et al., 2006). In theory, VRH may allow for hypnosis to occur in patients with low hypnotizability that might otherwise not benefit from regular hypnosis. Furthermore, the addition of an interactive, virtual environment along with a presence in that environment may improve suggestibility, a key component of hypnosis (Askay, Patterson, & Sharar, 2009; Patterson, et al., 2006).

Discussion

At present, there have not been any studies directly investigating or proposing the use of virtual reality as a treatment for IBS. This may be attributed to the relative novelty of VRTs combined with the ambiguous etiology of IBS. Nevertheless, there is a need for effective IBS treatments that can address both the psychological and physiological components of the conditions, especially relating to IBS pain. Therefore, the goal of this investigation was to isolate the key components leading to positive outcomes within current methods in the hopes of theoretically devising a more effective and generally acceptable treatment methodology for IBS sufferers. Through the research literature, several critical themes emerged for developing a successful and comprehensive IBS treatment. Firstly, it was argued that in order to provide a generalizable treatment for the IBS community, the treatment should include analgesic properties, in order to address the common symptom of abdominal pain in IBS sufferers. Secondly, the treatment should be able to provide both short-term benefits (e.g. specific symptom relief) and overall long-term benefits (e.g. improved quality of life, maintained IBS relief) for its treatment population with limited-to-no side effects. Thirdly, the approach should be flexible in its ability to treat individuals with variable pre-treatment characteristics or traits, such as the patient's level of psychological distress, ability to cope, suggestibility, etc. Although the specific mechanisms causing IBS cannot be concluded from this investigation, the two overarching themes from current treatments suggest that IBS contains both psychological and physiological components. Thus, the final criterion for a comprehensive IBS treatment is that the method simultaneously addresses both the psychological and physiological demands of the condition, specifically pertaining to IBS-derived pain.

The Application of Virtual Reality for IBS

Virtual reality has already proven its effectiveness as a treatment for psychological disorders, such as PTSD, a variety of phobias (e.g. Emmelkamp et al., 2002; Difede et al., 2002; Rothbaum et al., 1999), and physical pain conditions (e.g. therapies for severe burn victims, Patterson et al., 2006). These findings

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indicate that VRTs have the potential to treat both psychological and physiological conditions. This adaptability makes VRTs a good candidate for the treatment of IBS, because sufferers are known to have a vast array of comorbid psychological conditions (e.g. depression) as well as a high variability in the severity of their physiological symptoms (Whitehead et al., 2002; Rome Foundation, 2006).

Further rationalizations for using VRTs as an IBS treatment can be derived by directly comparing VRTs to current IBS treatments and their elements. For example, VRTs may be able to provide a safer alternative for treating abdominal pain than CNS medications, because unlike CNS drugs that can produce unforeseen and severe reactions in users (Chang, 2008; Talley, 2004), the side effects from VRTs appear to be rare, mild, and limited to short-term motion sickness-like reactions (McCauley, & Sharkey, 1992). There are also several advantages to using VRTs over psychotherapies such as CBT. Perhaps the most important advantage is that VRTs have the ability to provide immediate pain relief (e.g. Hoffman et al., 2000), whereas CBTs are not designed to give instant outcomes, as evidenced by the length of treatment needed for significant symptom improvements in CBT trials (see Blanchard et al., 2005). VRTs are not only rapidly acting analgesics; they can also be used to deliver other forms of therapy. Perhaps the best example of this is the use of hypnotherapy within VRT programs. Not only can VRTs be programmed to include already effective treatments, such as hypnotherapy, but they may also be able to improve upon these treatments. For example, VRTs can create vivid environments, which may help facilitate guided imagery techniques, such as the gut-focused imagery (e.g. the gut is a like a calm stream) described by Zimmerman (2003).

Although VRTs are relatively untested, the premise of integrating one form of effective symptom-reducing therapy into another to create improved outcomes is promising, especially considering the anxiety reducing properties of hypnosis combined with the analgesic properties of VRTs. Perhaps then, the most important factor that makes VRTs ideal for use with IBS is its inherent versatility and adaptability. This should be especially helpful for conditions such as IBS, which theoretically have multiple mechanisms interacting with one another and require multiple treatment interven-

tions. Furthermore, when virtual reality is combined or used in conjunction with hypnotherapy or psychotherapy, preconditions or characteristics leading to negative outcomes in any one treatment (e.g. low level of suggestibility) may be overcome. Therefore, VRTs can help physicians and therapists treat a larger population of IBS patients versus current treatments alone.

This investigation is only a preliminary step towards creating a new treatment for IBS sufferers and there are undoubtedly a host of obstacles to overcome before VRT for IBS can become a reality. Future studies should investigate the costs of both the equipment needed for providing VRT, and the cost and time needed to test and develop functional software specifically designed to meet IBS patients' needs. Furthermore, this investigation did not address either potential ethical concerns of using digital therapies, or the challenges typical clinicians might face in adapting their scope of practice to include VRTs for IBS patients.

Ultimately, VRTs address psychological conditions, physiological components of pain, and safety concerns while being flexible in their ability to work fluidly with other forms of treatment. In addition, they show great potential for being able to provide comprehensive treatments to a wider range of patients than current treatment methods. These combined factors demonstrate that using VRTs for IBS, at least as an adjunct therapy, would be a rational next step in the progression of treatments for this condition. Due to the novelty of applying virtual reality for IBS, more research is needed to examine the feasibility of producing this theoretical treatment approach.

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